GUIDANCE NOTES
GD 19-2022

INTERNATIONAL SHIP CLASSIFICATION

GUIDELINES FOR THE PREPARATION OF THE CARGO SECURING MANUAL

2022

Effective from 1 September 2022

CONTENTS

CHAPTER 1   GENERAL

1.1 Abbreviations and definitions

1.1.1 For the purposes of the Guidelines:

(1) IMO: International Maritime Organization;

(2) MSC: Maritime Safety Committee;

(3) DSC: Sub-committee on Dangerous Goods, Solid Cargoes and Containers;

(4) SOLAS: the International Convention for the Safety of Life at Sea;

(5) CSS: the Code of Safe Practice for Cargo Stowage and Securing;

(6) CSM: Cargo Securing Manual;

(7) CSAP: Cargo Safe Access Plan;

(8) IACS: International Association of Classification Societies.

1.1.2 For the purposes of the Guidelines:

(1) Cargo units refer to vehicles (road cars, ro-ro trailers, etc.), railroad car, container, board, tray, portable container, dismountable container components, packaging unit, whole-set cargo, other cargo transport units such as shipping box, break bulk cargo such as line roller, heavy cargo such as locomotive and transformer. Besides that, loading equipment or parts not permanently fixed onboard are also deemed as “cargo units”.

(2) Standardized cargo means cargo for which the ship is provided with an approved securing system based upon cargo units of specific types.

(3) 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.

(4) Non-standardized cargo means cargo which requires individual stowage and securing arrangements.

1.2 Explanation

1.2.1 The Guidelines is developed based on SOLAS 1974 and its amendments (Chapter VI, reg.5 and Chapter VII, reg.5) and MSC.1/Circ.1353/Rev.2.

1.2.2 The Guidelines is intended to provide the shipowner with general guidance and methods for the preparation of CSM.

1.2.3 The Guidelines is the basis for approving CSM by ISC.

1.2.4 The Guidelines is in compliance with the requirements of documents mentioned in 1.3. If otherwise specified by the flag Administration, the CSM is also to be in compliance with the requirements of the flag Administration.

1.3 Basis

1.3.1 Documents on which the development of the Guidelines is based are as follows:

(1) SOLAS 1974 and its amendments, Chapter VI “Carriage of cargoes” and Chapter VII “Carriage of dangerous goods”;

(2) International Convention on Load Lines, 1966 and its amendments;

(3) International Maritime Dangerous Goods Code;

(4) MSC.1/Circ.1353/Rev.2 “Revised Guidelines for the Preparation of the Cargo Securing Manual”;

(5) Resolution A.1048(27) “Code of Safe Practice for Ships Carrying Timber Deck Cargoes, 2011 (2011 TDC CODE)” and its amendment MSC.1/Circ.1624;

(6) Resolution A.714(17) “Code of Safe Practice for Cargo Stowage and Securing” and its amendments, including MSC/Circ.664 (Chapter 1, Chapter 2, revision to Annex 6 and new addition of Annex 13), MSC/Circ.691 (revision to Chapter 1 and Annex 5), MSC/Circ.740 (revision to Annex 12), MSC.1/Circ.1623 (revision to Annex 13), MSC.1/Circ.1352/Rev.1 (new addition of Annex 14 “Guidance on Providing Safe Working Conditions for Securing of Containers on Deck”);

(7) Resolution A.489(XII) “Safe Stowage and Securing of Cargo Units and Other Entities in Ships other than Cellular Container Ships”;

(8) Resolution A.533(13) “Elements to be taken into Account When Considering the Safe Stowage and Securing of Cargo Units and Vehicles in Ships” and its amendment MSC.1/Circ.1354;

(9) MSC.479(102) “Revised Guidelines for Securing Arrangements for the Transport of Road Vehicles on Ro-ro Ships”;

(10) Appendix 1 “Container Securing” of Chapter 7, PART TWO of ISC Rules for Classification of Sea-going Steel Ships.

(11) Appendix 1 “Container Securing” of Chapter 7, PART TWO of ISC Rules for Construction of Sea-going Ships Engaged on Domestic Voyages.

CHAPTER 2   SCOPE OF APPLICATION

2.1 General requirements

2.1.1 Within the application scope of SOLAS convention, all ships except those engaged solely in the carriage of bulk cargoes either liquid or solid are to be provided with the approved CSM.

2.1.2 Requirements of SOLAS Chapters 6 and 7 on cargo securing also apply to ships of less than 500 gross tonnage which are also to comply with requirements of 2.1.1 of this Chapter.

2.1.3 For ships not engaged on international voyages, the relevant requirements of the Guidelines may be taken as reference.

2.2 Types of ship

2.2.1 The following ships are to be provided with CSM:

(1) dry cargo ships;

(2) multipurpose ships;

(3) container ships;

(4) ro-ro ships;

(5) bulk carriers carrying cargo units;

(6) passenger ships carrying cargo units;

(7) offshore supply vessels;

(8) other specially designed ships, such as cable layer, pipe layer;

2.3 Cargo Safe Access Plan (CSAP)

2.3.1 Chapter 5 “Cargo Safe Access Plan (CSAP)” of CSM applies to dedicated container ships or other ships which are specifically designed and fitted for the purpose of carrying containers on the deck, the keels of ships are laid or ships are at a similar stage of construction on or after 1 January 2015.

CHAPTER 3 CONTENTS AND REQUIREMENTS OF CARGO SECURING MANUAL

3.1 General requirements

3.1.1 CSM is to be prepared in accordance with the documents listed in 1.3 of the Guidelines and experience gained from the practice of ship's stowage and securing.

3.1.2 The format and required contents of CSM are included in MSC.1/Circ.1353/Rev.2 "Revised Guidelines for the Preparation of the Cargo Securing Manual", however, not all of the chapters or contents apply to all the ships.

3.1.3 Full investigation is to be made prior to the preparation of CSM. Where necessary, reflections from the crew on the stowage and securing of cargoes are to be considered. And attention is to be paid to the following items which are also to be considered:

(1) Whether there are fixed cargo securing devices on board the ship. For example, the fixed securing points on the deck of ro-ro ship for securing vehicles, the fixed securing devices on the deck or cargo hatch cover of container ship for securing containers;

(2) Whether there are portable cargo securing devices on board the ship. For example, twistlock, tensioner, lashing chain, lashing wire and lashing rod etc.;

(3) Whether the cargo securing device is provided with the product certificate and identification marking indicating its Maximum Securing Load;

(4) Whether there is a formal system for the inspection, maintenance and replacement of cargo securing device on board the ship;

(5) Whether there is a guidebook for the correct operation of cargo securing devices and for the correct lashing of cargoes on board the ship;

(6) Whether the master is provided with a guidance note for the calculation of the loads on securing devices in order to ensure that the cargo securing device is fit for the intended purposes;

(7) Whether the bulk carrier is to stow cargo units, e.g. coiled sheet steel, timber etc.;

(8) Whether the master has knowledge of the correct methods for stowage and securing in order to avoid the excessive loads on containers at the bottom of the stack in non-cellular ships

(9) Whether the shipowner, cargo owner and master know the maximum permissible cargo load of the hatch cover, deck and bottom tank used for carrying cargoes;

(10) Where lashings are made on structural members such as side frames, bulkhead stiffeners and deck beams, whether the load-carrying capacity of these structural members are known.

3.1.4 The CSM prepared for a certain ship does not apply to another ship. For example, the format and contents of the CSM of a dry cargo ship are different from those of the CSM of a container ship due to different cargo and securing devices.

3.1.5 For ships carrying standardized or semi-standardized cargoes, all detailed information are to be provided whether or not the fixed securing points or standardized securing devices are previously approved.

3.2 Types of cargo

3.2.1 For relations between cargo types and applicable ship types and cargoes, see Table 3.2.1.

Table 3.2.1

Types of cargo	Cargo examples	Applicable ship types
Standardized cargo	Containers (with approved container securing devices)	Dedicated container ships, multipurpose ships (where applicable)
Semi-standardized cargo	Vehicles (road cars, ro-ro trailers), railroad car	Ro-ro ships
Non-standardized cargo	Containers (without dedicated securing devices), coiled sheet steel, heavy cargo items, timber (in cargo hold), etc.	Dry cargo ships, multipurpose ships, ro-ro ships, bulk carriers and passenger ships carrying cargo unit, offshore supply vessels, etc.

3.2.2 For relations between cargo types and applicable documents and information, see Table 3.2.2. In Table 3.2.2, "*" means applicable, "—"means not applicable, "(*)"means applicable as appropriate.

Table 3.2.2

Documents and information	**Cargo types**		
	Standardized	Semi-standardized	Non-standardized
MSC.1/Circ.1353/Rev.2 "Revised Guidelines for the Preparation of the Cargo Securing Manual"	*	*	*
CSS, Chapter 1 - General	*	*	*
CSS, Chapter 2 - Principles of safe stowage and securing of cargoes	*	*	*
CSS, Chapter 3 - Standardized stowage and securing systems	*	--	--
CSS, Chapter 4 - Semi-standardized stowage and securing	--	*	--
CSS, Chapter 5 - Non-standardized stowage and securing	--	--	*
CSS, Chapter 6 - Actions which may be taken in heavy weather	*	*	*
CSS, Chapter 7 - Actions which may be taken once cargo has shifted	*	*	*
CSS, Annex 1 - Safe stowage and securing of containers on deck of ships which are not specially designed and fitted for the purpose of carrying containers	--	--	*
CSS, Annex 2 - Safe stowage and securing of portable tanks	--	--	*
CSS, Annex 3 - Safe stowage and securing of portable receptacles	--	--	*
CSS, Annex 4 - Safe stowage and securing of wheel-based (rolling) cargoes	--	*	*

Documents and information	Cargo types		
	Standardized	Semi-standardized	Non-standardized
CSS, Annex 5 - Safe stowage and securing of heavy cargo items such as locomotives, transformers, etc.	--	--	*
CSS, Annex 6 - Safe stowage and securing of coiled sheet steel	--	--	*
CSS, Annex 7 - Safe stowage and securing of heavy metal products	--	--	*
CSS, Annex 8 - Safe stowage and securing of anchor chains	--	--	*
CSS, Annex 9 - Safe stowage and securing of metal scrap in bulk	--	--	(*)
CSS, Annex 10 - Safe stowage and securing of flexible intermediate bulk containers	--	--	*
CSS, Annex 11 - General guidelines for the under-deck stowage of logs	--	--	*
CSS, Annex 12 - Safe stowage and securing of unit loads	--	--	*
CSS, Annex 13 - Methods to assess the efficiency of securing arrangements for semi-standardized cargo and non-standardized cargo	--	(*)	*
CSS, Annex 14 - Guidance on providing safe working conditions for securing of containers on deck	*	--	--
Resolution A.489(XII) "Safe Stowage and Securing of Cargo Units and Other Entities in Ships other than Cellular Container Ships"	--	*	*
Resolution A.533(13) "Elements to be taken into Account When Considering the Safe Stowage and Securing of Cargo Units and Vehicles in Ships" and its amendment	*	*	*
MSC.479(102) "Revised Guidelines for Securing Arrangements for the Transport of Road Vehicles on Ro-ro Ships"	--	*	--

3.3 Ships carrying timber deck cargoes

3.3.1 Ships carrying timber deck cargoes, which are provided with timber load lines are to comply with Regulation 44 of the International Convention on Load Lines, 1966 and requirements of Resolution A.1048(27) "Code of Safe Practice for Ships Carrying Timber Deck Cargoes, 2011 (2011 TDC CODE)" and its amendments.

3.3.2 Detailed requirements of the convention and regulations in relation to the securing of timber are to be stated in CSM anyhow. And all of the detailed information on securing devices are to be provided in accordance with MSC.1/Circ.1353/Rev.2.

3.4 Acceleration of ship motions and securing force

3.4.1 For container ships (standardized cargo), the assessment of the acceleration of ship motions and force is to be carried out in accordance with Appendix 1 “Container securing” to Chapter 7, PART TWO of ISC Rules for Classification of Sea-going Steel Ships.

3.4.2 For ships carrying semi-standardized cargo and non-standardized cargoes, the assessment of the acceleration of ship motions and force is to be carried out in accordance with “Advanced calculation method” of CSS Annex 13.

3.5 Inspection and maintenance of cargo securing devices

3.5.1 Methods for inspection and maintenance of cargo securing devices are to be included in CSM and such inspection and maintenance works are to be carried out by the shipowner or the crew with the relevant records made.

3.5.2 For repairing and replacing of cargo securing devices, the acceptable limits for the wear and tear of securing devices are to be given.

3.5.3 Methods for inspection and maintenance may be based on the instructions of supplier and experience of the shipowner.

3.6 Fixed and portable securing devices

3.6.1 All documents and information of all fixed and portable securing devices are to be provided in accordance with the requirements of the Guidelines.

3.6.2 Appropriate certificates are to be provided when the securing devices are added and replaced on board the ship.

3.7 Preparation of Cargo Securing Manual

3.7.1 Contents and interpretations for the preparation of CSM with actual guidance meanings are given in the Appendix to the Guidelines.

3.7.2 The format of the Appendix is not identical with that of a certain CSM, which is to illustrate the following items:

(1) format for the preparation of CSM;

(2) texts to be included in the CSM;

(3) information and documents to be included in the CSM.

3.7.3 CSM is to be written in the language understood by the crew. If the language or languages used is not English, French or Spanish, a translation into one of these languages should be included. For ships only sailing in the internal waters of China, the language can be only Chinese.

APPENDIX CONTENTS AND INTERPRETATIONS OF CARGO SECURING MANUAL

(cover)

Cargo Securing Manual
XXXX Ship

The Manual is prepared in accordance with the International Convention for the Safety of Life at Sea, 1974 and its amendments and detailed requirements and format of MSC.1/Circ.1353/Rev.2 “Revised Guidelines for the preparation of the Cargo Securing Manual”.

Name of the preparation unit
Date of preparation

(title page)

Name of Ship:	XXXX
Flag:	XXXX
Type of Ship:	XXXX
Shipowner:	XXXX
Class:	XXXX
IMO Number:	XXXX

Main Particulars of the Ship

Length B.P.:	XXXX m
Breadth Molded:	XXXX m
Depth Molded:	XXXX m
Draft:	XXXX m
Service Speed:	XXXX kn
Gross Tonnage:	XXXX
Range of Metacentric Height *GM*:	XXXX-XXXX m

Brief introduction

1. The Manual is prepared in accordance with the International Convention for the Safety of Life at Sea,1974 and its amendments and detailed requirements and format of MSC.1/Circ.1353/Rev.2 “Revised Guidelines for the preparation of the Cargo Securing Manual”.
2. The Manual provides guidance to the master and crew for the correct operation of stowage and securing of cargo units.
3. The master has the responsibility to carry out effective stowage and securing of the cargo units carried on board in accordance with the Manual and to ensure that the ship is provided with sufficient number of securing devices.
4. The Manual is to be provided on board the ship so as to facilitate the inspections carried out by the personnel of port state and flag State, surveyors of classification society and other parties concerned.
5. If the Manual is to be revised, it is to be submitted for approval again, however, the following items may be updated:
(1) Where there are replacement or new addition of cargo securing devices, the device is to be recorded in the annex;
(2) Meanwhile, certificates of new devices are also to be added to the annex.

Contents

CSS Annex 13	Methods to assess the efficiency of securing arrangements for semi-standardized cargo and non-standardized cargo
CSS Annex 14	Guidance on providing safe working conditions for securing of containers on deck
Resolution A.1048(27)	Code of Safe Practice for Ships Carrying Timber Deck Cargoes and its amendments

Chapter 1 General

1.1 The guidance given herein should by no means rule out the principles of good seamanship, neither can it replace experience in stowage and securing practice.

1.2 The information and requirements set forth in this Manual are consistent with the requirements of:

(1) the vessel's trim and stability booklet;

(2) International Load Line Certificate (1966) and its amendments;

(3) the hull strength loading manual (if provided);

(4) the International Maritime Dangerous Goods (IMDG) Code (if applicable).

1.3 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.

1.4 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.

1.5 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 devices being replaced.

1.6 There should be a sufficient quantity of reserve cargo securing devices on board the ship.

1.7 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.

1.8 The Cargo Safe Access Plan (CSAP) is intended to provide detailed information for persons engaged in work connected with cargo stowage and securing. Safe access should be provided and maintained in accordance with this plan.

1.9 The crew should get familiar with the loading booklet before using this manual.

1.10 Photos or graphical illustration of common used devices and detailed method of using should be included in this manual as far as applicable, for the convenience of the crew.

1.11 Definitions

Cargo units refer to vehicles (road cars, Ro/Ro trailers, etc.), railroad car, container, board, tray, portable container, dismountable container components, packaging unit, whole-set cargo, other cargo transport units such as shipping box, break bulk cargo such as line roller, heavy cargo such as locomotive and transformer. Besides that, loading equipment or parts not permanently fixed onboard are also deemed as "cargo units".

Cargo securing devices are 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.

Fixed securing device means securing points and their supporting structure. These devices may be internal ones, such as those welded within the hull structure, and may also be exposed to weather, such as those directly welded to the external of the hull structure.

Portable securing device means portable device used for lashing, securing and supporting of cargo units.

Interpretation: Any other definitions relating to ship equipment and business involved in the Manual are included herein.

Chapter 2 Securing Devices and Arrangements

2.1 Fixed securing devices

2.1.1 This Sub-chapter should indicate and where necessary illustrate the number, locations, type and MSL of the fixed devices used to secure cargo and should as a minimum contain the following information:

(1) fixed securing devices on bulkheads, web frames, stanchions, etc. (e.g., pad eyes, eyebolts, etc.);

(2) fixed securing devices on decks (e.g., elephant feet fittings, container fittings, apertures, etc.);

(3) fixed securing devices on deckheads.

2.1.2 Documentation for each type of the fixed securing device is to be provided, which is to include information as applicable regarding:

(1) name of manufacturer;

(2) type designation of item with simple sketch for ease of identification;

(3) material(s), including minimum safe operational temperature;

(4) identification marking;

(5) strength test result or ultimate tensile strength test result;

(6) result of non destructive testing; and

(7) Maximum Securing Load (*MSL*).

Interpretation: All fixed securing devices and their appropriate supporting structures are to be assessed during plan approval, the structural drawings which are required to be submitted for classification approval are to indicate all fixed securing devices/fittings, the specified *MSL*, and range of operation.

Fixed securing device is to be considered as a part of the hull structure and surveyed during the normal survey of the hull.

2.1.3 No part may be welded to the ship structure without the permission of the master.

2.1.4 The Maximum Securing Load the ship structure may undertake is not to exceed:

‘tween deck frames t

main frames............ t

transverse bulkhead stiffeners.......... t

upper deck .... t

bottom of cargo hold……t

The securing arrangements which exceed the limits mentioned above will cause severe damage to the structure. Loads not acting on strength members are to be avoided.

Interpretation: When conducting the welding of beds, lashing pad eyes and other forms of welding, the yield strength of the weld fillet is at least to be equivalent to that of the material welded. For example, the yield strength of normal hull structural steel is 235 N/mm^2, therefore, pad eyes made of such material are not to be welded to the hull structure with the thickness less than that of the pad eyes. Unless the yield strength and thickness of the hull structure are equal to or greater than those of the pad eye, or the size of the lashing pad eye is to be reduced and the number of pad eyes is to be increased and the hull structure where welded is to be strengthened.

2.1.5 Where the securing device is to be welded to the deck plating or bulkhead plating, they are to overlap the stiffeners, beams, longitudinals or floors, and appropriate welding area is to be provided.

2.1.6 All replacement stacking devices, lashing pad eyes and lashing rings are to be provided with the certificates in compliance with the appropriate national or international standards in order to prove their Maximum Securing Load.

2.1.7 Loads are neither to act on the hull structure directly, nor to form a certain angle against the permitted stress-bearing surface of securing device.

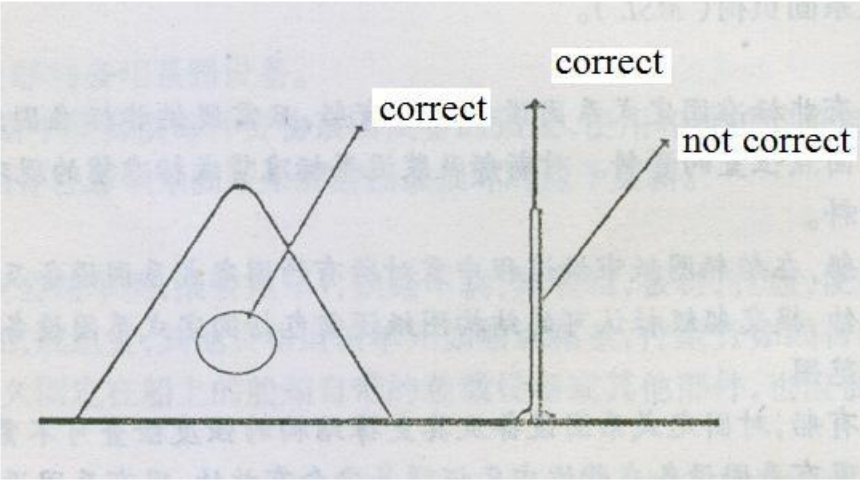


Figure 2.1.7

2.2 Portable securing devices

2.2.1 This Paragraph lists the number of, and the functional and *MSL* of the portable cargo securing devices carried on board the ship, and are supplemented by appropriate drawings and sketches, where necessary. The portable securing devices should include all of the following:

(1) container stacking fittings, container deck securing fittings, fittings for interlocking of containers, bridge-fittings, etc.;

(2) chains, wire lashings, rods, etc.;

(3) tensioners (e.g. turnbuckles, chain tensioners, etc.);

(4) securing gear for cars, if appropriate, and other vehicles;

(5) trestles and jacks, etc., for vehicles (trailers) where provided;

(6) anti-skid material (e.g. soft boards) for use with cargo units.

Example: No.1 masthouse

wire lashing 6x26, diameter: 9 mm, breaking load 42.0 kN

twistlock, *MSL*= 5t, yellow

twistlock, *MSL*= 10t, red

shackle “D” 19 mm, safe working load: 2t, white

shackle “D” 29 mm. safe working load: 5t, yellow

2.2.2 A list for the portable securing devices, which is to be supplemented with appropriate documentation for each type of device, as far as practicable, is to be included in this Paragraph. The appropriate documentation is to include information as applicable regarding:

(1) name of manufacturer;

(2) type designation of item with simple sketch for ease of identification;

(3) material(s), including minimum safe operational temperature;
(4) identification marking;
(5) strength test result or ultimate tensile strength test result;
(6) result of non destructive testing; and
(7) Maximum Securing Load (MSL).

Interpretation: Certificates for all portable cargo securing devices are to be included in the Manual and kept on board the ship for information, however, the certificates are not to be approved as a part of the Manual.

When replacement securing devices are placed on board, appropriate certificates are to be provided.

2.3 Inspection and maintenance schemes

2.3.1 This Paragraph is to describe that regular inspections and maintenance are to be carried out under the responsibility of the master and detailed actions to inspect and maintain the ship's cargo securing devices. Cargo securing devices inspections as a minimum are to include:

(1) routine visual examinations of components being utilized; and
(2) periodic examinations/re-testing as required by the Administration. When required, the cargo securing devices concerned should be subjected to inspections by the Administration.

For example: Regular visual inspections and maintenance are to be carried out by onboard personnel organized by the master. Every type of device is to be inspected in order to detect the wear and tear which may be bad for the accurate and safe play of design efficiency and other potential defects which may cause damage to personnel. For special purposes, the device is to be inspected before use in order to confirm whether its strength and function are applicable. If permanent deformation and damage are detected, the device is to be rejected in principle. If such permanent deformation and damage may be repaired, the device is to be repaired as soon as possible. Appropriate numbers of spare parts of securing device are always to be provided on board the ship. And portable securing devices are to be inspected for damage by “watch keeper” before being stored.

(1) Lashing eye plates and lashing ring
 ① the welded parts of the device and hull structure are to be inspected, and such parts are to be re-welded after the notch is grooved where defects and cracks are found;
 ② if cracks are found in the body of the device, the device is to be replaced immediately, and weld repair is not permitted;
 ③ the most appropriate repairing method is to be taken if the stowage surface is not smooth due to significant deformation of supporting structures such as the deck, bottom of hold, hatch cover, bulkhead plating, web frame, pillar and bulwark;
 ④ wear, deformation and other defects are to be inspected. If significant defects are found, the device is to be replaced by the one with equivalent strength. The welding of the device is to be carried out by an approved welder and is to be operated in accordance with the welding procedures strictly;
 ⑤ if corrosion is found, rust–removing is to be carried out and paint applied. If minor corrosion with no effect on the function, no repair is required.

(2) Lashing wire
 ① it is to be checked whether it is permanently twisted, squashed, corroded or the fiber core

is dry and exposed. Once found, it is to be replaced as appropriate;

② if breaks of the wire, wear or corrosion exceeding 5% are found within the length of 10 times the diameter of the wire rope, the wire is to be replaced immediately.

(3) Lashing chain, lashing hook, tensioner, vehicle lashing band

① it is to be checked whether it is permanently twisted or squashed; Once found, it is to be replaced as appropriate, and the turning of the end and activity of the pin are to be examined;

② if cracks are found in the body of the device, the device is to be replaced immediately, and weld repair is not permitted;

③ if minor wear and corrosion with no effect on the function, no replacement is required;

④ if significant wastage or damage of the chain, it is to be replaced.

(4) Twistlock, turnbuckle, lashing rod, bridge fitting, connected member and tension/pressure component

① all devices are to be inspected for deformation and damage before re-use. If inoperable, the internal part is to be checked to get it operable again;

② if cracks are found in the body of the device, the device is to be replaced immediately, and weld repair is not permitted;

③ the structural damage of twistlock and connected plate are probably caused by rough handling by the port. Such rough handling will probably cause damage to other components. It is recommended to collect these components with suitable package or box before lowering them to the deck in order to avoid losses caused due to improper operation.

④ if corrosion is found, rust-removing is to be carried out and paint applied. If minor corrosion with no effect on the function, no repair is required;

⑤ greasing the turning components frequently.

(5) Container foundation, twistlock socket, pad eye and other lock socket

① the welded parts of the device and hull structure are to be inspected, and such parts are to be re-welded after the notch is grooved where defects and cracks are found;

② if cracks are found in the body of the device, the device is to be replaced immediately, and weld repair is not permitted;

③ the most appropriate repairing method is to be taken if the stowage surface is not smooth due to significant deformation of supporting structures such as the deck, bottom of hold, hatch cover;

④ the socket is to be examined to identify the wear, deformation or defect, and inspection is to be carried out with standard twistlock; Appropriate repairing method is to be taken if safety is effected;

⑤ if corrosion is found, rust-removing is to be carried out and paint applied. If minor corrosion with no effect on the function, no repair is required;

⑥ the rust within the socket is to be cleaned and careful inspection of its size is to be carried out;

⑦ the dirt and cargo residuals left in the socket are to be cleaned before use;

⑧ deformation of hull structure at any securing point is to be reported to ISC as soon as possible.

2.3.2 This Paragraph documents actions to inspect and maintain the ship's cargo securing devices. And all items are to be recorded in a Cargo Securing Device Inspection and Maintenance Log attached to CSM, which should include information on:

(1) the procedures for accepting, maintaining and repairing or rejecting cargo securing devices;

(2) record of inspection, i.e.

① date of examination;

② name and signature of person conduction examination;

③ name and identification of items examined;

④ results of examination/inspection and maintenance/repair undertaken, if any.

2.3.3 This Paragraph contains information for the Master regarding inspections and adjustments of securing arrangements during the voyage.

For example:

(1) The integrity of the securing arrangements should be maintained throughout the voyage.

(2) Particular attention should be paid to the need for tight lashings, grips and clips to prevent weakening through chafing. Timber cradles, bedding and shoring should be checked, in so far as practicable and accessible.

(3) Lashings should be regularly checked and re-tightened. It is of paramount importance that all lashings be carefully examined at regular intervals during the voyage and tightened, as the vibration and working of the ship may cause the cargo to settle and compact. Lashings may also become slack due to deformation of cargo and temperature differential. The adjustment of the securing devices includes tightening wires or other devices with turnbuckles. Additional securing devices may be used, where necessary.

(4) Greasing the thread of clips and turnbuckles increases working life and prevents corrosion.

(5) Action which may be taken in heavy weather:

① General

The purpose of this section is not to usurp the responsibilities of the master, but rather to offer some advice on how stresses induced by excessive accelerations caused by bad weather conditions could be avoided.

② Excessive accelerations

Measures to avoid excessive accelerations are:

a) alteration of course or speed, or a combination of both;

b) heaving to;

c) early avoidance of areas of adverse weather and sea conditions; and

d) timely ballasting or deballasting to improve the behaviour of the ship, taking into account the actual stability conditions.

③ Voyage planning

One way of reducing excessive accelerations is for the master, as far as possible and practicable, to plan the voyage of the ship carefully so as to avoid areas with severe weather and sea conditions. The master should always consult the latest available weather information.

Where heavy individual unit is carried on the deck, such as vehicles, tailors, compartments and big cases, information on securing is included in Chapter 3, and it is recommended that the master use the most effective method to secure these cargoes in order to avoid cargo shifting during the voyage in dangerous area.

Where area of heavy sea condition (sea condition exceeding Beaufort scale 6) is not avoidable, deck cargoes are to be secured in accordance with the following principles:

a) to prevent cargo (especially roll vehicles) shifting and tipping with appropriate mechanical means (e.g. cross lashing made in both sides and ends with the lashing chain of tensioner);

b) on vehicles with plate type spring, the weight of the vehicle is to be transmitted to the supporting base with wheels;

c) where cargoes are carried by vehicles or trailers, the chassis of vehicle/trailer is to be secured, cross lashing is to be made to prevent tipping;

d) the breaking strength of the wire used for securing cargoes or vehicles is at least to be three times the design load.

(6) Actions which may be taken once cargo has shifted

The following actions may be considered:

① alterations of course to reduce accelerations;

② reductions of speed to reduce accelerations and vibration;

③ monitoring the integrity of the ship;

④ restowing or resecuring the cargo and, where possible, increasing the friction; and

⑤ diversion of route in order to seek shelter or improved weather and sea conditions.

2.3.4 Computerized maintenance procedures may be referred to in this Sub-chapter.

Chapter 3 Stowage and Securing of Non-standardized Cargo and Semi-standardized Cargo

3.1 Handling and safety instructions

Interpretation: This Sub-chapter should contain instructions on the proper handling of the securing devices and safety instructions related to handling of securing devices and to securing and unsecuring of units by ship or shore personnel.

3.1.1 General principles of cargo securing

All cargoes are to be stowed and secured in such a way that the ship and persons on board are not put at risk.

The safe stowage and securing of cargoes depend on proper planning, execution and supervision.

Personnel commissioned to tasks of cargo stowage and securing is to be properly qualified and experienced.

Personnel planning and supervising the stowage and securing of cargo is to have a sound practical knowledge of the application and content of the Manual, if provided.

Decisions taken for measures of stowage and securing cargo are to be based on the most severe weather conditions which may be expected by experience for the intended voyage.

Ship-handling decisions taken by the master, especially in bad weather conditions, are to take into account the type and stowage position of the cargo and the securing arrangements.

3.1.2 Behaviour of cargoes

Some cargoes have a tendency to deform or to compact themselves during the voyage, which will result in a slackening of their securing gear.

Cargoes with low friction coefficients, when stowed without proper friction-increasing devices such as dunnage, soft boards, rubber mats, etc., are difficult to secure unless tightly stowed across the ship.

3.1.3 Equipment

The ship's cargo securing equipment should be:

available in sufficient quantity;

suitable for its intended purpose;

of adequate strength;

easy to use; and

well maintained.

3.1.4 Special cargo transport units

The shipowner and the ship operator should, where necessary, make use of relevant expertise when considering the shipment of a cargo with unusual characteristics which may require special attention to be given to its location on board vis-à-vis the structural strength of the ship, its stowage and securing, and the weather conditions which may be expected during the intended voyage.

3.1.5 Cargo information

Before accepting a cargo for shipment, the shipowner or ship operator should obtain all necessary information about the cargo and ensure that:

the different commodities to be carried are compatible with each other or suitably separated;

the cargo is suitable for the ship;

the ship is suitable for the cargo; and

the cargo can be safely stowed and secured on board the ship and transported under all expected conditions during the intended voyage.

The master should be provided with adequate information regarding the cargo to be carried so that its stowage may be properly planned for handling and transport.

3.1.6 Suitability of cargo for transport

Cargo carried in containers, road vehicles, shipborne barges, railway wagons and other cargo transport units should be packed and secured within these units so as to prevent, throughout the voyage, damage or hazard to the ship, to the persons on board and to the marine environment.

3.1.7 Cargo distribution

(1) It is of utmost importance that the master takes great care in planning and supervising the stowage and securing of cargoes in order to prevent cargo sliding, tipping, racking, collapsing, etc.

(2) The cargo should be distributed so as to ensure that the stability of the ship throughout the entire voyage remains within acceptable limits so that the hazards of excessive accelerations are reduced as far as practicable.

(3) Cargo distribution should be such that the structural strength of the ship is not adversely affected.

3.1.8 Cargo securing arrangements

(1) Particular care should be taken to distribute forces as evenly as practicable between the cargo securing devices. If this is not feasible, the arrangements should be upgraded accordingly.

(2) If, due to the complex structure of a securing arrangement or other circumstances, the person in charge is unable to assess the suitability of the arrangement from experience and knowledge of good seamanship, the arrangement should be verified by using an acceptable calculation method.

(3) The number of cargo securing devices is to be sufficient and suitable for cargo lashing, and additional securing devices may be used where necessary.

(4) The lashing wire is to be as short as possible, since the long wire is hard to be tightened and to keep the original tension.

3.1.9 Residual strength after wear and tear

Cargo securing arrangements and equipment should have sufficient residual strength to allow for normal wear and tear during their lifetime.

3.1.10 Friction forces

Where friction between the cargo and the ship's deck or structure or between cargo transport units is insufficient to avoid the risk of sliding, suitable material such as soft boards or dunnage should be used to increase friction.

3.1.11 Shipboard supervision

(1) The principal means of preventing the improper stowage and securing of cargoes is through proper supervision of the loading operation and inspections of the stow.

(2) As far as practicable, cargo spaces should be regularly inspected throughout the voyage to ensure that the cargo, vehicles and cargo transport units remain safely secured.

3.1.12 Entering enclosed spaces

The atmosphere in any enclosed space may be incapable of supporting human life through lack of oxygen or it may contain flammable or toxic gases. The master should ensure that it is safe to enter any enclosed space.

3.1.13 General elements to be considered by the master

Having evaluated the risk of cargo-shifting, the master should ensure, prior to loading of any cargo,

cargo transport unit or vehicle that:

(1) the deck area for their stowage is, as far as practicable, clean, dry and free from oil and grease;

(2) the cargo, cargo transport unit or vehicle, appears to be in suitable condition for transport, and can be effectively secured;

(3) all necessary cargo securing equipment is on board and in good working condition; and

(4) cargo in or on cargo transport units and vehicles is, to the extent practicable, properly stowed and secured on to the unit or vehicle.

3.1.14 Cargo stowage and securing declaration

(1) Where there is reason to suspect that a container or vehicle into which dangerous goods have been packed or loaded is not in compliance with the provisions of Section 12 or 17, as appropriate, of the General Introduction to the IMDG Code, or where a container packing certificate/vehicle packing declaration is not available, the unit should not be accepted for shipment.

(2) Where practicable and feasible, road vehicles should be provided with a cargo stowage and securing declaration, stating that the cargo on the road vehicle has been properly stowed and secured for the intended sea voyage, taking into account the IMO/ILO guidelines for packing cargo in freight containers or vehicles.

3.1.15 Causes for cargo losses

Sufficient attention is to be paid to the following common causes which lead to cargo damage:

(1) heavy sea condition;

(2) insufficient number of dunnage or the dunnage is useless;

(3) insufficient strength of securing device;

(4) uneven lashing in STBD and PORT direction or in fore and aft direction;

(5) significant deformation of the securing pad eye of the wire;

(6) incorrect use of securing device;

(7) uneven strength between wires, pad eyes, chains, turnbuckle, shackles, lashing rod and securing points;

(8) damage to device caused due to cargo lashing alongside sharp or unprotected edge;

(9) no attention is paid to forces due to motion of the ship;

(10) no sufficient personnel and time provided for cargo lashing before the voyage commences.

3.1.16 Safety instructions for stowage and lashing of cargoes by the crew or terminal workers

(1) The crew is to supervise in the field of cargo lashing in order to prevent incorrect stowage and securing.

(2) The working site is to be kept organized and sufficient illumination is to be provided in the dark.

(3) The deck and step of the working site are to be free from oil and grease.

(4) Sufficient number of ladders is to be provided where necessary.

(5) Before operation, the crew is to check the site and confirm that no obstacle exists and the site is fit for handling operations.

(6) The crew and terminal workers are to be focused and wear necessary labor protection appliances, such as safety belt, safety hat, etc..

3.2 Evaluation of the forces acting on the cargo unit

Interpretation: This Paragraph is to include the following information:

(1) Acceleration table or graphs of different positions on board the ship within the applicable

metacentric height and under adverse sea condition;
(2) Illustrations of forces acting on cargoes affected by the above mentioned acceleration;
(3) Calculated examples for the number and strength of portable securing device under the effect of the above mentioned force, and examples for the safety coefficient of different types of portable securing devices;
(4) It is recommended that the calculation method used be converted into a form suiting the particular ship, its securing devices and the cargo carried, and this form may consist of applicable diagrams, tables or calculated examples;
(5) Other operational arrangements such as electronic data processing or use of a loading computer may be accepted as alternatives to the requirements of (1) to (4) above, providing that this system contains the same information.

3.2.1 Forces

(1) Forces, which have to be absorbed by suitable arrangements for stowage and securing to prevent cargo shifting, are generally composed of components acting relative to the axes of the ship:

- longitudinal;
- transversal; and
- vertical.

For the purpose of stowage and securing cargo, longitudinal and transverse forces are considered predominant.
(2) Transverse forces alone, or the resultant of transverse, longitudinal and vertical forces, normally increase with the height of the stow and the longitudinal distance of the stow from the ship's centre of motion in a seaway. The most severe forces can be expected in the furthest forward, the furthest aft and the highest stowage position on each side of the ship.
(3) The transverse forces exerted increase directly with the metacentric height of the ship. An undue metacentric height may be caused by:

① improper design of the ship;
② unsuitable cargo distribution; and
③ unsuitable bunker and ballast distribution.

(4) Cargo should be so distributed that the ship has a metacentric height in excess of the required minimum and, whenever practicable, within an acceptable upper limit to minimize the forces acting on the cargo.
(5) In addition to the forces referred to above, cargo carried on deck may be subjected to forces arising from the effects of wind and green seas.
(6) Improper ship handling (course or speed) may create adverse forces acting on the ship and the cargo.
(7) The magnitude of the forces may be estimated by using the appropriate calculation methods as contained in the Manual, if provided.
(8) Although the operation of anti-roll devices may improve the behaviour of the ship in a seaway, the effect of such devices should not be taken into account when planning the stowage and securing of cargoes.

3.2.2 Methods to assess the efficiency of securing arrangements for non-standardized cargo

Interpretation: The assessment of the efficiency of securing arrangements for non-standardized cargo may be carried out according to Annex 13 to CSS Code or with the method accepted by the

Administration.

3.2.3 The recommended dedicated calculation forms are given below in accordance with CSS Annex 13:

Calculation form 1 Value of acceleration

K1	Length of ship		[m]	GM	K8			
K2	Moulded breadth		[m]		on deck high	on deck low	tween deck	lower hold
K3	Speed		[kn]					
K4	Metacentric height GM		[m]					
K5	Distance from the center of gravity of cargo unit to A.P		[m]					
K6	K6=K5/K1		[-]					
K7	Correction coefficient in relation to the length and speed of the ship		[-]					
K8	Correction coefficient, B/GM < 13		[-]					
Basic acceleration								
				on deck high	on deck low	tween deck	lower hold	
K9	Longitudinal basic acceleration		[m/s^2]					
K10	Vertical basic acceleration (see Table 1 according to K6)		[m/s^2]					
K11	Transverse basic acceleration (see Table 1 according to K6)		[m/s^2]					
Value of acceleration								
				on deck high	on deck low	tween deck	lower hold	
K12	Longitudinal acceleration=K9·K7		[m/s^2]					
K13	Vertical acceleration=K10·K7		[m/s^2]					
K14	Transverse acceleration=K11·K7·K8		[m/s^2]					

Calculation Form 2 Transverse sliding and tipping (direction: PORT or STBD)

K1	Mass of cargo unit		[t]	Calculation of force			
K2	Lever-arm of tipping		[m]	K8	Sliding force=K1•K5+K6•p_1+K7•p_2		[kN]
K3	Lever-arm of stableness		[m]	K9	Tipping moment=K8•K2		[kN.m]
K4	Friction coefficient		[-]	Stability characteristics of cargo			
K5	Transverse acceleration		[m/s^2]				
K6	Windage area		[m^2]	K10	Friction=9.81•K1•K4		[kN]
K7	Sprayed area		[m^2]	K11	Moment of stableness=9.81•K3•K1		[kN.m]

Lashing table

Lashing number		1	2	3	4	5	6	7	8	9	10		
K12	MSL[kN]												
K13	Vertical lashing angle α												
K14	Value of f (see Table 4)												
K15=0.67•K12•K14												K18=$\Sigma K15_{1-10}$	
K15	Sliding [kN]											K18	
K16	Lever-arm of securing [m]												
K17=0.67•K12•K16												K19=$\Sigma K17_{1-10}$	
K17	Tipping[kN.m]											K19	

Balance of calculation and criteria

Sliding [kN]	K8		K10		K18		K10+K18	Not satisfied/satisfied
		<		+		=		
Tipping [kN.m]	K9		K11		K19		K11+K19	Not satisfied/satisfied
		<		+		=		

note: wind force p_1=1kN/m^2 Spray force p_2=1 kN/m^2

Calculation form 3 Longitudinal sliding (direction: fore or aft)

<table>
<tr><td>K1</td><td>Mass of cargo unit</td><td colspan="2"></td><td>[t]</td><td colspan="9" rowspan="2">Calculation of force</td></tr>
<tr><td>K2</td><td>Friction coefficient</td><td colspan="2"></td><td>[-]</td></tr>
<tr><td>K3</td><td>Longitudinal acceleration</td><td colspan="2"></td><td>[m/s^2]</td><td>K7</td><td colspan="4">Sliding force=K1·K3+K5·p_1+K6·p_1</td><td colspan="2"></td><td colspan="2">[kN]</td></tr>
<tr><td>K4</td><td>Vertical acceleration</td><td colspan="2"></td><td>[m/s^2]</td><td colspan="9" rowspan="2">Stability characteristics of cargo</td></tr>
<tr><td>K5</td><td>Windage area</td><td colspan="2"></td><td>[m^2]</td></tr>
<tr><td>K6</td><td>Sprayed area</td><td colspan="2"></td><td>[m^2]</td><td>K8</td><td colspan="4">Friction=(9.81·K4) ·K1·K2</td><td colspan="2"></td><td colspan="2">[kN]</td></tr>
<tr><td colspan="14">Lashing table</td></tr>
<tr><td colspan="2">Lashing number</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td colspan="2"></td></tr>
<tr><td>K9</td><td>MSL[kN]</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>K10</td><td>Vertical lashing angle α</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>K11</td><td>Value of f (see Table 4)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td colspan="12">K12=0.67·K9·K11 or =0.67·0.5·K9 (whichever is less) (note: the lashing is longitudinal)</td><td colspan="2">K13=ΣK$12_{1\text{-}10}$</td></tr>
<tr><td>K12</td><td>Sliding[kN]</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>K13</td><td></td></tr>
<tr><td colspan="14">Balance of calculation and criteria</td></tr>
<tr><td rowspan="2">Sliding [kN]</td><td colspan="2">K7</td><td colspan="4">K8</td><td colspan="3">K13</td><td colspan="2">K8+K13</td><td colspan="2">Not satisfied/satisfied</td></tr>
<tr><td></td><td><</td><td colspan="2"></td><td>+</td><td colspan="2"></td><td>=</td><td colspan="3"></td><td colspan="2"></td></tr>
</table>

note: wind force p_1=1kN/m^2 Spray force p_2=1 kN/m^2

3.2.4 Calculated examples for securing calculation through the dedicated calculation forms as specified in 3.2.3 are given below:

Calculation steps:

(1) Calculation of the value of acceleration, see calculation Form 1:

Step 1: fill in GM, k4, distance from the center of gravity of cargo unit to A.P, k5;

Step 2: calculate k6;

Step 3: obtain k8 according to detailed GM;

Step 4: obtain basic acceleration k10 and k11 from Table 1;

Step 5: calculate the amended accelerations k12, k13 and k14.

(2) Calculate balance of transverse sliding and tipping, see calculation Form 2:

Step 1: fill in the mass of cargo unit k1, lever-arm of tipping k2, lever-arm of stableness k3, friction coefficient k4, transverse acceleration k5, windage area k6, sprayed area k7;

Step 2: calculate the transverse sliding force k8;

Step 3: calculate transverse tipping moment k9;

Step 4: calculate friction k10;

Step 5: calculate the moment of stableness k11;

Step 6: fill in lashing table k12 and k13;

Step 7: obtain k14 from Table 4;

Step 8: calculate the securing force of lashing k18;

Step 9: fill in k16;

Step 10: calculate securing moment of lashing k19;

Step 11: balance calculation and criteria.

(3) Calculate balance of longitudinal sliding, see calculation Form 3:

Step 1: fill in the mass of cargo unit, k1, friction coefficient, k2, longitudinal acceleration, k3, vertical acceleration, k4, windage area, k5, sprayed area, k6;

Step 2: calculate longitudinal sliding force, k7;

Step 3: calculate friction, k8;

Step 4: fill in lashing table k9 and k10;

Step 5: obtain k11 from Table 4;

Step 6: calculate securing force of lashing, k13;

Step 7: balance calculation and criteria.

Calculation form 1 Value of acceleration

K1	Length of ship	120	[m]	GM	K8			
K2	Moulded breadth	20	[m]		on deck high	on deck low	tween deck	lower hold
K3	Speed	15	[kn]	<1.54	1.00	1.00	1.00	1.00
K4	Metacentric height GM	1.4	[m]	1.80	1.10	1.08	1.06	1.04
K5	Distance from the center of gravity of cargo unit to A.P	84	[m]	2.07	1.22	1.16	1.11	1.07
K6	K6=K5/K1	0.7	[-]	2.33	1.32	1.25	1.16	1.10
K7	Correction coefficient in relation to the length and speed of the ship	0.89	[-]	2.60	1.45	1.34	1.21	1.13
K8	Correction coefficient, B/GM < 13	1	[-]	2.86	1.56	1.42	1.26	1.15

Basic acceleration

			on deck high	on deck low	tween deck	lower hold
K9	Longitudinal basic acceleration	[m/s^2]	3.8	2.9	2.0	1.5
K10	Vertical basic acceleration (see Table 1 according to K6)	[m/s^2]	6.2	6.2	6.2	6.2
K11	Transverse basic acceleration (see Table 1 according to K6)	[m/s^2]	6.9	6.3	5.6	5.3

Value of acceleration

			on deck high	on deck low	tween deck	lower hold
K12	Longitudinal acceleration=K9•K7	[m/s^2]	3.38	2.58	1.78	1.34
K13	Vertical acceleration=K10•K7	[m/s^2]	5.52	5.52	5.52	5.52
K14	Transverse acceleration=K11•K7•K8	[m/s^2]	6.14	5.61	4.98	4.71

Calculation form 2 Transverse sliding and tipping (direction: PORT)

K1	Mass of cargo unit	62	[t]	Calculation of force			
K2	Lever-arm of tipping	1.8	[m]	K8	Sliding force=K1•K5+K6•p_1+K7•p_2	384	[kN]
K3	Lever-arm of stableness	2	[m]	K9	Tipping moment=K8•K2	691	[kN.m]
K4	Friction coefficient	0.3	[-]	Stability characteristics of cargo			
K5	Transverse acceleration	5.61	[m/s^2]				
K6	Windage area	24	[m^2]	K10	Friction=9.81•K1•K4	182	[kN]
K7	Sprayed area	12	[m^2]	K11	Moment of stableness=9.81•K3•K1	1216	[kN.m]

Lashing table

Lashing number		1	2	3	4	5	6	7	8	9	10		
K12	MSL[kN]	90	90	90	90								
K13	Vertical lashing angle α	40	40	40	40								
K14	Value of *f* (see Table 4)	0.96	0.96	0.96	0.96								
K15=0.67•K12•K14												K18=ΣK15_{1-10}	
K15	Sliding [kN]	57.6	57.6	57.6	57.6							K18	230
K16	Lever-arm of securing [m]	2.57	2.57	2.57	2.57								
K17=0.67•K12•K16												K19=ΣK17_{1-10}	
K17	Tipping[kN.m]	154.2	154.2	154.2	154.2							K19	617

Balance of calculation and criteria

Sliding [kN]	K8		K10		K18		K10+K18	Not satisfied/satisfied
	384	<	182	+	230	=	412	Satisfied
Tipping [kN.m]	K9		K11		K19		K11+K19	Not satisfied/satisfied
	691	<	1216	+	617	=	1833	Satisfied

note: wind force p_1=1kN/m^2 Spray force p_2=1 kN/m^2

Calculation form 2 Transverse sliding and tipping (direction: STBD)

K1	Mass of cargo unit	62	[t]	Calculation of force			
K2	Lever-arm of tipping	1.8	[m]	K8	Sliding force=K1•K5+K6•p_1+K7•p_2	384	[kN]
K3	Lever-arm of stableness	2	[m]	K9	Tipping moment=K8•K2	691	[kN.m]
K4	Friction coefficient	0.3	[-]	Stability characteristics of cargo			
K5	Transverse acceleration	5.61	[m/s^2]				
K6	Windage area	24	[m^2]	K10	Friction=9.81•K1•K4	182	[kN]
K7	Sprayed area	12	[m^2]	K11	Moment of stableness=9.81•K3•K1	1216	[kN.m]

Lashing table

Lashing number		1	2	3	4	5	6	7	8	9	10		
K12	MSL[kN]	90	90	90	90								
K13	Vertical lashing angle α	40	40	10	10								
K14	Value of f (see Table 4)	0.96	0.96	1.04	1.04								
K15=0.67•K12•K14												K18=ΣK15$_{1-10}$	
K15	Sliding [kN]	57.6	57.6	62.7	62.7							K18	240
K16	Lever-arm of securing [m]	2.57	2.57	1.22	1.22								
K17=0.67•K12•K16												K19=ΣK17$_{1-10}$	
K17	Tipping[kN.m]	154.2	154.2	73.2	73.2							K19	455

Balance of calculation and criteria

Sliding	K8		K10		K18		K10+K18	Not satisfied/satisfied
[kN]	384	<	182	+	240	=	422	Satisfied
Tipping	K9		K11		K19		K11+K19	Not satisfied/satisfied
[kN.m]	691	<	1216	+	455	=	1671	Satisfied

note: wind force p_1=1kN/m^2 Spray force p_2=1 kN/m^2

3.3 Application of portable securing devices on various cargo units, vehicles and stowage blocks

3.3.1 This Sub-chapter should draw the master's attention to the correct application of portable securing devices, taking into account the following factors:

(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 including vehicles;

(7) intended stowage pattern of the cargo units including vehicles; and

(8) mass and dimensions of the cargo units and vehicles.

3.3.2 This Sub-chapter should describe the application of portable cargo securing devices as to number of lashings and allowable lashing angles. Where necessary, the text should be supplemented by suitable drawings or sketches to facilitate the correct understanding and proper application of the securing devices to various types of cargo and cargo units. It should be pointed out that for certain cargo units and other entities with low friction resistance, it is advisable to place soft boards or other anti-skid material under the cargo to increase friction between the deck and the cargo.

3.3.3 This Sub-chapter should contain guidance as to the recommended location and method of stowing and securing of containers, trailers and other cargo carrying vehicles, palletized cargoes, unit loads and single cargo items (e.g., woodpulp, paper rolls, etc.), heavy weight cargoes, cars and other vehicles.

Interpretation: it is to be pointed that lashing is not the only way of cargo securing. It is a common way to use lashing devices to secure deck cargoes, however, in cargo hold, it is more common to use shore or wedge to secure the packaged unit, since in this way the reaction force of the hull structure (e.g. frames, bulkhead stiffeners or deck beams) may be used. While carrying cargo units or vehicles of low frictions, soft boards or anti-skid materials are to be filled between the deck and cargo.

The maximum permissible stowage load of the deck and hatch cover is not to be exceeded. The value of maximum permissible load of related hull structures is to be specified. Unnecessary damage to the deck and hatch cover are usually caused by focused and uneven cargo loads. The maximum permissible stowage load of the hull structure is included in ship’s General Arrangement and stowage manual, and relevant indexes are to be used for the Manual.

3.3.4 CSS Annexes 1 to 12 is part of Paragraphs 3.3.2 and 3.3.3.

3.3.5 When weather-dependent lashing is applied, operational procedures are to be developed in accordance with Annex 13 of the CSS Code.

3.4 Supplementary requirements for ro-ro ships

Interpretation: The manual should contain sketches showing the layout of the fixed securing devices with identification of strength (MSL) as well as longitudinal and transverse distances between securing points. In preparing this Sub-chapter further guidance should be utilized from IMO Assembly Resolutions A.533(13) and MSC.479(102), as appropriate.

In designing securing arrangements for cargo units, including vehicles and containers, on ro-ro passenger ships and specifying minimum strength requirements for securing devices used, forces due to the motion of the ship, angle of heel after damage or flooding and other considerations relevant to the effectiveness of the cargo securing arrangement should be taken into account.

3.4.1 General elements

(1) cargo units including vehicles intended for the carriage of cargo in sea transport are in sound structural condition and have an adequate number of securing points of sufficient strength so that they can be satisfactorily secured to the ship. Vehicles should, in addition, be provided with an effective braking system;

(2) cargo units and vehicles are provided with an adequate number of securing points to enable the cargo to be adequately secured to the cargo unit or vehicle so as to withstand the forces, in particular the transverse forces, which may arise during the sea transport;

(3) safe access and safe places of work are provided for persons engaged in work connected with cargo stowage and securing.

3.4.2 Elements to be considered by the shipowner and shipbuilder

(1) In considering the number and strength of the securing points, the following elements should be taken into account:

① duration of the voyage;
② geographical area of the voyage;
③ sea conditions which may be expected;
④ size, design and characteristics of the ship;
⑤ dynamic forces under adverse weather conditions;
⑥ types of cargo units and vehicles to be carried;
⑦ intended stowage pattern of the cargo units and vehicles;
⑧ weight of cargo units and vehicles; and
⑨ safe access, safe place of work, illumination and working conditions for persons engaged in work connected with cargo stowage and securing.

(2) The Cargo Securing Manual should provide information on the characteristics of cargo securing items and their correct application.

(3) Ship's mobile cargo handling equipment not fixed to the ship should be provided with adequate securing points.

(4) Ships which are specifically designed and fitted for the purpose of carrying containers should be provided with a Cargo Safe Access Plan (CSAP) in order to demonstrate that personnel will have safe access for container securing operations.

3.4.3 Elements to be considered by the master

(1) When accepting cargo units or vehicles for shipment and having taken into account the elements listed in Paragraph 3.4.2(1) above, the master should be satisfied that:

① all decks intended for the stowage of cargo units including vehicles are in so far as is practicable free from oil and grease;
② cargo units including vehicles are in an apparent good order and condition suitable for sea transport particularly with a view to their being secured;
③ the ship has on board an adequate supply of cargo securing gear which is maintained in sound working condition;
④ cargo units including vehicles are adequately stowed and secured to the ship;

⑤ where practicable, cargoes are adequately stowed on and secured to the cargo unit or vehicle;

⑥ where applicable, safe access to be provided in accordance with the CSAP and maintained throughout cargo operations.

(2) In addition, cargo spaces should be regularly inspected to ensure that the cargo, cargo units and vehicles remain safely secured throughout the voyage.

3.4.4 Securing arrangements for the transport of road vehicles on ro-ro ships

(1) This Paragraph applies to ro-ro ships which regularly carry road vehicles on either long or short international voyages in unsheltered waters.

(2) Securing points on ships' decks

① The distance between securing points in the longitudinal direction should in general not exceed 2.5 m. However, there may be a need for the securing points in the forward and after parts of the ship to be more closely spaced than they are amidships.

② The thwartships spacing of securing points should not be less than 2.8 m not more than 3 m. However, there may be a need for the securing points in the forward and after parts of the ship to be more closely spaced than they are amidships.

③ The maximum securing load (MSL) of each securing point should be 100 kN. If the securing point is designed to accommodate more than one lashing (y lashings), the corresponding strength should be not less than y × 100 kN.

④ In ro-ro ships which only occasionally carry roads vehicles, the spacing and strength of securing points should be such that the special considerations which may be necessary to stow and secure road vehicles safely are taken into account.

(3) Securing points on road vehicles

① Securing points on road vehicles should be designed for securing the road vehicles to the ship and should have an aperture capable of accepting only one lashing. The securing point and aperture should permit varying directions of the lashing to the ship's deck.

② The same number of not less than two or more than six securing points should be provided on each side of the road vehicle in accordance with the provisions of (3)③.

③ The minimum number and minimum strength of securing points should be in accordance with the following table, where n is the total number of securing points on each side of the road vehicle.

Gross vehicle Mass GVM(t)	Minimum number of securing points on each side of the road vehicle	Minimum strength without permanent deformation of each securing point as fitted (kN)
3.5≤GVM≤20	2	$GVM \times 10 \times 1.2 / n$
20＜GVM≤30	3	
30＜GVM≤40	4	

Note 1: For road trains, the fable applies to each component, i.e. to the motor vehicle and each trailer, respectively.

Note 2: Semi-trailer towing vehicles are excluded from the table above. They should be provided with two securing points at the front of the vehicle, the strength of which should be sufficient to prevent lateral movement of the front of the vehicle. A towing coupling at the front may replace the two securing points.

Note 3: If the towing coupling is used for securing vehicles other than semi-trailer towing vehicles, this should not replace or be substituted for the above-mentioned minimum number and strength of securing points on each side of the vehicle.

④ Each Securing Point on the Vehicle should be marked in a Clearly visibly colour.

⑤ Securing points on vehicles should be so located as to ensure effective restraint of the vehicle by the lashings.

⑥ Securing points should be capable of transferring the forces from the lashings to the chassis of the road vehicle and should never be fitted to bumpers or axles unless these are specially constructed and the forces are transmitted directly to the chassis.

⑦ Securing points should be so located that lashings can be readily and safely attached particularly where side-guards are fitted to the vehicle.

⑧ The internal free passage of each securing point's aperture should be not less than 80 mm but the aperture need not be circular in shape.

⑨ Equivalent or superior securing arrangements may be considered for vehicles for which the provisions of Table (3)③ are unsuitable.

(4) Lashings

① The maximum securing load (MSL) of lashings should normally not be less than 100 kN and they should be made of material having suitable elongation characteristics. The required number and MSL of lashings may be calculated according to Annex 13 to the Code of Safe Practice for Cargo Stowage and Securing (CSS Code), taking into consideration the criteria mentioned in Paragraph (6) "Safety factor" of Annex 13.

② Lashings should be so designed and attached that, provided there is safe access, it is possible to tighten them If they become slack. Where practicable and necessary, the lashings should be examined at regular intervals during the voyage and tightened as necessary.

③ Lashings should be attached to the securing points with hooks or other devices so designed that they cannot disengage from the aperture of the securing point if the lashing slackens during the voyage.

④ Only one lashing should be attached to any one aperture of the securing point on the vehicle.

⑤Lashings should only be attached to the securing points provided for that purpose.

⑥ Lashings should be attached to the securing points on the vehicle in such a way that the angle between the lashing and the horizontal and vertical planes lies preferably between 30° and 60°.

⑦ Bearing in mind the characteristics of the ship and the weather conditions expected on the Intended voyage, the master should decide on the number of securing points and lashings to be used for each voyage.

⑧ Where there is doubt that a road vehicle compiles with the provisions of Table (3)③, the master may, at his discretion, load the vehicle on board, taking into account the apparent condition of the vehicle, the weather and sea conditions expected on the Intended voyage and all other circumstances.

(5) Stowage

① Depending on the area of operation, the predominant weather conditions and the characteristics of the ship, road vehicles should be slowed so that the chassis are kept as static as possible by not allowing free play in the suspension of the vehicles. This can be done, for example, by compressing the springs by lightly securing the vehicle to the deck, by Jacking up the chassis prior to securing the vehicle or by releasing the air pressure on compressed air suspension systems.

① Taking into account the conditions referred to in (5)① and the fact that compressed air suspension systems may loose air, the air pressure should be released on every vehicle fitted with such a system if the voyage is of more than 24 hours duration. If practicable, the air pressure should be released also on voyages of a shorter duration. If the air pressure is not released, the vehicle should be jacked up to prevent any slackening of the lashings resulting from any air leakage from the system during the voyage.

② Where lacks are used on a vehicle, the chassis should be strengthened in way of the lacking-up points and the position of the jacking-up points should be clearly marked.

③ Special consideration should be given to the securing of road vehicles stowed in positions where they may be exposed to additional forces. Where vehicles are stowed athwartship, special consideration should be given to the forces which may arise from such stowage.

④ Wheels should be shocked to provide additional security in adverse conditions.

⑤ Vehicles with diesel engines should not be left in gear during the voyage.

⑥ Vehicles designed to transport loads likely to have an adverse effect on their stability, such as hanging meat, should have integrated in their design a means of neutralizing the suspension system.

⑧ Stowage should be arranged in accordance with the following:

a) The parking brakes of each vehicle or of each element of a combination of vehicles should be applied and locked.

b) Semi-trailers, by the nature of their design, should not be supported on their landing legs during sea transport unless the landing legs are specially designed for that purpose and so marked. An uncoupled semi-trailer should be supported by a trestle or similar device placed in the immediate area of the drawplate so that the connection of the fifth-wheel to the kingpin is not restricted. Semi-trailer designers should consider the space and the reinforcements required and the selected areas should be clearly marked.

3.5 Bulk carriers

Interpretation: If bulk carriers carry cargo units falling within the scope of Chapter VI/5 or Chapter VII/5 of the SOLAS Convention, this cargo shall be stowed and secured in accordance with a Cargo Securing Manual, approved by the Administration.

3.6 Timber deck cargoes

Interpretation: This Paragraph is to describe methods for stowage and securing of timber deck cargoes in accordance with Resolution A.1048(27) “Code of Safe Practice for Ships Carrying Timber Deck Cargoes” and Regulation 44 of the International Convention on Load Lines, 1966. The existing Cargo Securing Manual approved in accordance with Resolution A.715(17) “Code of Safe Practice for Ships Carrying Timber Deck Cargoes” may continue to be valid. Resolution A.1048(27) is given as an annex of this manual.

Chapter 4 Stowage and Securing of Containers and Other Standardized Cargo

4.1 Handling and safety instructions

4.1.1 Instructions for correct use of securing device

Examples:

(1) Twistlock (applicable to containers carried on the deck and hatch covers only)

① put the twistlock in the foundation or corner fitting of the lower container, and to confirm that it is open;

② when the upper containers are totally put on the twistlock, tighten it with twistlock shaft manually or by operation rod;

③ during unloading, put the wrench to the original position and the twistlock is in loose condition;

④ when the upper containers are lifted away, the twistlock is to be put down and the lower container may be lifted away.

(2) Cone (applicable to containers in cargo hold only)

① put the cone in the foundation or corner fitting of the lower container;

② when the upper container is totally put on the cone, the container will be fixed with the cell guides;

③ during unloading, when the upper containers are lifted away, put down the cone directly and the lower containers may be lifted away.

(3) Lashing rod, turnbuckle, wrench and wheel handle (applicable to containers carried on the deck and hatch covers only)

① connect the lashing pad eyes of turnbuckle and hatch covers with fixed pins;

② insert the hook head of lashing rod into the corner fittings of the container;

③ adjust the length of turnbuckle to get the lashing rod inserted into the turnbuckle;

④ tighten the turnbuckle with wrench or wheel handle to get the appropriate pre-tensioning force;

⑤ during unloading, loose the turnbuckle with wheel handle or wrench and put down the lashing rod, put it in the storage place, and the turnbuckle is not required to be put down from the pad eye, it is only to be put in a safe position.

(4) Pressure-containing part of bulkhead (applicable to containers in cargo hold only)

① put the cone core in the foundation or corner fitting of container;

② insert the portable plate into the cone core based on the distance from the cone core to the bulkhead and confirm that the plate fully contacts with the bulkhead;

③ when the upper containers are totally put on the pressure-containing part, the containers are locked, and the transverse motion towards ship sides is also prevented;

④ during unloading, put out the portable plate from cone core, and put the cone core out from the corner fitting, the lower containers may be lifted and unloaded.

(5) Connected plate

① put the twistlock into the corner fitting of containers;

② put the connect plate between two twistlocks;

③ tighten the container with twistlock handle when the upper containers are placed;

④ during unloading, put down the plate after the upper containers are lifted away.

(6) Bridge fitting

① the adjacent two upper containers are placed;
② adjust the hook of bridge fitting to the appropriate distance;
③ insert into the corner fitting of container;
④ tighten the adjusting nut for a certain pre-tensioning force;
⑤ during unloading, loose it with the wrench, adjust the hook distance to the appropriate position, and put it out.

4.1.2 Safety instructions for the use of securing device and securing and loosing of containers or other standardized cargoes by onboard or shore personnel

(1) The crew is to supervise in the field of cargo lashing in order to prevent incorrect stowage and securing.

(2) The working site is to be kept organized and sufficient illumination is to be provided in the dark.

(3) The deck and step of the working site are to be free from oil and grease.

(4) Sufficient number of ladders is to be provided where necessary.

(5) Before operation, the crew is to check the site and confirm that no obstacle exists and the site is fit for handling operations.

(6) The crew and terminal workers are to be focused and wear necessary labor protection appliances, such as safety belt, safety hat, etc..

4.2 Stowage and securing instructions

Interpretation: applicable to any stowage and securing system (i.e. stowage within or without cellguides) for containers and other standardized cargo.

4.2.1 Stowage and securing plan

Interpretation: This Paragraph is to consist of a comprehensive and understandable plan or set of plans providing the necessary overview on:

(1) longitudinal and athwartship views of under deck and on deck stowage locations of containers as appropriate;

(2) alternative stowage patterns for containers of different dimensions;

(3) maximum stack masses;

(4) permissible vertical sequences of masses in stacks;

(5) maximum stack heights with respect to approved sight lines (see MSC 63 for the amendments to SOLAS Chapter VI); and

(6) application of securing devices using suitable symbols with due regard to stowage position, stack mass, sequence of masses in stack and stack height. The symbols used should be consistent throughout the Manual.

4.2.2 Stowage and securing principle on deck and under deck

Interpretation: This Paragraph is to support the interpretation of the stowage and securing plan with regard to container stowage, highlighting:

(1) the use of the specified devices; and

(2) any guiding or limiting parameters as dimension of containers, maximum stack masses, sequence of masses in stacks, stacks affected by wind load, height of stacks.

Examples: Stowage and securing principle on deck and under deck is given below:

(1) According to the forms of lashing and the position of container on board the ship, different forces act on the container and securing device;

(2) In addition to the selected securing device, the strength (permissible racking force, pressure and corner post load) of the container being secured is also to be considered while calculating the securing system;
(3) Lifting force (where there are more than two tiers of containers) is mainly absorbed by the twistlock arranged between the foundation and container and that between container and container;
(4) Lashings in the vertical direction may be added (e.g. there are six tiers of containers in the outermost stack or the stack is affected by wind loads);
(5) Lashing is normally considered as the strengthening of the container frame, the application of lashing is to prevent the lifting force (max. 150 kN) from exceeding the permissible range;
(6) Distribution of mass specified in the Manual represents the best form in the given condition;
(7) The centralization of the mass of stack from up to down is permissible, and centralization from down to up is not permissible (e.g. if a heavy container is carried on the upmost tier of the stack, the stress of foundation, twistlock and lashing fitting will exceed the permissible range);
(8) The tier number of the stack is not to exceed that specified in the Manual, since such may increase the loads withstood by the securing system and the sight may also be limited;
(9) The mass of stack is described in the Manual for containers with the height of 8’6’’, and containers with the height of 9’6’’ is not to be stowed randomly, since the center of gravity will be moved up and the wind load will be increased. The mass of stack may be reduced or be centralized from up to down as compensation, where necessary;
(10) Special attention is to be paid to securing in severe sea condition such as heavy sea and strong wind, and additional securing may be required if possible;
(11) Cone is not to be used as alternative to twistlock for securing containers on the deck;
(12) The pre-stressing force of each lashing rod is to be as even as possible. Lashing rod, turnbuckle and lashing pad eye are to be of continuous strength to prevent break;
(13) Stowage is to be carried out after the hatch cover is totally locked, or motion will be caused due to the loose locking of hatch cover;
(14) The maximum mass of stack is not to be exceeded, or the stresses of hatch cover structure, securing device and containers will exceed the permissible range and containers will be lost;
(15) The given mass of stack is not to be exceeded, or the stress of securing device and containers will exceed the permissible range and the containers will be lost.

4.3 Other permissible stowage forms

Interpretation: This Paragraph provides necessary information for the master to deal with the cargo stowage which deviates from the guidance given in 4.2, including the appropriate warning to the potential consequences due to the misunderstanding of the guidance or misuse of securing device. The information to be provided is as follows:
(1) different vertical distribution of the mass of stack;
(2) effect of the wind to stack without enclosure;
(3) methods of stowage of containers of different size; and
(4) reduction of the mass, height of the stock or reduction of the securing effect for other reason.

4.4 Forces acting on the cargo unit

Interpretation: This Paragraph is to specify the distribution of acceleration based on the stowage and securing system, and indicate the basic condition of stability, and provide information of the force generated due to the wind and sea water on the deck.
This Paragraph is also to include the information on the normal increase of the acceleration with the increase of metacentric height. Where the excessive stability is not avoidable, this Paragraph is to give the recommended method for limiting the mass of stack and stowage height to reduce the risk of cargo damage due to stowage on the deck.
Ships of ISC is to calculate the forces acting on the cargo unit in accordance with the requirements of Appendix 1 “Container Securing” to Chapter 7, PART TWO of ISC Rules for Classification of Sea-going Steel Ships or ISC Rules for Construction of domestic sailing Ships.

Chapter 5 Cargo Safe Access Plan (CSAP)

5.1 Ships which are specifically designed and fitted for the purpose of carrying containers should be provided with a Cargo Safe Access Plan (CSAP) in order to demonstrate that personnel will have safe access for container securing operations. This plan should detail arrangements necessary for the conducting of cargo stowage and securing in a safe manner. It should include the following for all areas to be worked by personnel:

(1) hand rails;

(2) platforms;

(3) walkways;

(4) ladders;

(5) access covers;

(6) location of equipment storage facilities;

(7) lighting fixtures;

(8) container alignment on hatch covers/pedestals;

(9) fittings for specialized containers, such as reefer plugs/receptacles;

(10) first aid stations and emergency access/egress;

(11) gangways; and

(12) any other arrangements necessary for the provision of safe access.

Interpretation: If accepted by the flag Administration, the specific requirements of Cargo Safe Access Plan (CSAP) may take CSS Code Annex 14 for reference, CSS Annex 14 is set out in the Annex. In addition, IACS UI SC265 and UI SC266 are to be considered in the implementation of Annex 14.

Annex 1 Record book of new and replacement of cargo securing devices

Name	Quantity	Manufacturer	Certificate No.	Date	Signature

Annex 2 Record book of cargo securing device inspections and maintenance

Date	Item	Result	Actions of inspection and maintenance	Signature

CSS Annex 1 Safe stowage and securing of containers on deck of ships which are not specially designed and fitted for the purpose of carrying containers

1 Stowage

1.1 Containers carried on deck or on hatches of such ships should preferably be stowed in the fore-and-aft direction.

1.2 Containers should not extend over the ship's sides. Adequate supports should be provided when containers overhang hatches or deck structures.

1.3 Containers should be stowed and secured so as to permit safe access for personnel in the necessary operation of the ship.

1.4 Containers should at no time overstress the deck or hatches on which they are stowed.

1.5 Bottom-tier containers, when not resting on stacking devices, should be stowed on timber of sufficient thickness, arranged in such a way as to transfer the stack load evenly on to the structure of the stowage area. If the lower corner of the container is not permanently welded to the hull structure, the stowage height is recommended not to exceed 1 tier and sufficient wood plates are to be put at the bottom corner fittings (notice: do not touch the threshold or boundary beam of the container). The whole mass of container is to be evenly distributed on the hatch cover or deck.

1.6 The containers are to be locked with tightening devices or other similar tool as far as possible in the process of stowage of containers. Where the stowage height is two tiers or more, the bottom corner fitting of the bottom-tier containers is to be permanently fixed on the stacking device. Containers are to be connected with twistlocks or cones and the top is to be transversely fixed with bridge lock or tensioner. Another way is to prevent the transverse and longitudinal motions with permanently welded limit lever and the containers are connected by cones which cannot be tightened, provided they are to be secured by lashing chains, lashing rod or lashing wires of sufficient strength. If two tiers of containers are to be stowed without permanent stacking devices in the bottom, the bottom is to be secured and to be tightened with twistlock to meet the requirement for the carriage of “deck cargoes”. Where there is no permanent stacking device or transverse connecting cone, the transverse securing at the top and bottom of bridge fitting. In such case, the chucks are to be put in the clearance of corner fittings to get the bridge fitting completely tensioned. Thus the rigidity of stowage is ensured. Where there is no chuck, the bridge fitting may be damaged due to huge working stress. Where there is no permanent stacking device or limit lever, the unit longitudinally stowed is to be secured independently. Surrounding lashing will never be allowed. It is not enough to fix the end of the unit arranged longitudinally with tensioner or bridge fitting only.

1.7 When stowing containers on deck or hatches, the position and strength of the securing points should be taken into consideration.

1.8 It is hard to know the mass of container and its accurate stowage place before the completion of stowing, and sometimes the mass is not determined until the voyage commences. Given this, the mean mass of container of 20ft may be assumed as 20t, and 26t for those of 40ft, the center of gravity located in the geometric center.

1.9 Most of the container is designed to withstand 9 tiers of container height therefore, collapse of the structure rarely occurs. However, in some cases, the lower containers will collapse due to the excessive stress because that the mass of upper containers exceeds the permissible limits. So special attention is to be paid that the mass load of the container is not to exceed the safety limitation.

1.10 Where the containers are carried in the cargo hold, they are to be secured as a solid entirety, and chucks are to be inserted between the top of container and top of the hold to ensure the interlock between cargo units. If get loose, the containers will be worn in heavy weather; If the heavy cargo is carried in upper tier, the corner post will be flexible or get collapsed.

2 Securing

2.1 All containers should be effectively secured in such a way as to protect them from sliding and tipping. Hatch covers carrying containers should be adequately secured to the ship.

2.2 Containers should be secured using one of the three methods recommended in Figure 1 or methods equivalent thereto.

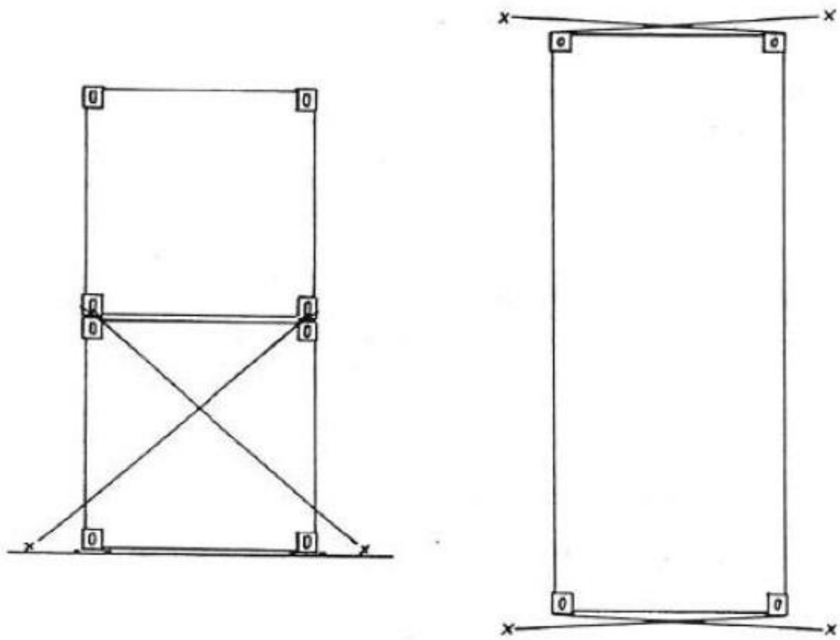


Figure 1(a) Medium-weight containers: weight of top container not more than 70% of that of bottom container

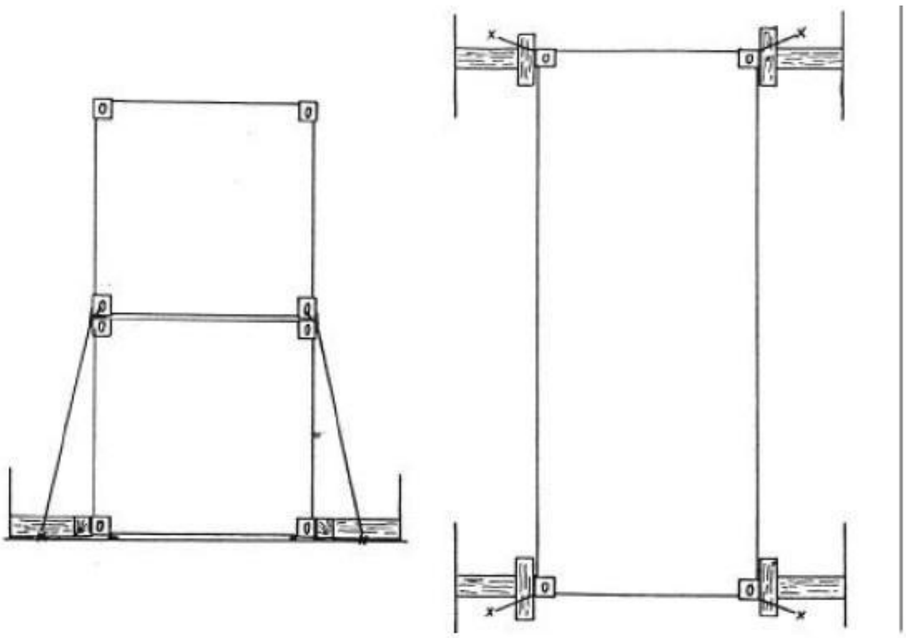


Figure 1(b) Medium-weight containers: weight of top container may be more than 70% of that of bottom container

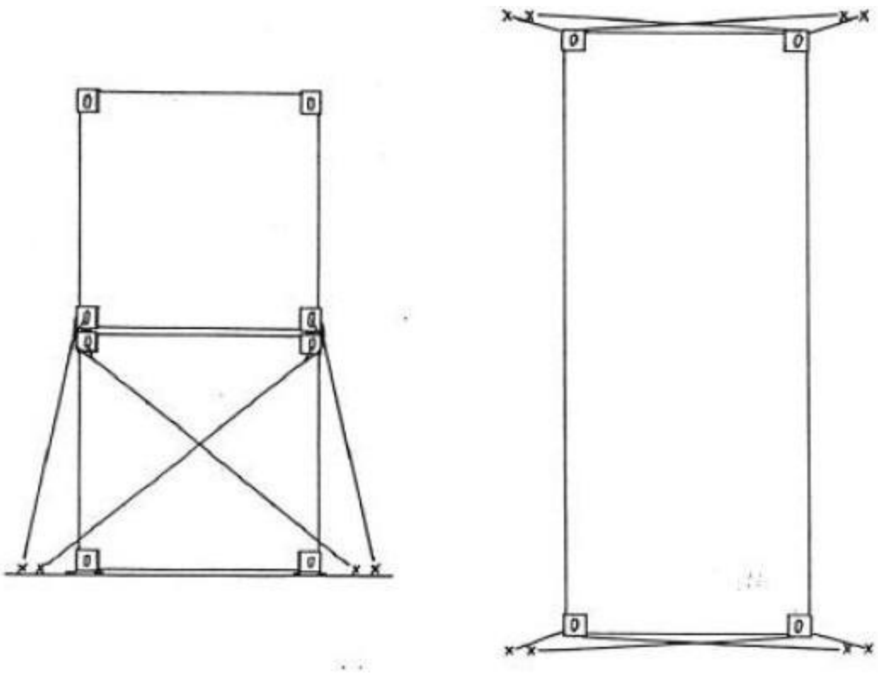


Figure 1(c) Heavyweight containers: weight of top container may be more than 70% of that of bottom container

2.3 Lashings should preferably consist of wire ropes or chains or material with equivalent strength and elongation characteristics.

2.4 Timber shoring should not exceed 2 m in length.

2.5 Wire clips should adequately greased, and tightened so that the dead end of the wire is visibly compressed (Figure 2).

2.6 Lashings should be kept, when possible, under equal tension.

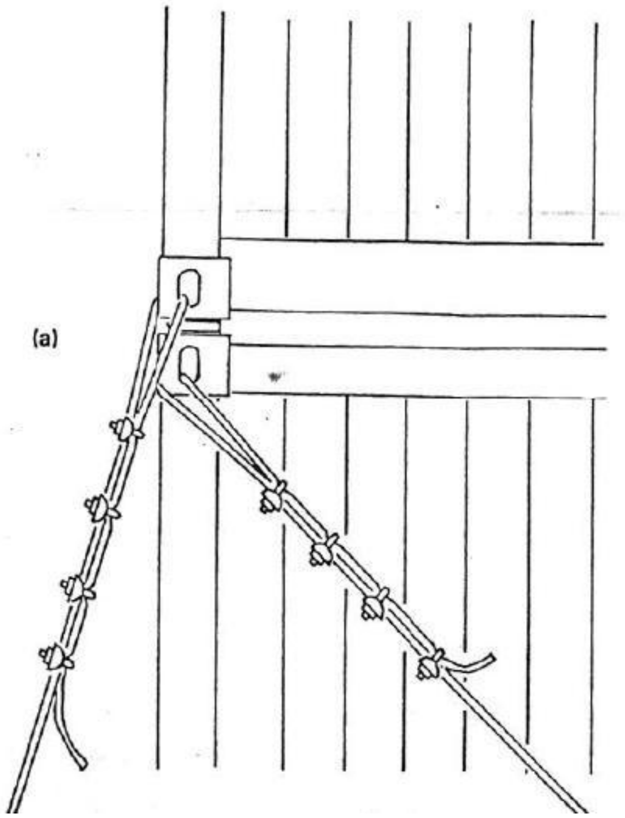


Figure 2(a) Fastening of wire lashings to corner fittings

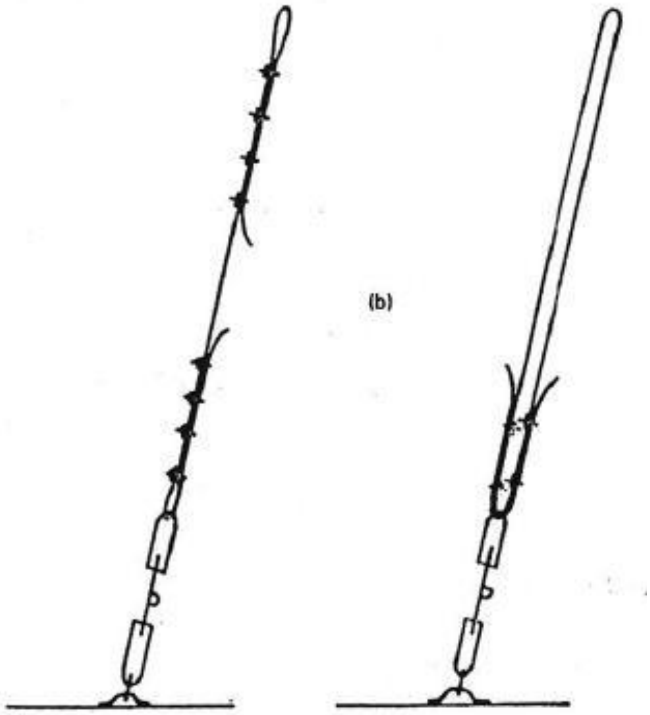


Figure 2(b) Alternative constructions of wire lashings

CSS Annex 2 Safe stowage and securing of portable tanks

1 Introduction

1.1 The provisions of this Annex apply to a portable tank, which in the context of this Annex, means a tank which is not permanently secured on board the vessel and has a capacity of more than 450 *l* and a shell fitted with external stabilizing members and items of service equipment and structural equipment necessary for the transport of liquids, solids or gases.

1.2 These provisions do not apply to tanks intended for the transport of liquids, solids or gases having a capacity of 450 *l* or less.

Note : The capacity for portable tanks for gases is 1,000 *l* or more.

2 General provisions for portable tanks

2.1 Portable tanks should be capable of being loaded and discharged without the need of removal of their structural equipment and be capable of being lifted on to and off the ship when loaded.

2.2 The applicable requirements of the International Convention for Safe Containers (CSC), 1972, as amended, should be fulfilled by any tank-container which meets the definition of a container within the terms of that Convention. Additionally, the provisions of Section 13 of the General Introduction to the IMDG Code should be met when the tank will be used for the transport of dangerous goods.

2.3 Portable tanks should not be offered for shipment in an ullage condition liable to produce an unacceptable hydraulic force due to surge within the tank.

2.4 Portable tanks for the transport of dangerous goods should be certified in accordance with the provisions of the IMDG Code by the competent approval authority or a body authorized by that authority.

3 Portable tank arrangement

3.1 The external stabilizing members of a portable tank may consist of skids or cradles and, in addition, the tank may be secured to a platform-based container. Alternatively, a tank may be fixed within a framework of ISO or non-ISO frame dimensions.

3.2 Portable tank arrangements should include fittings for lifting and securing on board.

Note: All types of the aforementioned portable tanks may be carried on multipurpose ships but need special attention for lashing and securing on board.

4 Cargo information

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

(1) dimensions of the portable tank and commodity if non-dangerous and, if dangerous, the information required in accordance with the IMDG Code;

(2) the gross mass of the portable tank; and

(3) whether the portable tank is permanently secured on to a platform-based container or in a frame and whether securing points are provided.

5 Stowage

5.1 The typical distribution of accelerations of the ship should be borne in mind in deciding whether the portable tank will be stowed on or under deck.

5.2 Tanks should be stowed in the fore-and-aft direction on or under deck.

5.3 Tanks should be stowed so that they do not extend over the ship's side.

5.4 Tanks should be stowed so as to permit safe access for personnel in the necessary operation of the ship.

5.5 At no time should the tanks overstress the deck or hatches; the hatchcovers should be so secured to the ship that tipping of the entire hatchcover is prevented.

6 Securing against sliding and tipping

6.1 Non-standardized portable tanks

6.1.1 The securing devices on non-standardized portable tanks and on the ship should be arranged in such a way as to withstand the transverse and longitudinal forces, which may give rise to sliding and tipping. The lashing angles against sliding should not be higher than 25°and against tipping not lower than 45° to 60° (Figure 1).

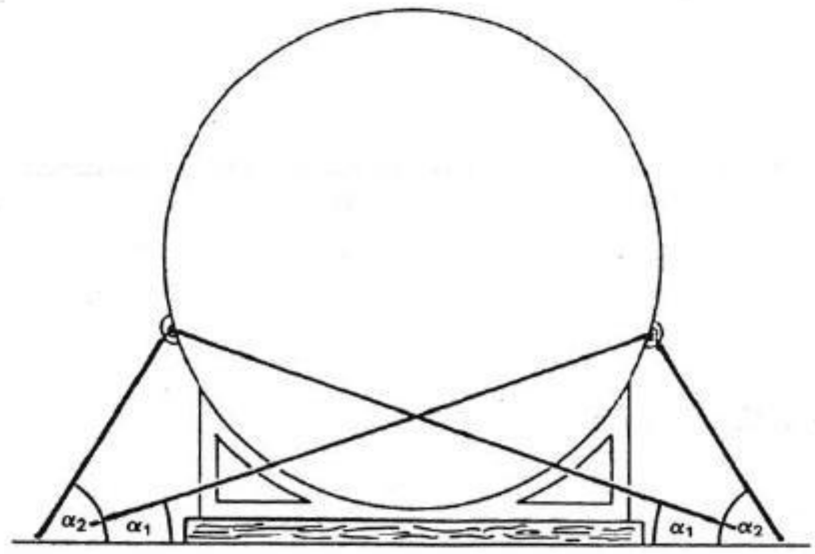


Figure 1 Securing of portable tanks with favourable lashing angles

α1: favourable angle against sliding; α2: favourable angle against tipping

6.1.2 Whenever necessary, timber should be used between the deck surface and the bottom structure of the portable tank in order to increase friction. This does not apply to tanks on wooden units or with similar bottom material having a high coefficient of friction.

6.1.3 If stowage under deck is permitted, the stowage should be such that the portable non-standardized tank can be landed directly on its place and bedding.

6.1.4 Securing points on the tank should be of adequate strength and clearly marked.

Note.: Securing points designed for road and rail-transport may not be suitable for transport by sea.

6.1.5 Lashings attached to tanks without securing points should pass around the tank and both ends of the lashing should be secured to the same side of the tank (Figure 2).

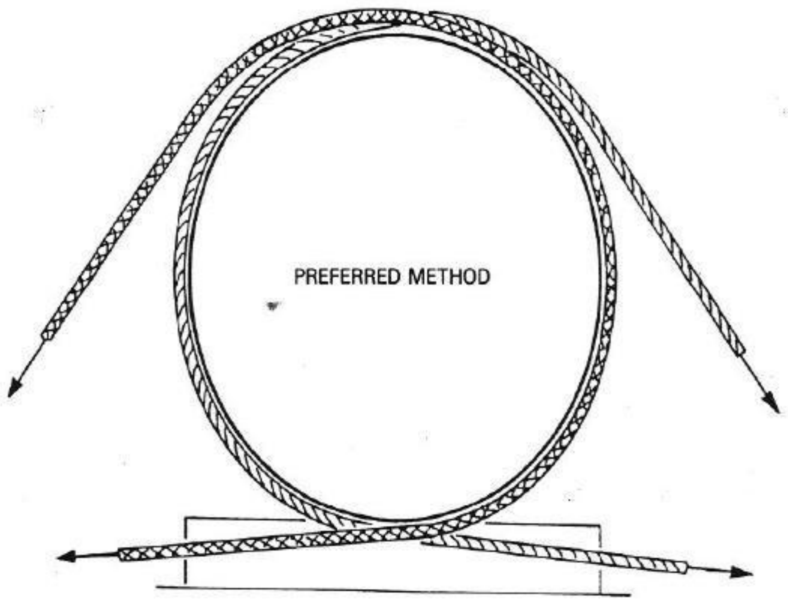


Figure 2 Securing of portable tanks having no securing points

6.1.6 Sufficient securing devices should be arranged in such a way that each device takes its share of the load with an adequate factor of safety.

6.1.7 The structural strength of the deck or hatch components should be taken into consideration when tanks are carried thereon and when locating and affixing the securing devices.

6.1.8 Portable tanks should be secured in such a manner that no load is imposed on the tank or fittings in excess of those for which they have been designed.

6.2 Standardized portable tanks (tank-containers)

6.2.1 Standardized portable tanks with ISO frame dimensions should be secured according to the system of lashing with which the ship is equipped, taking into consideration the height of the tank above the deck and the ullage in the tank.

7 Maintenance of securing arrangements

7.1 The integrity of the securing arrangements should be maintained throughout the voyage.

7.2 Particular attention should be paid to the need for tight lashings, grips and clips to prevent weakening through chafing.

7.3 Lashings should be regularly checked and retightened.

CSS Annex 3 Safe stowage and securing of portable receptacles

1 Introduction

1.1 A portable receptacle, in the context of these guidelines, means a receptacle not being a portable tank, which is not permanently secured on board the ship and has a capacity of 1,000 *l* or less and has different dimensions in length, width, height and shape and which is used for the transport of gases or liquids.

2 Portable receptacles can be divided into:

2.1 cylinders of different dimensions without securing points and having a capacity not exceeding 150 *l*;

2.2 receptacles of different dimensions with the exception of cylinders in conformity with 2.1 having a capacity of not less than 100 *l* and not more than 1,000 *l* and whether or not fitted with hoisting devices of sufficient strength; and

2.3 assemblies, known as "frames", of cylinders in conformity with 2.1, the cylinders being interconnected by a manifold within the frame and held firmly together by metal fittings. The frames are equipped with securing and handling devices of sufficient strength (e.g. cylindrical receptacles are equipped with rolling hoops and receptacles are secured on skids).

3 Cargo information

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

(1) dimensions of the receptacle and commodity if non-dangerous and, if dangerous, the information as required in accordance with the IMDG Code;

(2) gross mass of the receptacles; and

(3) whether or not the receptacles are equipped with hoisting devices of sufficient strength.

4 Stowage

4.1 The typical distribution of accelerations of the ship should be borne in mind in deciding whether the receptacles should be stowed on or under deck.

4.2 The receptacles should preferably be stowed in the fore-and-aft direction on or under deck.

4.3 Receptacles should be dunnaged to prevent their resting directly on a steel deck. They should be stowed and chocked as necessary to prevent movement unless mounted in a frame as a unit. Receptacles for liquefied gases should be stowed in an upright position.

4.4 When the receptacles are stowed in an upright position, they should be stowed in a block, cribbed or boxed in with suitable and sound timber. The box or crib should be dunnaged underneath to provide clearance from a steel deck. The receptacles in a box or crib should be braced to prevent movement. The box or crib should be securely chocked and lashed to prevent movement in any direction.

5 Securing against sliding and shifting

5.1 Cylinders

Cylinders should be stowed fore-and-aft on athwartships dunnage. Where practicable, the stow should be secured by using two or more wires, laid athwartships prior to loading, and passed around the stow to securing points on opposite sides. The wires are tightened to make a compact stow by using appropriate tightening devices. During loading, wedges may be necessary to prevent cylinders rolling.

5.2 Cylinders in containers

Cylinders should, whenever practicable, be stowed upright with their valves on top and with their protective caps firmly in place. Cylinders should be adequately secured, so as to withstand the rigours of the intended voyage, by means of steel strapping or equivalent means led to lashing points on the container floor. When cylinders cannot be stowed upright in a closed container, they should be carried in an open top or a platform-based container.

5.3 Receptacles

Securing of receptacles stowed on or under deck should be as follows:

(1) lashings should be positioned as shown in Figure 1;

(2) where possible, the hoisting devices on receptacles should be used to lash them; and

(3) at regular times the lashings should be checked and retightened.

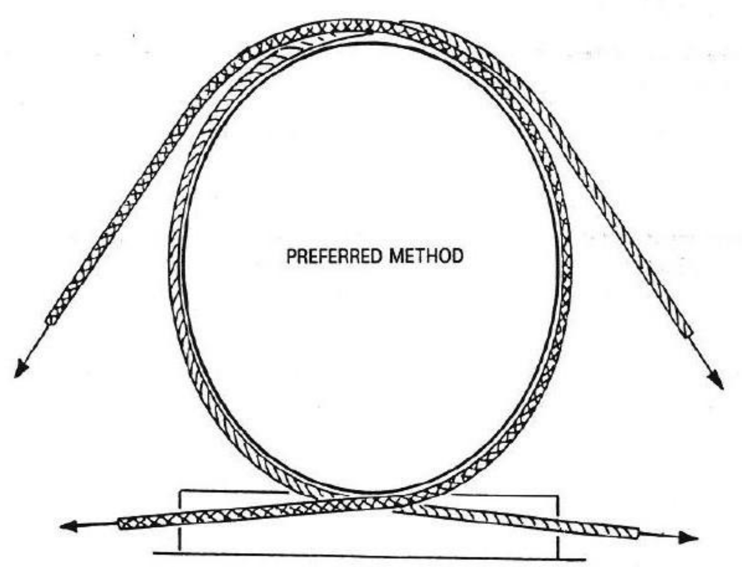


Figure 1 Securing of receptacles having no securing points

CSS Annex 4 Safe stowage and securing of wheel-based (rolling) cargoes

1 Introduction

Wheel-based cargoes, in the context of these guidelines, are all cargoes which are provided with wheels or tracks, including those which are used for the stowage and transport of other cargoes, except trailers and road-trains (covered by Chapter 4 of this Code), but including buses, military vehicles with or without tracks, tractors, earth-moving equipment, roll-trailers, etc.

2 General recommendations

2.1 The cargo spaces in which wheel-based cargo is to be stowed should be dry, clean and free from grease and oil.

2.2 Wheel-based cargoes should be provided with adequate and clearly marked securing points or other equivalent means of sufficient strength to which lashings may be applied.

2.3 Wheel-based cargoes which are not provided with securing points should have those places, where lashings may be applied, clearly marked.

2.4 Wheel-based cargoes, which are not provided with rubber wheels or tracks with friction-increasing lower surface, should always be stowed on wooden dunnage or other friction-increasing material such as soft boards, rubber mats, etc.

2.5 When in stowage position, the brakes of a wheel-based unit, if so equipped, should be set.

2.6 Wheel-based cargoes should be secured to the ship by lashings made of material having strength and elongation characteristics at least equivalent to steel chain or wire.

2.7 Where possible, wheel-based cargoes, carried as part cargo, should be stowed close to the ship's side or in stowage positions which are provided with sufficient securing points of sufficient strength, or be block-stowed from side to side of the cargo space.

2.8 To prevent any lateral shifting of wheel-based cargoes not provided with adequate securing points, such cargoes should, where practicable, be stowed close to the ship's side and close to each other, or be blocked off by other suitable cargo units such as loaded containers, etc.

2.9 To prevent the shifting of wheel-based cargoes, it is, where practicable, preferable to stow those cargoes in a fore-and-aft direction rather than athwartships. If wheel-based cargoes are inevitably stowed athwartships, additional securing of sufficient strength may be necessary.

2.10 The wheels of wheel-based cargoes should be blocked to prevent shifting.

2.11 Cargoes stowed on wheel-based units should be adequately secured to stowage platforms or, where provided with suitable means, to its sides. Any movable external components attached to a wheel-based unit, such as derricks, arms or turrets should be adequately locked or secured in position.

CSS Annex 5 Safe stowage and securing of heavy cargo items such as locomotives, transformers, etc.

1 Cargo information

The master should be provided with sufficient information on any heavy cargo offered for shipment so that he can properly plan its stowage and securing; the information should at least include the following:

1.1 gross mass;

1.2 principal dimensions with drawings or pictorial descriptions, if possible;

1.3 location of the centre of gravity;

1.4 bedding areas and particular bedding precautions if applicable;

1.5 lifting points or slinging positions; and

1.6 securing points, where provided, including details of their strength.

2 Location of stowage

2.1 When considering the location for stowing a heavy cargo item, the typical distribution of accelerations on the ship should be kept in mind:

(1) lower accelerations occur in the midship sections and below the weather deck; and

(2) higher accelerations occur in the end sections and above the weather deck.

2.2 When heavy items are to be stowed on deck, the expected "weather side" of the particular voyage should be taken into account if possible.

2.3 Heavy items should preferably be stowed in the fore-and-aft direction.

3 Distribution of weight

The weight of the item should be distributed in such a way as to avoid undue stress on the ship's structure. Particularly with the carriage of heavy items on decks or hatch covers, suitable beams of timber or steel of adequate strength should be used to transfer the weight of the item on to the ship's structure.

4 Cargo stowed in open containers, on platforms or platform-based containers

4.1 While the stowage and securing of open containers, ISO platform or platform-based containers (flatracks) on a container ship or a ship fitted or adapted for the carriage of containers, should follow the information for that system, the stowage and securing of the cargo in such containers, should be carried out in accordance with the IMO)/ILO Guidelines for Packing Cargo in Freight Containers or Vehicles.

4.2 When heavy cargo items are carried on ISO) platform or platform-based containers (flatracks) the provisions of this Annex should be followed. Additionally, the following items should be taken into account:

.1 The ISO standard platform, etc. , used should be of a suitable type with regard to strength and MSL of the securing points.

.2 The weight of the heavy cargo item should be properly distributed.

.3 Where deemed necessary the heavy cargo item(s) carried on ISO standard platform or platform-based containers, etc., should not only be secured to the platform(s) or platform-based containers, etc., but also to neighbouring platforms (s), etc., or to securing points located at fixed structure of the ship. The elasticity of the last mentioned lashings should be sufficiently in line with the overall elasticity of the stowage block underneath the heavy cargo item(s) in order to avoid overloading those lashings.

5 Securing against sliding and tipping

5.1 Whenever possible, timber should be used between the stowage surface and the bottom of the unit in order to increase friction. This does not apply to items on wooden cradles or on rubber tyres or with similar bottom material having a high coefficient of friction.

5.2 The securing devices should be arranged in a way to withstand transverse and longitudinal forces which may give rise to sliding or tipping.

5.3 The optimum lashing angle sliding is about 25°, while the optimum lashing angle against tipping is generally found between 45°and 60° (Figure 1).

5.4 If a heavy cargo item has been dragged into position on greased skid boards or other means to reduce friction, the number of lashings used to prevent sliding should be increased accordingly.

5.5 If, owing to circumstances, lashings can be set at large angles only, sliding must be prevented by timber shoring, welded fittings or other appropriate means. Any welding should be carried out in accordance with accepted hot work procedures.

6 Securing against heavy seas on deck

Whilst it is recognized that securing cargo items against heavy seas on deck is difficult, all efforts should be made to secure such items and their supports to withstand such impact and special means of securing may have to be considered.

7 Heavy cargo items projecting over the ship’s side

Items projecting over the ship's side should be additionally secured by lashings acting in longitudinal and vertical directions.

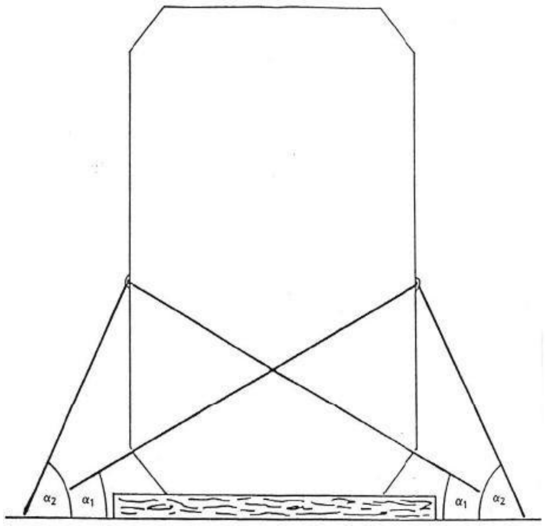


Figure 1 Principles of securing heavy items against sliding and tipping

α1: favourable lashing angle against sliding; α2: favourable lashing angle against tipping

8 Attachment of lashings to heavy cargo items

8.1 If lashings are to be attached to securing points on the item, these securing points should be of adequate strength and clearly marked. It should be borne in mind that securing points designed for road or rail transport may not be suitable for securing the items on board ship.

8.2 Lashings attached to items without securing points should pass around the item, or a rigid part thereof, and both ends of the lashing should be sectored to the same side of the unit (Figure 2).

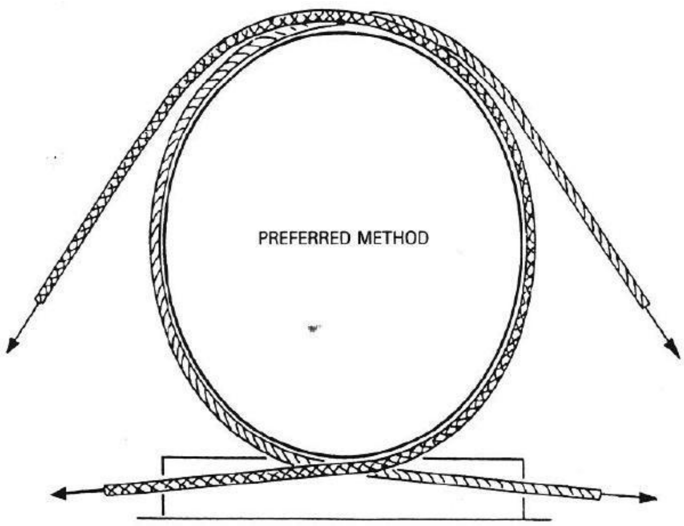


Figure 2 Principle of securing heavy items leaving no suitable securing points

9 Composition and application of securing devices

9.1 Securing devices should be assembled so that each component is of equal strength.

9.2 Connecting elements and tightening devices should be used in the correct way. Consideration should be given to any reduction of the strength of the lashings during the voyage through corrosion, fatigue or mechanical deterioration and should be compensated by using stronger securing material.

9.3 Particular attention should be paid to the correct use of wire, grips and clips. 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.

9.4 Securing devices should be arranged in such a way that each device takes its share of load according to its strength.

9.5 Mixed securing arrangements of devices with different strength and elongation characteristics should be avoided.

10 Maintenance of securing arrangements

10.1 The integrity of the securing arrangements should be maintained throughout the voyage.

10.2 Particular attention should be paid to the need for tight lashings, grips and clips and to prevent weakening through chafing. Timber cradles, beddings and shorings should be checked.

10.3 Greasing the thread of clips and turnbuckles increases their holding capacity and prevents corrosion.

11 Securing calculation

11.1 Where necessary, the securing arrangements for heavy cargo items should be verified by an appropriate calculation in accordance with Annex 13 to the Code.

CSS 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 slowed 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).

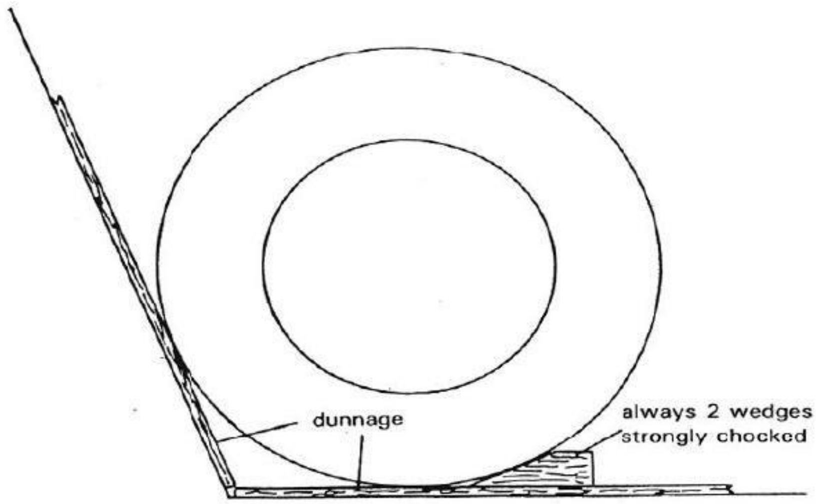


Figure 1 Principle of dunnaging and wedging coils

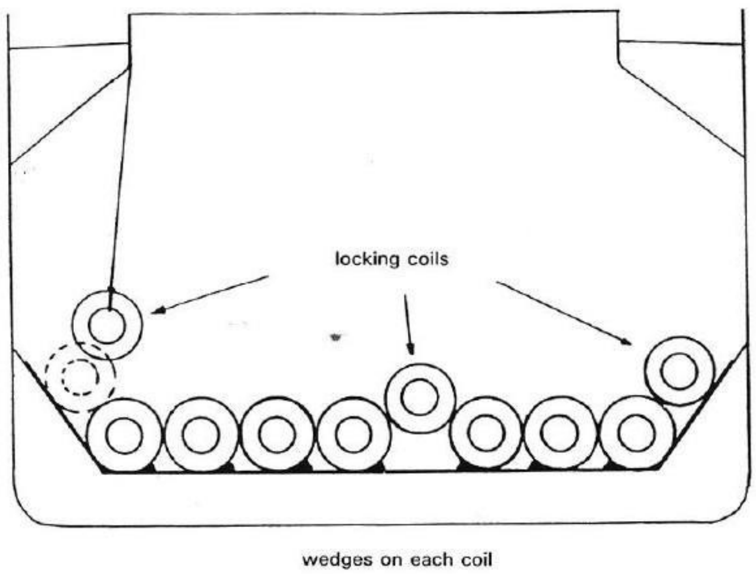


Figure 2 Inserting of locking coils

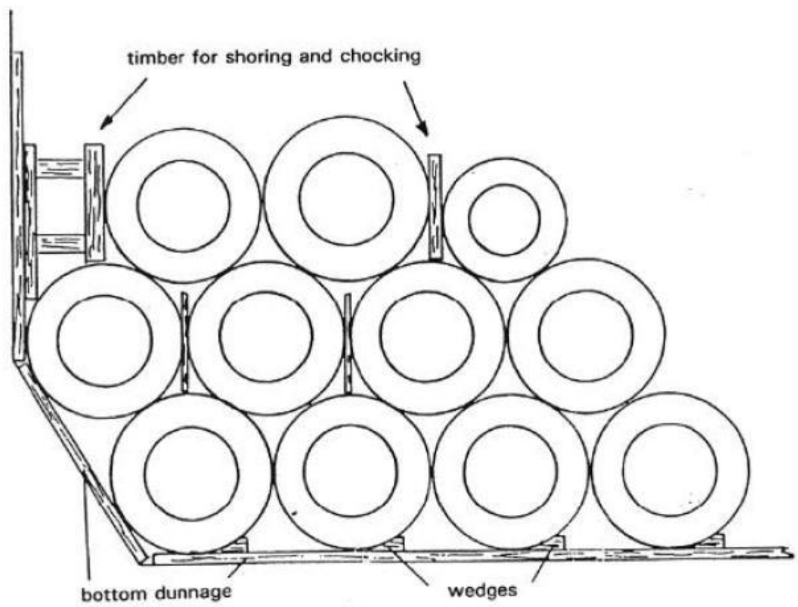


Figure 3 Shoring and chocking in voids between coils

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).

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 retighten 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.

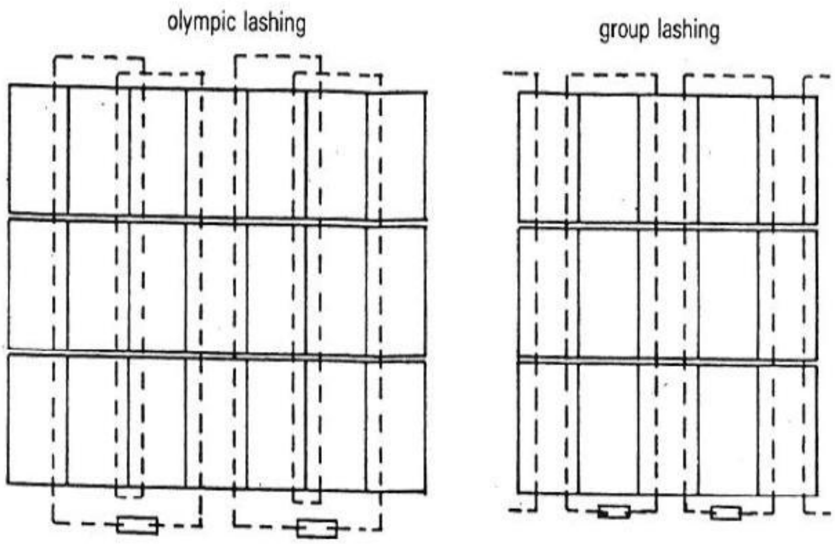


Figure 4 Securing of top tier against fore-and-aft shifting (view from top)

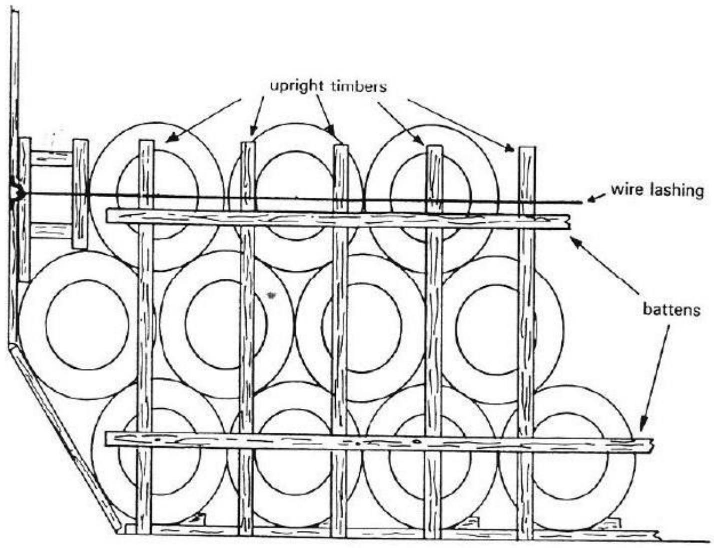


Figure 5 Securing of end row in top tier against fore-and-aft shifting

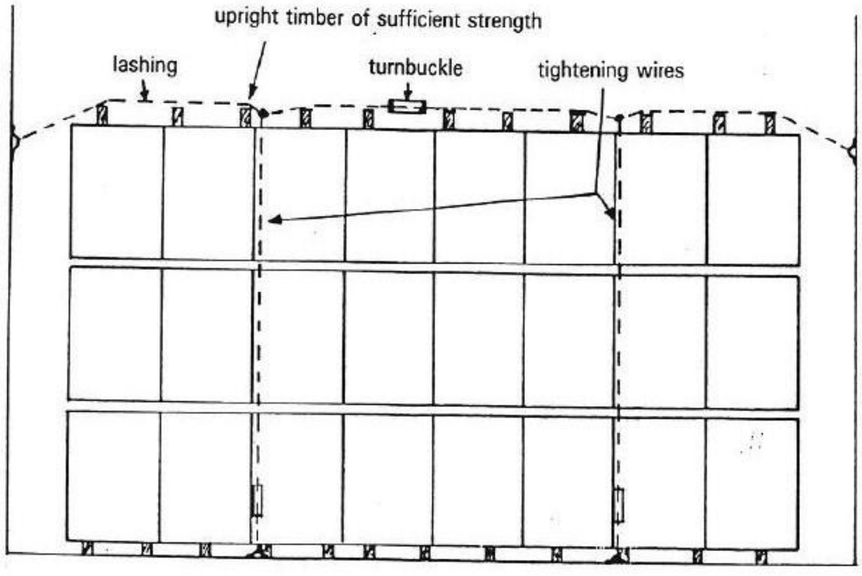


Figure 6 Securing of end row in top tier against fore-and-aft shifting (view from top)

CSS 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:

1.2.1 overstressing of the ship's structure if the permissible hull stress or permissible deck loading is exceeded;

1.2.2 overstressing of the ship's structure as a result of a short roll period caused by excessive metacentric height; and

1.2.3 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:

2.4.1 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;

2.4.2 cargo should be stowed level whenever possible and practicable;

2.4.3 the surface of the cargo should be secured; and

2.4.4 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 athwartships 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:

2.7.1 having other cargo stowed on top of it; or

2.7.2 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 stowages 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.

CSS 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 on to 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 on to 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.

CSS Annex 9 Safe stowage and securing of bulk metal scrap

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:

1.2.1 shifting of the stow which in turn can cause a list;

1.2.2 shifting of individual heavy pieces which can rupture the side plating below the waterline and give rise to serious flooding;

1.2.3 excessive loading on tank tops or 'tween-decks; and

1.2.4 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.

CSS Annex 10 Safe stowage and securing of flexible intermediate bulk containers

1 Introduction

1.1 A flexible intermediate bulk container (FIBC), in the context of these guidelines, means a flexible portable packaging to be used for the transport of solids with a capacity of not more than 3 m^3 (3,000 *l*) designed for mechanical handling and tested for its satisfactory resistance to transport and transport stresses in a one-way type or multi-purpose design.

2 Cargo information

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

2.1 the total number of FIBCs and the commodity to be loaded;

2.2 the dimensions of the FIBCs;

2.3 the total gross mass of the FIBCs;

2.4 one-way type or multi-purpose design; and

2.5 the kind of hoisting (one hook or more hooks to be used).

3 Recommendations

3.1 The ideal ship for the carriage of FIBCs is one with wide hatches so that the FIBCs can be landed directly in the stowage positions without the need for shifting.

3.2 The cargo spaces should, where practicable, be rectangular in shape and free of obstructions.

3.3 The stowage space should be clean, dry and free from oil and nails.

3.4 When FIBCs have to be stowed in deep hatch wings, easy access and sufficient manoeuvring space for suitably adapted fork-lift trucks should be available.

3.5 When FIBCs are stowed in the hatchway only, the space in the wings and the forward and aft end of the cargo space should be loaded with other suitable cargo or blocked off in such a way that the FIBCs are adequately supported.

4 Stowage

4.1 The typical distribution of the accelerations of the ship should be kept in mind when FIBCs are loaded.

4.2 The width of the ship divided by the width of the FIBC will give the number of FIBCs which can be stowed athwartships and the void space left. If there will be a void space, the stowage of the FIBCs should start from both sides to the centre, so that any void space will be in the centre of the hatchway.

4.3 FIBCs should be stowed as close as possible against each other and any void space should be chocked off.

4.4 The next layers should be stowed in a similar way so that the FIBCs fully cover the FIBCs underneath. If in this layer a void space is left, it should also be chocked off in the centre of the hatchway.

4.5 When there is sufficient room in the hatchway on top of the layers underneath to stow another layer, it should be established whether the coamings can be used as bulkheads. If not, measures should be taken to prevent the FIBCs shifting to the open space in the wings. Otherwise, the FIBCs should be stowed from one coaming to another. In both cases any void space should be in the centre and should be chocked off.

4.6 Chocking off is necessary in all cases to prevent shifting of the FIBCs to either side and to prevent a list of the ship developing in rough weather (Figure 1).

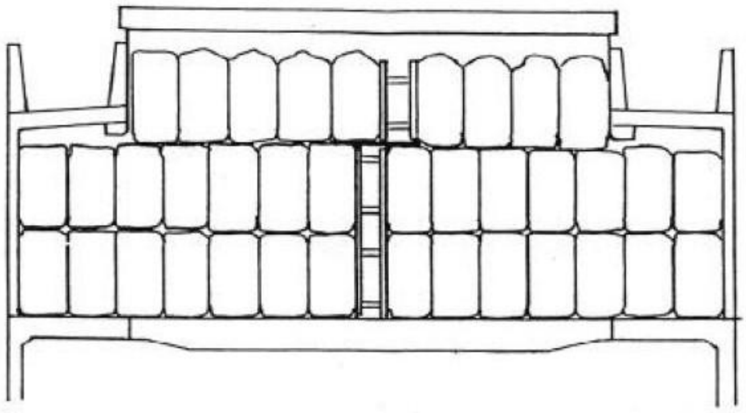


Figure 1 Stowage of FIBCs with chocked void spaces in the centre of the stowage area

5 Securing

5.1 In cases where only a part of a 'tween-deck or lower hold is used for the stowage of FIBCs, measures should be taken to prevent the FIBCs from shifting. These measures should include sufficient gratings or plywood sheets placed against the FIBCs and the use of wire lashings from side to side to secure the FIBC cargo.

5.2 The wire lashings and plywood sheets used for securing should be regularly checked, in particular before and after rough weather, and retightened if necessary.

CSS Annex 11 General guidelines for the under-duck 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:

2.1 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;

2.2 using the above information, a pre-stow plan should be developed to allow the maximum utilization of the available space; the better the under-deck stowage, the more cargo can safely be carried on deck;

2.3 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;

2.4 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;

2.5 the bilge wells should be free of extraneous material such as wood bark and wood splinters;

2.6 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;

2.7 side sparring, pipe guards, etc., designed to protect internal hull members should be in place; and

2.8 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 apparently inexplicable list, a shift of deck cargo, and potential capsize.

3 During loading operations:

3.1 each lift of logs should be hoisted aboard the ship in close proximity to the ship to minimize any potential swinging of the lift;

3.2 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;

3.3 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;

3.4 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;

3.5 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;

3.6 athwartship voids should be filled tier by tier as loading progresses;

3.7 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;

3.8 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;

3.9 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;

3.10 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;

3.11 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

3.12 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

5.1 the ship's heeling angle and rolling period should be checked, in a seaway, on a regular basis;

5.2 wedges, wastes, hammers and portable pump, if provided, should be stored in an easily accessible place; and

5.3 the master or a responsible officer should ensure that it is safe to enter an enclosed cargo space by:

5.3.1 ensuring that the space has been thoroughly ventilated by natural or mechanical means;

5.3.2 testing the atmosphere of the space at different levels for oxygen deficiency and harmful vapour where suitable instruments are available; and

5.3.3 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.

CSS Annex 12 Safe stowage and securing of unit loads

1 Introduction

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

1.1 placed or stacked, and secured by strapping, shrink-wrapping or other suitable means, on a load board such as a pallet; or

1.2 placed in a protective outer packaging such as a pallet box; or

1.3 permanently secured together in a sling.

Note: A single large package such as a portable tank or receptable, 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:

2.1 the total number of unit loads and commodity to be loaded;

2.2 the type of strapping or wrapping used;

2.3 the dimensions of a unit load in metres; and

2.4 the gross mass of a unit load in kilograms;

2.5 relevant examination certificates for per-slings around cargo units. The slings should be identified by specific means, e.g. colour coding, batch numbers or otherwise.

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).

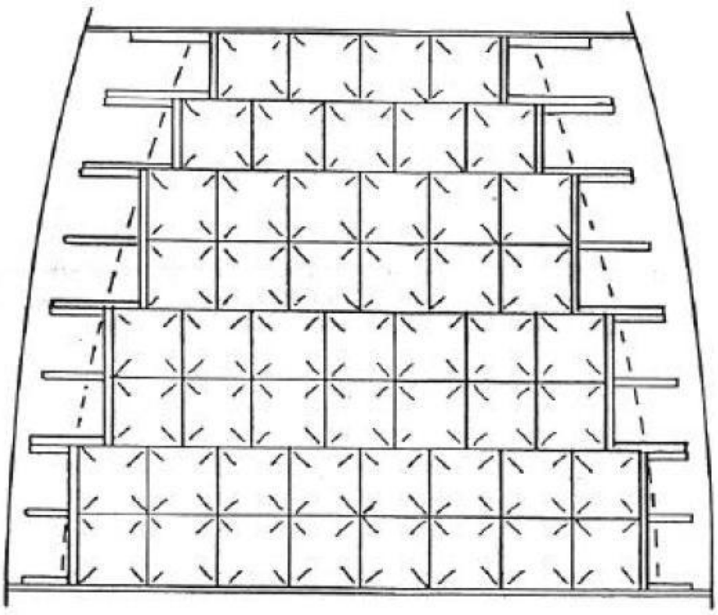


Figure 1 Stowage and chocking of unit loads in a tapered stowage area (view from top)

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.

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

Block stowage should be ensured and no void space be left between the unit loads.

6 Securing when stowed athwartships

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 wing of a cargo space and free at two sides

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

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).

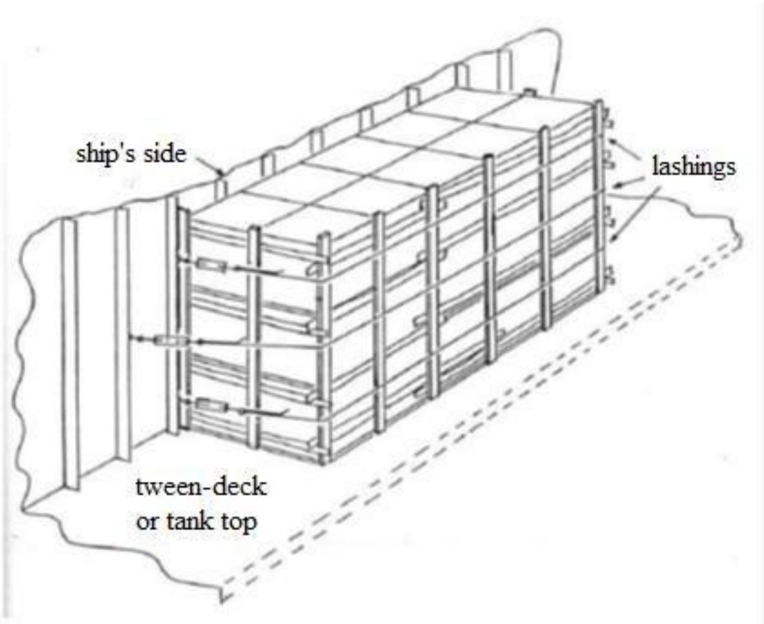


Figure 2 Securing of units stowed at the ship's side

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 retightened if necessary. In particular, after rough weather, wire lashings should be checked and retightened if necessary.

CSS Annex 13 Methods to assess the efficiency of securing arrangements for semi-standardized cargo and non-standardized cargo (IMO MSC.1/Circ.1623)

1 Scope of application

1.1 The methods described in this Annex should be applied to semi-standardized cargo and non-standardized cargo, including very heavy and/or very large cargo items. Standardized stowage and securing systems, in particular containers on containerships, are excluded.

1.2 Cargoes carried on towed barges should be secured according to the provisions of this Annex, except that the assumed external forces may be determined using an alternative method acceptable to the Administration instead of that described in Section 7.1 of this Annex.

1.3 Very heavy and/or very large cargo items as addressed in Chapter 1.8 of CSS Code may require provisions and considerations beyond the general scope of this Annex. Examples of such provisions and considerations are given in Appendix 3 of this Annex.

1.4 Semi-standardized cargoes, for which the securing arrangements are often designed based on worst case assumptions on cargo properties, lashing angles and stowage positions on board, may require provisions and considerations beyond the general scope of this Annex. Examples of such provisions and considerations are given in Appendix 4 of this Annex.

1.5 Notwithstanding the general principles contained in this Annex, the adequacy of cargo securing may be demonstrated by means of detailed engineering calculations based upon the general principles and encompassing the additional provisions and considerations shown in Appendix 3 of this Annex. Computer programs used for that purpose should be validated against a suitable range of model tests or full-scale results in irregular seas. When using new software for new and unconventional applications, the validation should be documented.

1.6 The application of the methods described in this Annex is supplementary to the principles of good seamanship and should not replace experience in stowage and securing practice.

2 Purpose of the methods

The methods should:

2.1 provide guidance for the preparation of Cargo Securing Manuals and the examples therein;

2.2 assist ship's staff in assessing the securing of cargo items not covered by the Cargo Securing Manual;

2.3 assist qualified shore personnel in assessing the securing of cargo items not covered by the Cargo Securing Manual;

2.4 serve as a reference for maritime and port-related education and training.

3 Presentation of the methods

The methods are presented in a universally applicable and flexible way. It is recommended that designers of Cargo Securing Manuals convert this presentation into a format suiting the particular ship, its securing equipment and the cargo carried. This format may include applicable diagrams, tables or calculated examples.

4 Strength of securing equipment

4.1 Manufacturers of securing equipment should at least supply information on the nominal breaking strength of the equipment in kilonewtons (kN).

4.2 The MSLs for different securing devices are given in the table below if not given under 4.3. Safe Working Load (SWL) may be substituted for MSL for securing purposes, provided this is equal to or exceeds the strength defined by MSL. The MSL of timber should be taken as 0.3kN/cm^2 normal to the grain.

Table 1 – Determination of MSL from breaking strength

Material	M_{SL}
shackles, rings, deckeyes, turnbuckles of mild steel	50 % of breaking strength
fibre rope	33 % of breaking strength
web lashing	50% of breaking strength
wire rope (single use)	80 % of breaking strength
wire rope (re-usable)	30 % of breaking strength
steel band (single use)	70% of breaking strength
chains'	50 % of breaking strength

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

4.4 When the components of a lashing device are connected in series (e.g. a wire to a shackle to a deckeye), the minimum MSL in the series should apply to that device.

4.5 Where temporary welded fittings are used, they should be designed to be adequate for the expected loading, and installed by qualified welders in accordance with established welding procedures. The design and placement of these fittings should be such as to minimize bending.

4.6 Simple stoppers may be used to provide securing against sliding. These are generally welded to a surface by fillet welds, characterized by thickness (*a*) and length (*l*). A face plate should be provided against the cargo piece so that welds are not loaded by a shear force at right angles to the weld direction or by significant bending forces. As a simple rule of thumb for welded steel stoppers, the MSL of single-lay weld leg can then be approximated as 4kN/cm (*l*) normal to the face plate, assuming 5 mm weld thickness (*a*). For a triple-lay weld leg, MSL can be taken as 10kN/cm normal to the face plate.

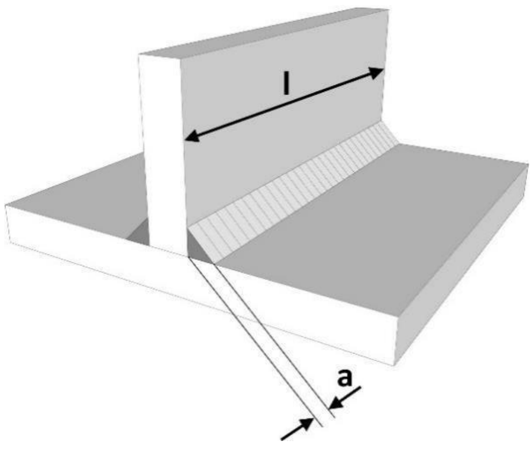


Figure 1 – Welding of steel stoppers

4.7 All securing devices to be accounted for in the balance calculations described in this Annex should be capable of transferring forces directly from the vessel to the cargo or vice versa, in order to reflect their MSLs. For that purpose, lashings should be attached to fixed securing points or strong supporting structures marked on the cargo item or advised as being suitable, or taken as a loop around the item with both ends secured to the same side as shown in Annex 5 of CSS Code. Lashings going over the top of the cargo item, whose only function is to increase friction by their pre-tension, cannot be credited in the evaluation of securing arrangements under this Annex.

5 Rule-of-thumb method

5.1 The total of the MSL values of the securing devices on each side of a cargo item (port as well as starboard) should equal the weight of the item.

5.2 This method, which implies a transverse acceleration of 1g (9.81 m/s^2), applies to nearly 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 of friction.

5.3 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.

6 Safety factor

6.1 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.

$$\mathrm{CS} = \frac{\mathrm{MSL}}{\text{safety factor}}$$

6.2 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.

6.3 If securing devices of different elasticity are used in the same direction, e.g. welded bottom stoppers and fibre belts or long wire lashings, the more flexible securing devices in such an arrangement should be excluded if they, due to their elongation, do not contribute to preventing initial movement of the cargo.

7 Advanced calculation method

7.1 Assumption of external forces

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

$$F(x,y,z) = m \cdot a(x,y,z) + Fw(x,y) + Fs(x,y)$$

where

$F(x,y,z)$ = longitudinal, transverse and vertical forces;

m = mass of the item;

a(x,y,z) = longitudinal, transverse and vertical accelerations (the basic acceleration data are presented in Table 2);

Fw(x,y) = longitudinal and transverse forces by wind pressure;

Fs(x,y) = longitudinal and transverse forces by sea sloshing.

Table 2 – Basic acceleration data

Transverse acceleration a_y in m/s²										Longitudinal acceleration a_x in m/s²
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/s²										
	7.6	6.2	5.0	4.3	4.3	5.0	6.2	7.6	9.2	

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, and basic acceleration can also be calculated according to the methods in Appendix 3 of the Annex.

7.1.2 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 length of ship is 100 m;

.4 service speed is 15 knots; and

.5 $B/GM \geq 13$ (*B* = moulded breadth of ship, *GM* = metacentric height).

7.1.3 For operation in a restricted area, reduction factors for accelerations may be considered, taking into account the season of the year, the accuracy of the weather forecast affecting the wave heights during the intended voyage and the duration of the voyage. Restricted area means any sea area in which the weather can be forecast for the entire sea voyage or shelter can be found during the voyage.

7.1.4 Reduction factors, f_R, may be applied to significant wave heights, H_s, not exceeding 12 m for the design of securing arrangements in any of the following cases:

.1 The required securing arrangement is calculated for the maximum expected 20-year significant wave height in a particular restricted area and the cargo is always secured according to the designed arrangement when operating in that area.

.2 The maximum significant wave height that a particular securing arrangement can withstand is calculated and the vessel is limited to operating only in significant wave heights up to the maximum calculated. Procedures for ensuring that any operational limitation is not exceeded should be developed and followed and documented in the ship's approved Cargo Securing Manual.

.3 Required securing arrangements are designed for different significant wave heights and the securing arrangement is selected according to the maximum expected wave height for each voyage for which an accurate weather forecast is available. Thus, the duration of the voyage should not exceed 72 hours or a duration as accepted by the Administration.

7.1.5 The basic acceleration data in Table 2 may be multiplied by the following reduction factor:

$f_R = 1 - (H_s - 13)^2 / 240$,

where H_s is:

.1 the maximum expected 20-year significant wave height in the area according to ocean wave statistics; or

.2 the maximum predicted significant wave height on which the operational limitations are based; or

.3 for voyages not exceeding 72 hours， the maximum predicted significant wave height according to weather forecasts.

7.1.6 When weather-dependent lashing is applied, operational procedures for the following activities should be developed, followed and documented in the ship's approved Cargo Securing Manual, or otherwise included in the ship's safety management system:

.1 decision on the level of cargo securing based on the length of the voyage and the weather forecast;

.2 communication to all concerned parties of the decided level of cargo securing for the intended voyage;

.3 execution and supervision of appropriate cargo securing efforts in accordance with the Cargo Securing Manual; and

.4 monitoring of environmental conditions and ship motions to ensure that the applied level of cargo securing is not exceeded.

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

Table 3 – Correction factors for length and service speed

Length(m) / Speed (kn)	50	60	70	80	90	100	120	140	160	180	200
9	1.20	1.09	1.00	0.92	0.85	0.79	0.70	0.63	0.57	0.53	0.49
12	1.34	1.22	1.12	1.03	0.96	0.90	0.79	0.72	0.65	0.60	0.56
15	1.49	1.36	1.24	1.15	1.07	1.00	0.89	0.80	0.73	0.68	0.63
18	1.64	1.49	1.37	1.27	1.18	1.10	0.98	0.89	0.82	0.76	0.71
21	1.78	1.62	1.49	1.38	1.29	1.21	1.08	0.98	0.90	0.83	0.78
24	1.93	1.76	1.62	1.50	1.40	1.31	1.17	1.07	0.98	0.91	0.85

7.1.8 For length/speed combinations not directly tabulated, the following formula may be used to obtain the correction factor:

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

where: v = speed in knots;

L = length between perpendiculars in metres.

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, the transverse acceleration figures should be corrected by a factor given in Table 4.

Table 4 – Correction factors for B/GM

B/*GM*	3	4	5	6	7	8	9	10	11	12	13 or above
on deck, high	2.64	2.28	1.98	1.74	1.56	1.40	1.27	1.19	1.11	1.05	1.00
on deck, low	2.18	1.93	1.72	1.55	1.42	1.30	1.21	1.14	1.09	1.04	1.00
tween deck	1.62	1.51	1.41	1.33	1.26	1.19	1.14	1.09	1.06	1.03	1.00
lower hold	1.24	1.23	1.20	1.18	1.15	1.12	1.09	1.06	1.04	1.02	1.00

7.1.9 The following should be observed:

.1 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;

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

.3 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;

.4 Forces by wind and sea to cargo items above the weather deck should be accounted for by a simple approach:
force by wind pressure = 1 kN per m^2;
force by sea sloshing = 1 kN per m^2

.5 The wind force may be reduced by the same principles as the accelerations, i.e. multiplying it with a reduction factor, f_R, based on the expected significant wave height;

.6 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;

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

.8 For voyages in a restricted area and with forecast wave heights for which no sea sloshing is expected, sea sloshing forces may be neglected.

7.2 Balance of forces and moments

7.2.1 The balance calculation should preferably be carried out for:

.1 transverse sliding in port and starboard directions;

.2 transverse tipping in port and starboard directions; and

.3 longitudinal sliding under conditions of reduced friction in forward and aft directions.

7.2.2 In the case of symmetrical securing arrangements, one appropriate calculation for each case above is sufficient.

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

Table 5 – Friction coefficients

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

A friction increasing material or deck coating with higher friction coefficients may be used assuming a certified conservative friction coefficient and the endurable shear stress of the material under repeated loads, as they occur in heavy weather at sea. The applicability of these data should be reviewed with due consideration of the prevailing conditions in terms of moisture, dust, greasy dirt, frost, ice or snow as well as the local pressure applied (weight per area) to the material. Specific advice on this matter as well as instructions for maintenance of coatings should be included in the ship's Cargo Securing Manual, if appropriate.

7.2.4 Transverse sliding

7.2.4.1 The balance calculation should meet the following condition (see also Figure 12):

$$F_y \leqslant \mu \cdot m \cdot g + CS_1 \cdot f_1 + CS_2 \cdot f_2 + \cdots + CS_n \cdot f_n$$

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/s^2);

CS is calculated strength of transverse securing devices (kN), CS=MSL/1.5;

f is a function or μ and vertical securing angle α (see Table 6).

7.2.4.2 A vertical securing angle α greater than 60° will reduce the effectiveness of this particular securing device in respect to sliding of the item. 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.

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

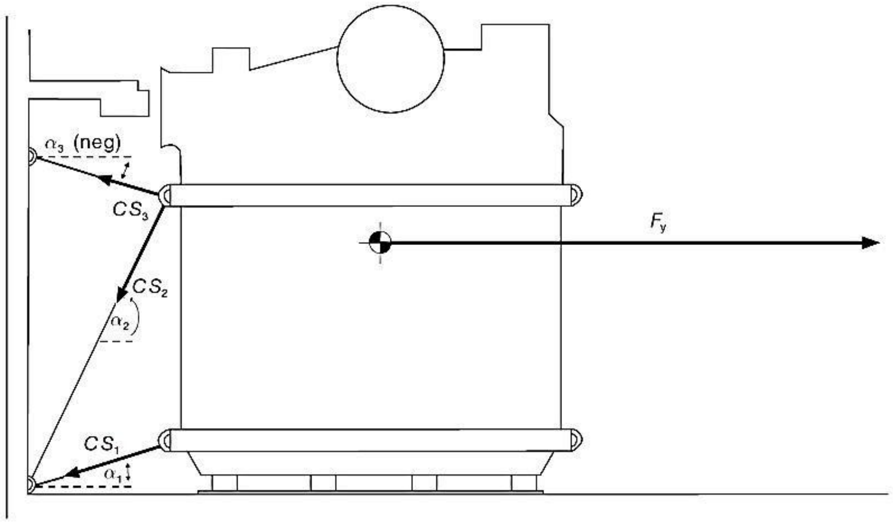


Figure 2 – Balance of transverse forces

Table 6 – f values as a function of α and μ

α / μ	-30°	-20°	-10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
0.3	0.72	0.82	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

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

7.2.4.4 As an alternative to using Table 6 to determine the forces in a securing arrangement, the method outlined in Paragraph 7.3 can be used to take account of transverse and longitudinal components of lashing forces.

7.2.5 Transverse tipping

This balance calculation should meet the following condition (see also Figure 3):

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

where:

F_y, m, g, CS, n are as explained under 7.2.1.;

a is lever-arm of tipping (m) (see Figure 3);

b is lever-arm of stableness (m) (see Figure 3);

c is lever-arm of securing force (m) (see Figure 3).

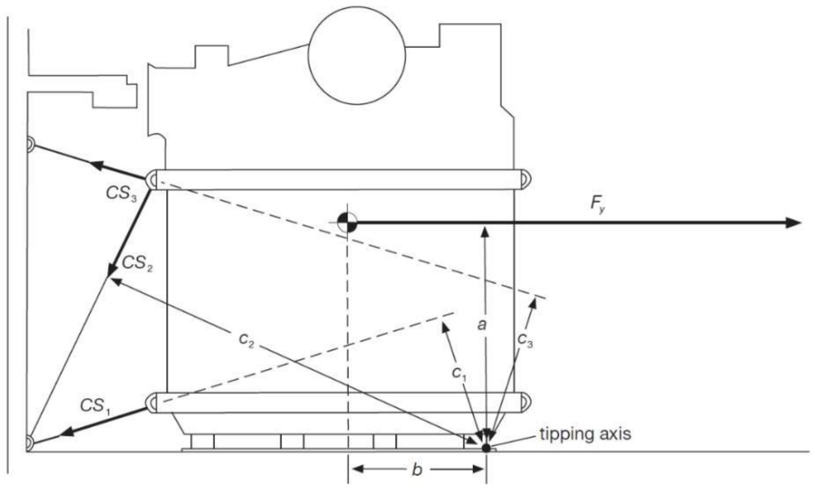


Figure 3 – Balance of transverse moments

7.2.6 Longitudinal sliding

7.2.6.1 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:

$$Fx \leqslant \mu \cdot (m \cdot g - fz \cdot Fz) + CS1 \cdot f1 + CS2 \cdot f2 + \ldots + CSn \cdot fn$$

where:

F_x is longitudinal force from load assumption (kN)

μ , *m*, *g*, *f*, *n* are as explained under 7.2.1

F_z is vertical force from load assumption (kN)

f_z is a correction factor for the vertical force, depending on friction as indicated below:

μ	0.0	0.1	0.2	0.3	0.4	0.6
f_z	0.20	0.50	0.70	0.80	0.85	0.90

7.2.6.2 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.

7.2.6.3 Instead of service speed, a reduced operational speed is allowed to be used when the correction factor for length and speed is calculated according to Table 3 for the correction of the longitudinal and vertical accelerations. The longitudinal acceleration calculated using Table 3 in this Annex should be verified by monitoring during the voyage. When necessary, the speed should be further reduced in order to ensure that the calculated acceleration is not exceeded. In the Cargo Securing Manual, it should be noted that the speed has to be reduced in heavy head seas to avoid longitudinal shifting of cargo. It should also be noted for which speed the accelerations in longitudinal direction have been calculated.

Note: Correction factors for speeds less than the service speed are not allowed for the correction of transverse accelerations.

7.2.7 Calculated example

A calculated example for this method is shown in Appendix 1 of Annex 13.

7.3 Balance of forces – alternative method

7.3.1 The balance of forces described in paragraphs 7.2.4 and 7.2.6 will normally furnish a sufficiently accurate determination of the adequacy of the securing arrangement. However, this alternative method allows a more precise consideration of horizontal securing angles.

7.3.2 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 quadrantal mode, i.e. between 0° and 90°.

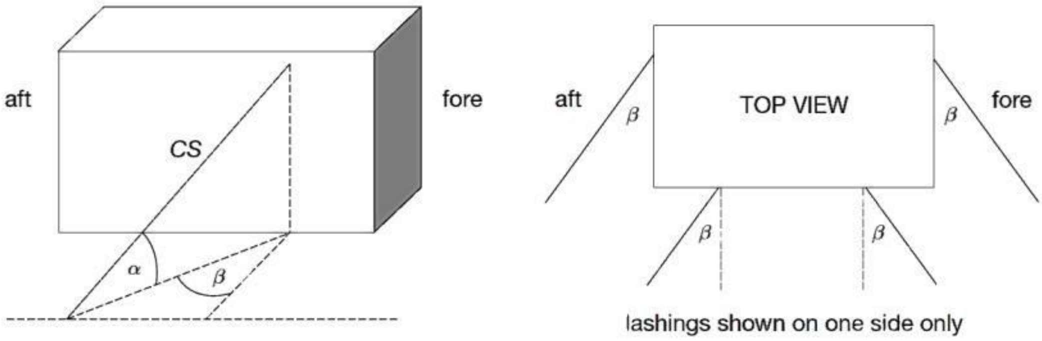


Figure 4 – Definition of the vertical and horizontal securing angles α and β

7.3.3 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 *fx* or *fy*. See Table 7.

7.3.4 Table 7 consists of five sets of figures, one each for the friction coefficients μ = 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 *fx* is obtained when entering the table with β from the right while *fy* 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:

Transverse sliding: $Fy \leq \mu \cdot m \cdot g + fy1 \cdot CS1 + \ldots + fyn \cdot CSn$

Longitudinal sliding: $Fx \leq \mu \cdot (m \cdot g - fz \cdot Fz) + fx1 \cdot CS1 + \ldots + fxn \cdot CSn$

Transverse tipping: $Fy \cdot a \leq b \cdot m \cdot g + 0.9 \cdot (CS1 \cdot c1 + CS2 \cdot c2 + \ldots + CSn \cdot cn)$

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 in Paragraph 7.2 except *fy* and *fx*, obtained from Table 7, and *CS* is as follows:

$$CS = \frac{MSL}{2.35}$$

A calculated example for this method is shown in Appendix 1 of Annex 13.

Table 7 – *fx* values and *fy* values as a function of *α*, *β* and *μ*

Table 7.1 for μ=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 μ=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 μ=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 μ=0.1

***β* for**	**α**														***β*for**
f_y	-30	-20	-10	0	10	20	30	40	45	50	60	70	80	90	f_x
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 μ=0.0

***β* for**	**α**														***β*for**
f_y	-30	-20	-10	0	10	20	30	40	45	50	60	70	80	90	f_x
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: $f_y = \cos\alpha \cdot \cos\beta + \mu \cdot \sin\alpha$ $\quad f_x = \cos\alpha \cdot \sin\beta + \mu \cdot \sin\alpha$

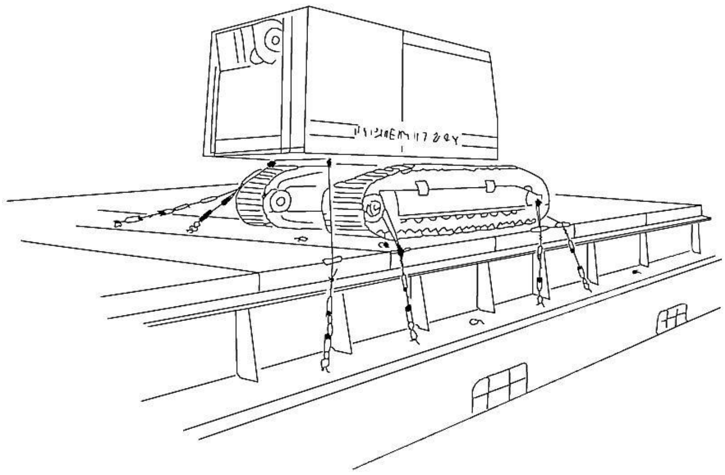
Appendix 1

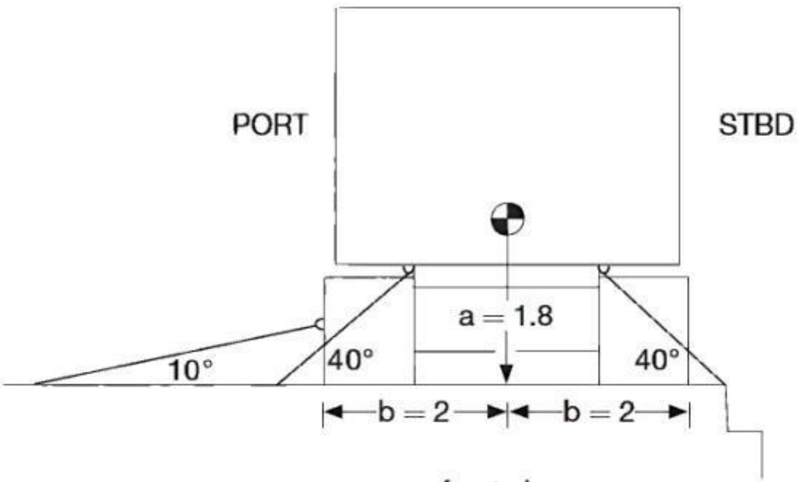
Calculated example 1

(refer to paragraph 7.2, Balance of forces and moments)

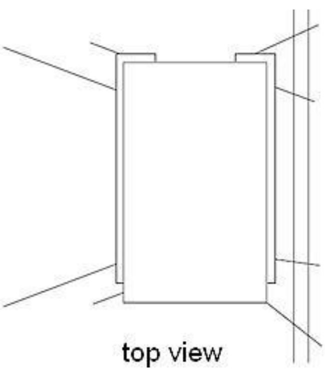
Ship: *L* = 120 m; *B* = 20 m; GM = 1.4 m; speed = 15 knots

Cargo: *m* = 62 t; dimensions = 6 × 4 × 4 m; stowage at 0.7L on deck, low





front view



top view

Securing material:
wire rope (single use): breaking strength = 125 kN; *MSL* = 100 kN
shackles, turnbuckles, deck rings: breaking strength = 180 kN; *MSL* = 90 kN stowage on dunnage boards: $\mu = 0.3$; *CS* = 90/1.5 = 60 kN

Securing arrangement:

side	***n***	***CS***	***α***	***f***	***c***
STBD	4	60 kN	40°	0.96	–
PORT	2	60 kN	40°	0.96	–
PORT	2	60 kN	10°	1.04	–

External forces:
$F_x = 2.9 \times 0.89 \times 62 + 16 + 8 = 184$ kN
$F_y = 6.3 \times 0.89 \times 62 + 24 + 12 = 384$ kN
$F_z = 6.2 \times 0.89 \times 62 = 342$ kN

Balance of forces (STBD arrangement):
$384 < 0.3 \times 62 \times 9.81 + 4 \times 60 \times 0.96$
384 < 412 this is OK!

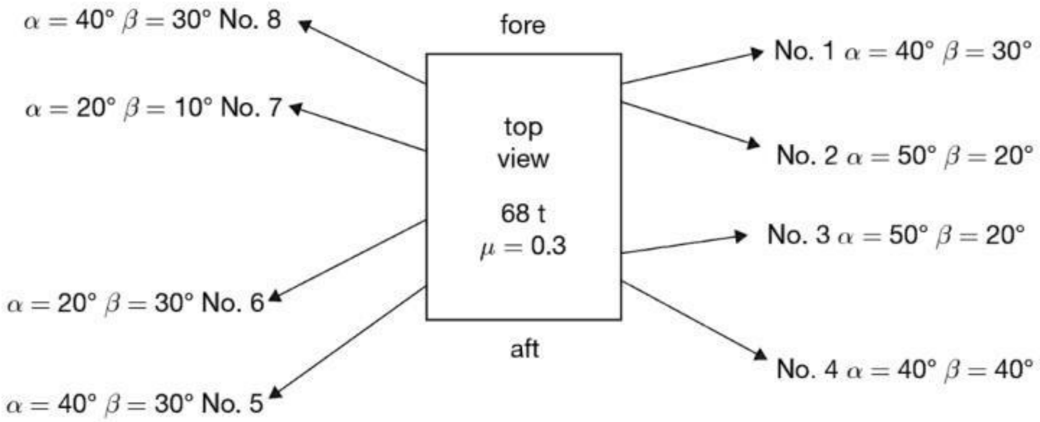
Balance of forces (PORT arrangement):
$384 < 0.3 \times 62 \times 9.81 + 2 \times 60 \times 0.96 + 2 \times 60 \times 1.04$
384 < 422 this is OK!

Balance of moments:
$384 \times 1.8 < 2 \times 62 \times 9.81$
691 < 1216 no tipping, even without lashings!

Calculated example 2

(refer to Section 7.3, Balance of forces – alternative method)

A cargo item of 68 t mass is stowed on timber ($\mu = 0.3$) in the 'tween deck at 0.7L of a vessel.
L = 160 m, *B* = 24 m, *v* = 18 knots and GM = 1.5 m.
Dimensions of the cargo item 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, f_z= 0.8 and $f_z \cdot F_z$ = 276.8 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:

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

312 < 443 this is OK!

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

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

312 < 468 this is OK!

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

$112 < 0.3\ (68 \times 9.81 - 276.8) + 46.4 + 30.2 + 18.1 + 46.4$

112 < 258 this is OK!

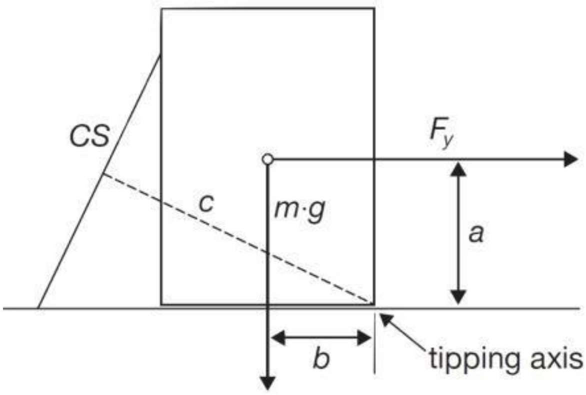
Longitudinal balance of forces (AFT arrangement) Nos. 2, 4, 5 and 6:

$112 < 0.3\ (68 \times 9.81 - 276.8) + 30.2 + 55.2 + 46.4 + 38.2$

112 < 287 this is OK!

Transverse tipping

Unless specific information is provided, the vertical centre of gravity of the cargo item 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 item.



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

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

$374 < 600 + 476$

$374 < 1076$ this is OK!

Appendix 2

Explanations and Interpretation of Methods to Assess the Efficiency of Securing Arrangements

1 The acceleration figures given in Table 2, in combination with the correction factors, represent peak values on a 25-day voyage. This does not imply that peak values in *x*, *y* and *z* directions occur simultaneously with the same probability. It can be generally assumed that peak values in the transverse direction will appear in combination with less than 60% of the peak values in longitudinal and vertical directions.

2 Peak values in longitudinal and vertical directions may be associated more closely because they have the common source of pitching and heaving.

3 The advanced calculation method uses the "worst case approach". That is expressed clearly by the transverse acceleration figures, which increase to forward and aft in the ship and thereby show the influence of transverse components of simultaneous vertical accelerations. Consequently, there is no need to consider vertical accelerations separately in the balances of transverse forces and moments. These simultaneously acting vertical accelerations create an apparent increase of weight of the item and thus increase the effect of the friction in the balance of forces and the moment of stableness in the balance of moments. For this reason there is no reduction of the force $m \cdot g$ normal to the deck due to the presence of an angle of heel.

4 The situation is different for the longitudinal sliding balance. The worst case would be a peak value of the longitudinal force F_x accompanied by an extreme reduction of weight through the vertical force F_z.

5 The friction coefficients shown in the tables of this Annex are generally lower than the ones given in other publications, such as the CTU Code. The reason for this can be seen in various influences which may appear in practical shipping, such as vibration of the ship, moisture, grease, oil, dust and other residues.

6 There are certain stowage materials available which are said to increase friction considerably. Extended experience with these materials may bring additional coefficients into practical use.

7 The principal way of calculating forces within the securing elements of a complex securing arrangement should necessarily include the consideration of:

.1 load-elongation behaviour (elasticity);

.2 geometrical arrangement (angles, length); and

.3 pre-tension, of each individual securing element.

8 This approach would require a large volume of information and a complex, iterative calculation. The results would still be doubtful due to uncertain parameters.

9 Therefore, the simplified approach was chosen with the assumption that the elements take an even load of *CS* (calculated strength) which is reduced against the *MSL* (maximum securing load) by the safety factor.

10 When employing the advanced calculation method, the way of collecting data should be followed as shown in the calculated example. It is acceptable to estimate securing angles, to take average angles for a set of lashings and similarly to arrive at reasonable figures of the levers a, b and c for the balance of moments.

11 It should be borne in mind that this Annex contains a number of assumptions based on approximations. Even though safety factors are also incorporated, there is no clear-cut borderline between safety and non-safety. If in doubt, the arrangement should be improved.

Appendix 3
Advanced Provisions and Considerations Applicable to Very Heavy and/or Very Large Cargo Items

This Appendix contains additional advice that may be considered for the stowage and securing of cargo with unusual characteristics, as referenced in Chapter 1.8 of this Code and may include items of exceptional mass and/or dimension. However, the listed considerations do not claim to be complete.

1 Longitudinal tipping

For the securing of large and tall cargo items in longitudinal direction, the balance calculation should also consider longitudinal tipping and meet the following condition:

$F_x \cdot a \leq b \cdot (m \cdot g - f_z \cdot F_z) + CS_1 \cdot c_1 + CS_2 \cdot c_2 + ... + CS_n \cdot c_n$ *[kNm]*

Where:

F_x, m, g, F_z, CS, n are as explained under 7.2.1 of this Annex.

a is lever-arm of tipping (m) (see Figure 3)

b is lever-arm of stableness (m) (see Figure 3)

c is lever-arm of securing force (m) (see Figure 3) The factor f_Z is obtained by the applicable relation of b/a as shown below:

b/a	0.1	0.2	0.3	0.4	0.6	1.0	2.0	3.0
f_Z	0.50	0.70	0.80	0.85	0.90	0.94	0.98	1.00

2 Rotational inertia of large cargo items

2.1 The algorithm used in 7.2.2 of this Annex and Section 1 above for defining the tipping moment acting on a distinct cargo item replaces the physical extent of the item by its centre of gravity. The tipping moment is then declared as the determined horizontal force F_x or F_y, multiplied by the vertical distance "*a*" of this centre of gravity to the edge of the footprint, i.e. the tipping axis of the item. This is sufficiently accurate, as long as the spatial dimensions of the item remain below about 6 metres.

2.2 Larger items, however, will develop a substantial additional tipping moment by their rotational inertia against the rotational acceleration of the ship in rolling or pitching motions. The additional tipping moment is independent from the stowage position of the item in the ship and always positive, i.e. intensifying the tipping impulse. This phenomenon requires additional securing measures and, therefore, should be included in tipping balances for large cargo items by the use of a simple algorithm.

2.3 Transverse tipping balance

2.3.1 For cargo items of width *w* (measured athwartships) and height h, where $(w^2 + h^2) > 50$ m^2, the additional tipping moment $k \cdot J$ due to rotational inertia of the cargo item should be added to the ordinary tipping moment $F_y \cdot a$ in the transverse tipping balance.

2.3.2 The appropriate figure of the moment of rotational inertia J should be supplied by the shipper related to the centre of gravity of the item for the plane of transverse tipping. If such information is not available, an estimated figure may be used by:

$J = m \cdot \left(\frac{w^2+h^2}{12}\right)$ *[tm²]* for homogeneous distribution of mass in the item

$J = m \cdot \left(\frac{(w+h)^2}{12}\right) [tm^2]$ for an item with peripheral concentration of mass.

The reverse angular acceleration k may be taken as $k = \frac{36 \cdot GM}{B^2} [s^{-2}]$.

2.4 Longitudinal tipping balance

2.4.1 For cargo items of length *l* (measured fore and aft) and height h, where $(l^2 + h^2) > 50\ m^2$, the additional tipping moment $k \cdot J$ due to rotational inertia of the cargo item should be added to the ordinary tipping moment $F_x \cdot a$ in the longitudinal tipping balance.

2.4.2 The appropriate figure of the moment of rotational inertia J should be supplied by the shipper related to the centre of gravity of the item for the plane of longitudinal tipping. If such information is not available, an estimated figure may be used by:

$J = m \cdot \left(\frac{l^2+h^2}{12}\right) [tm^2]$ for homogeneous distribution of mass in the item

$J = m \cdot \left(\frac{(l+h)^2}{12}\right) [tm^2]$ for an item with peripheral concentration of mass.

The reverse angular acceleration k may be taken as $k = \frac{25}{L} [s^{-2}]$.

3 Separate consideration of wind and sea sloshing

3.1 The algorithm used in this Annex for defining the horizontal force F_x or F_y, acting on a cargo item stowed on deck, combines horizontal weight components, inertia forces and wind/sloshing forces for reasons of simplification. This is correct for the balance of sliding; however, it is an approximation only for the balance of tipping. Particularly, high deck cargo items with their major wind exposed area well above the centre of gravity should be given a separate compilation of moments from wind forces, sea sloshing forces and gravity/inertia forces in order to get a more realistic tipping moment. The inertia forces strike on the centre of gravity of the cargo item, the sea sloshing strikes on the cargo area not more than 2 m above the weather deck and the wind forces strike on the lateral area of the cargo item exposed to wind.

Example: The figures of the tipping lever "*a*" relate to a large portal harbour crane shipped on deck of a heavy lift ship. The centres of attack by wind and spray deviate considerably from the centre of gravity. A separate compilation of the longitudinal tipping moment reads:

	F_x	a	$F_x \cdot a$
Gravity/inertia	1373 kN	13.0 m	17849 kNm
Wind	170 kN	20.0 m	3400 kNm
Spray	4 kN	1.0 m	4 kNm
Total	**1547 kN**		**21253 kNm**

3.2 The conventionally computed tipping moment would be only:

Total	**1547 kN**	**13.0 m**	**20111 kNm**

3.3 The surplus over the conventional tipping moment here is about 6%. The potential additional tipping moment by rotational inertia has not been reflected in this example.

4 Interpretation of "on deck high"

4.1 The stowage level "on deck high" in Table 2 of Annex 13 has been positioned at a distance above the water line of about two thirds of the ship's breadth. With extremely large cargo items, this level can easily be exceeded. In order to avoid uncertainties in the determination of transverse and longitudinal accelerations in such cases, it is recommended to use the original mathematical model, which has been the basis for acceleration tables in Annex 13. This model may easily be programmed, e.g. in a suitable spreadsheet.

4.2 The shown mathematical model is identical to that used in the *International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk* (IGC Code) (Resolution MSC. 5(48)). However, while in the IGC Code, the probability level of accelerations refers to the lifetime of a ship of 10^4 days, Annex 13, in order to remain within the scope of practical cargo securing experience, applies a reduction factor of 0.74, corresponding to the 25-day significant wave height in the North Atlantic. Furthermore, the model has been expanded to supply reasonable *K*-parameters for *B/GM*-relations less than 7, applicable to ships with exceptional large *GM*-values.

Mathematical model of the acceleration tables 2 to 4

4.3 The longitudinal, transverse and vertical accelerations acting on a cargo item may be obtained alternatively by the set of formulas as follows:

$$a_x = c_1 \cdot c_2 \cdot c_3 \cdot a_{x0} \cdot g \; [m/s^2]$$

$$a_y = c_1 \cdot c_2 \cdot c_3 \cdot a_{y0} \cdot g \; [m/s^2]$$

$$a_z = c_1 \cdot c_2 \cdot c_3 \cdot a_{z0} \cdot g \; [m/s^2]$$

a_x: longitudinal acceleration (gravity component of pitch included);

a_y: transverse acceleration (gravity component of roll included);

a_z: vertical acceleration (component due to static weight not included);

c_1: correction factor for navigation area, taken as 1.0 worldwide in Annex 13;

c_2: correction factor for season, taken as 1.0 for whole year in the Annex 13;

c_3: correction factor for 25 navigation days, taken as $0.6 + 0.1 \cdot \log_{10} 25 = 0.74$ in Annex 13

$$a_{x0} = \pm a_0 \cdot \sqrt{0.06 + A^2 - 0.25 \cdot A}$$

$$a_{y0} = \pm a_0 \cdot \sqrt{0.6 + 2.5 \cdot \left(\frac{x}{L} + 0.05\right)^2 + K \cdot \left(1 + 0.6 \cdot K \cdot \frac{z}{B}\right)^2}$$

$$a_{z0} = \pm a_0 \cdot \sqrt{1 + \left(5.3 - \frac{45}{L}\right)^2 \cdot \left(\frac{x}{L} + 0.05\right)^2 \cdot \left(\frac{0.6}{C_b}\right)^{3/2}}$$

where:

$$a_0 = 0.2 \cdot \frac{v}{\sqrt{L}} + \frac{34 - 600/L}{L}$$

$$A = \left(0.7 - \frac{L}{1200} + \frac{5 \cdot z}{L}\right) \cdot \left(\frac{0.6}{C_b}\right)$$

$K = R \cdot \frac{13 \cdot GM}{B}$, but never less than 1.0

$R = \left(\frac{B}{7 \cdot GM}\right)^{\left(\frac{GM}{B}\right)}$, but never greater than 1.0

L = length between perpendiculars, in m;

B = moulded breadth of ship, in m;

GM = metacentric height of ship, in m;

C_b = block coefficient of ship;

x = longitudinal distance from amidships to calculating point, positive forward, in m;
z = vertical distance from actual waterline to calculating point, positive upward, in m;
v = service speed, in knots;
g = gravity acceleration = 9.81 m/s^2.

5 Structural strength assessment

5.1 Dry cargo ships are typically designed on the assumption that cargo is homogeneously distributed. The maximum permissible surface load is usually specified in the ship's documentation and given in t/m² for all relevant stowage areas, i.e. double bottom (tank top), top of stepped side tanks, 'tween deck pontoons, weather deck and weather deck hatch covers.

5.2 Heavy cargo items tend to produce concentrated strip or point loads rather than homogeneous loads. Then care should be taken that the stress parameters, corresponding to the maximum permissible homogeneous load, are not exceeded by the load induced by the heavy item. The essential parameters for stresses in deck sections, hatch covers and 'tween deck pontoons or panels are shear forces and bending moments. Suitable steel or timber beams or equivalent panel structures should be used to transfer the strip or point load to the primary members of the load-bearing structure.

5.3 Where a loading situation appears to be too complex to be safely examined by manual calculation or where stress parameters obtained by a manual calculation method come close to the applicable limit of the supporting structure, utilization of finite element analysis should be considered.

6 Weather routeing

6.1 Utilizing weather routeing services may significantly contribute to performing a safe passage. Care should be taken that the engaged service complies with the recommendations laid down in MSC/Circ.1063 on *Participation of ships in weather routeing services*.

6.2 In case of transporting heavy and/or large cargo items, where safe securing is an essential requirement, the routeing decisions should be oriented to the avoidance of severe ship motions rather than to other criteria, such as swift passage or fuel economy. However, the engagement of a weather routeing service does not eliminate the need for the application of securing measures as required in this Annex.

7 Other considerations

When planning the transport of very heavy and/or very large cargo items on deck of a vessel, particular consideration should be given to:

.1 the observation of sight line requirements as stipulated in SOLAS Regulation V/22, and, in case of non-compliance, the conditions for a temporary exemption by the flag State Administration;

.2 the provision of unimpeded radar transmission with due observation of Resolution MSC.192(79) on *Revised performance standards for radar equipment* and SN.1/Circ.271 on *Guidelines for the installation of shipborne radar equipment*; and

.3 the provision of visibility of navigation light as required by Annex I of International Regulations for Preventing Collisions at Sea and specified in Resolution MSC.253(83) on

Performance standards for navigation lights, navigation light controllers and associated equipment.

Appendix 4
Advanced Provisions and Considerations Applicable to Semi-standardized Cargoes

This Appendix contains advice that may be considered for the stowage and securing of semi-standardized cargoes in addition to the other provisions of Chapter 4, Annex 4 and Annex 13 of this Code.

The provisions in Section 1 below may be used for the following conditions:

.1 worst case accelerations are used for the design of securing arrangements of semi-standardized cargoes, i.e. the most severe external forces within the particular deck or otherwise defined region of the vessel are applied;

.2 uniform securing arrangements are used for types of cargo items considering stepped weight classes, whereby arrangements always cover the highest weight within a class and the most unfavourable position of the centre of gravity;

.3 the range of lashing angles is well defined by the pattern of securing points in the vessel, as well as on vehicles. The assessment uses worst case angles, i.e. the worst combination of vertical and horizontal angles within the given ranges; and

.4 securing equipment is regularly inspected when used for recurrent application.

1 Performance factor for short voyages

For cargo securing arrangements considered in Section 7.1 case .3 (short duration voyages up to 72 hours), the forces and moments on the right side of the balance equations in Section 7.3 may be multiplied by the F_P performance factor of 1.15, as illustrated below:

Transverse sliding: $F_y \leq (\mu \cdot m \cdot g + f_{y1} \cdot CS_1 + \ldots + f_{yn} \cdot CS_n) \cdot F_P$

Longitudinal sliding: $F_x \leq (\mu \cdot (m \cdot g - f_z \cdot F_z) + f_{x1} \cdot CS_1 + \ldots + f_{xn} \cdot CS_n) \cdot F_P$

Transverse tipping: $F_y \cdot a \leq (b \cdot m \cdot g + 0.9 \cdot (CS_1 \cdot c_1 + CS_2 \cdot c_2 + \ldots + CS_n \cdot c_n)) \cdot F_P$

2 Asymmetrical securing arrangements

For asymmetrical lashing arrangements and for cargoes resting on supports with different coefficients of friction, separate sliding of the item's fore and aft ends should be considered in the transverse direction. The calculations for each end should be based on the part of the item's weight resting on each support and the characteristics of the cargo securing devices attached to each end.

3 Safety factor

In the case of elementary securing arrangements, where no more than two devices per impact direction are used and loads are evenly distributed by proper orientation to the centre of gravity of the cargo item, the calculated CS of securing devices may be obtained by:

$$CS = \frac{MSL}{1.2}$$

The specific conditions for the use of the reduced safety factor should be outlined in the ship's Cargo Securing Manual.

4 Friction coefficients

In addition to the friction coefficients in Table 5 in Section 7.2, the following friction coefficients (μ) may be applied.

Materials in contact	Friction coefficient (μ)
Steel–rubber tyre, dirty, wet or dry	0.3
Steel–solid rubber tyre, dry and clean	0.3
Steel–air rubber tyre, wet and clean	0.4
Steel–air rubber tyre, dry and clean	0.45

Remark: Conditions of cleanliness should be defined in the ship's Cargo Securing Manual. Air rubber tyre refers to a rubber tyre filled with air.

5 Effect of parking brake and wheel chocks

For wheel-based cargoes, the effect of parking brakes as well as the effect of wheel chocks may be taken into account when dimensioning securing arrangements against movement in the rolling direction. Usually parking brakes have a braking capacity corresponding to a force equal to $0.2 \cdot g \cdot GVM$ (kN), where GVM is the gross vehicle mass of the item in tonnes and in most cases the parking brake is applied on one axle only. If a wheel is chocked, it can be considered not to roll and the friction in the rolling direction should be taken as the lesser of the friction between the tyre and the ship's deck, and the chock and the ship's deck.

CSS Annex 14 Guidance on providing safe working conditions for securing of containers on deck

1 Aim

To ensure that persons engaged in carrying out container securing operations on deck have safe working conditions and, in particular safe access, appropriate securing equipment and safe places of work. These guidelines should be taken into account at the design stage when securing systems are devised. These guidelines provide shipowners, ship builders, classification societies, Administrations and ship designers with guidance on producing or authorizing a Cargo Safe Access Plan (CSAP).

2 Scope

2.1 Ships which are specifically designed and fitted for the purpose of carrying containers on deck.

2.2 apply the annexed amendments in its entirety for containerships, the keels of which were laid or which are at a similar stage of construction on or after 1 January 2015;

2.3 apply Sections 4.4 (Training and familiarization), 7.1 (Introduction), 7.3 (Maintenance) and Section 8 (Specialized container safety design) to existing containerships, the keels of which were laid or which are at a similar stage of construction before 1 January 2015; and

2.4 apply the principles of this guidance contained in Sections 6 (Design) and 7.2 (Operational procedures) to existing containerships as far as practical by the flag State Administration with the understanding that existing ships would not be required to be enlarged or undergo other major structural modifications as determined.

3 Definitions

3.1 Administration means the Government of the State whose flag the ship is entitled to fly.

3.2 Fencing is a generic term for guardrails, safety rails, safety barriers and similar structures that provide protection against the falls of persons.

3.3 Lashing positions include positions:

.1 in between container stows on hatch covers;

.2 at the end of hatches;

.3 on outboard lashing stanchions/pedestals;

.4 outboard lashing positions on hatch covers; and

.5 any other position where people work with container securing.

3.4 SATLs are semi-automatic twistlocks.

3.5 Securing includes lashing and unlashing.

3.6 Stringers are the uprights or sides of a ladder.

3.7 Turnbuckles and lashing rods[①] include similar cargo securing devices.

4 General

4.1 Introduction

4.1.1 Injuries to dockworkers on board visiting ships account for the majority of accidents that occur within container ports, with the most common activity that involves such injuries being the

① Refer to standard ISO 3874, Annex D Lashing rod systems and tensioning devices.

lashing/unlashing of deck containers. Ships' crew engaged in securing operations face similar dangers.

4.1.2 During the design and construction of containerships the provision of a safe place of work for lashing personnel is essential.

4.1.3 Container shipowners and designers are reminded of the dangers associated with container securing operations and urged to develop and use container securing systems which are safe by design. The aim should be to eliminate or at least minimize the need for:

.1 container top work;

.2 work in other equally hazardous locations; and

.3 the use of heavy and difficult to handle securing equipment.

4.1.4 It should be borne in mind that providing safe working conditions for securing containers deals with matters relating to design, operation, and maintenance, and that the problems on large containerships are not the same as on smaller ones.

4.2 Revised Recommendations on safety of personnel during container securing operations (MSC.1/Circ.1263)

4.2.1 Shipowners, ship designers and Administrations should take into account the recommendations on safe design of securing arrangements contained in these guidelines, and in the Recommendations on safety of personnel during container securing operations (MSC.1/Circ.1263).

4.3 Cargo Safe Access Plan (CSAP)

4.3.1 The Guidelines for the preparation of the Cargo Securing Manual (MSC/Circ.745) requires ships which are specifically designed and fitted for the purpose of carrying containers to have an approved Cargo Safe Access Plan (CSAP) on board, for all areas where containers are secured.

4.3.2 Stakeholders, including, but not limited to shipowners, ship designers, ship builders, administrations, classification societies and lashing equipment manufacturers, should be involved at an early stage in the design of securing arrangements on containerships and in the development of the CSAP.

4.3.3 The CSAP should be developed at the design stage in accordance with Chapter 5 of the Annex to MSC.1/Circ.1353.

4.3.4 Designers should incorporate the recommendations of this Annex into the CSAP so that safe working conditions can be maintained during all anticipated configurations of container stowage.

4.4 Training and familiarization

4.4.1 Personnel engaged in cargo securing operations should be trained in the lashing and unlashing of containers as necessary to carry out their duties in a safe manner. This should include the different types of lashing equipment that are expected to be used.

4.4.2 Personnel engaged in cargo securing operations should be trained in the identification and handling of bad order or defective securing gear in accordance with each ship's procedures to ensure damaged gear is segregated for repair and maintenance or disposal.

4.4.3 Personnel engaged in cargo securing operations should be trained to develop the knowledge and mental and physical manual handling skills that they require to do their job safely and efficiently, and to develop general safety awareness to recognize and avoid potential dangers.

4.4.4 Personnel should be trained in safe systems of work. Where personnel are involved in working at heights, they should be trained in the use of relevant equipment. Where practical, the use of fall protection equipment should take precedence over fall arrest systems.

4.4.5 Personnel who are required to handle thermal cables and/or connect and disconnect temperature control units should be given training in recognizing defective cables, receptacles and plugs.

4.4.6 Personnel engaged in containership cargo operations should be familiarized with the ship's unique characteristics and potential hazards arising from such operations necessary to carry out their duties.

5 Responsibilities of involved parties

5.1 Administrations should ensure that:

.1 lashing plans contained within the approved Cargo Securing Manual are compatible with the current design of the ship and the intended container securing method is both safe and physically possible;

.2 the Cargo Securing Manual, lashing plans and the CSAP are kept up to date; and

.3 lashing plans and the CSAP are compatible with the design of the vessel and the equipment available.

5.2 Shipowners and operators should ensure that:

.1 portable cargo securing devices are certified and assigned with a maximum securing load (MSL). The MSL should be documented in the cargo securing manual as required by the CSS Code;

.2 the operational recommendations of this Annex are complied with;

.3 correction, changes or amendments of the Cargo Securing Manual, lashing plans and the Cargo Safe Access Plan (CSAP) should be promptly sent to the competent authority for approval; and

.4 only compatible and certified equipment in safe condition is used.

5.3 Designers should follow design recommendations of these guidelines.

5.4 Shipbuilders should follow design recommendations of these guidelines.

5.5 Containership terminal operators should ensure that the recommendations of relevant parts of this Annex are complied with.

6 Design

6.1 General design considerations

6.1.1 Risk assessment

6.1.1.1 Risk assessments should be performed at the design stage taking into account the recommendations of this Annex to ensure that securing operations can be safely carried out in all anticipated container configurations. This assessment should be conducted with a view toward developing the Cargo Safe Access Plan (CSAP). Hazards to be assessed should include but not be limited to:

.1 slips, trips and falls;

.2 falls from height;

.3 injuries whilst manually handling lashing gear;

.4 being struck by falling lashing gear or other objects;

.5 potential damage due to container operations. High-risk areas should be identified in order to develop appropriate protection or other methods of preventing significant damage;

.6 adjacent electrical risks (temperature controlled unit cable connections, etc.);

.7 the adequacy of the access to all areas that is necessary to safely perform container securing operations;

.8 ergonomics (e.g., size and weight of equipment) of handling lashing equipment; and

.9 implications of lashing 9'6" high, or higher, containers and mixed stows of 40' and 45' containers.

6.1.1.2 Shipbuilders should collaborate with designers of securing equipment in conducting risk assessments and ensure that the following basic criteria are adhered to when building containerships.

6.1.2 Ship designers should ensure that container securing operations performed in outer positions can be accomplished safely. As a minimum, a platform should be provided on which to work safely. This platform should have fencing to prevent workers falling off it.

6.1.3 The space provided between the containers stows for workers to carry out lashing operations should provide:

.1 a firm and level working surface;

.2 a working area, excluding lashings in place, to provide a clear sight of twist lock handles and allow for the manipulation of lashing gear;

.3 sufficient spaces to permit the lashing gear and other equipment to be stowed without causing a tripping hazard;

.4 sufficient spaces between the fixing points of the lashing bars on deck, or on the hatch covers, to tighten the turnbuckles;

.5 access in the form of ladders on hatch coamings;

.6 safe access to lashing platforms;

.7 protective fencing on lashing platforms; and

.8 adequate lighting in line with these guidelines.

6.1.4 Ship designers should aim to eliminate the need to access and work on the tops of deck stows.

6.1.5 Platforms should be designed to provide a clear work area, unencumbered by deck piping and other obstructions and take into consideration:

.1 containers must be capable of being stowed within safe reach of the workers using the platform; and

.2 the work area size and the size of the securing components used.

6.2 Provisions for safe access

6.2.1 General provisions

6.2.1.1 The minimum clearance for transit areas should be at least 2 m high and 600 mm wide.

6.2.1.2 All relevant deck surfaces used for movement about the ship and all passageways and stairs should have non-slip surfaces.

6.2.1.3 Where necessary for safety, walkways on deck should be delineated by painted lines or otherwise marked by pictorial signs.

6.2.1.4 All protrusions in access ways, such as cleats, ribs and brackets that may give rise to a trip hazard should be highlighted in a contrasting colour.

6.2.2 Lashing position design (platforms, bridges and other lashing positions)

6.2.2.1 Lashing positions should be designed to eliminate the use of three high lashing bars and be positioned in close proximity to lashing equipment stowage areas. Lashing positions should be designed to provide a clear work area which is unencumbered by deck piping and other obstructions and take into consideration:

.1 the need for containers to be stowed within safe reach of the personnel using the lashing position so that the horizontal operating distance from the securing point to the container does not exceed 1,100 mm and not less than 220 mm for lashing bridges and 130 mm for other positions;

.2 the size of the working area and the movement of lashing personnel; and

.3 the length and weight of lashing gear and securing components used.

6.2.2.2 The width of the lashing positions should preferably be 1,000 mm, but not less than 750 mm.

6.2.2.3 The width of permanent lashing bridges should be:

.1 750 mm between top rails of fencing; and

.2 a clear minimum of 600 mm between storage racks, lashing cleats and any other obstruction.

6.2.2.4 Platforms on the end of hatches and outboard lashing stations should preferably be at the same level as the top of the hatch covers.

6.2.2.5 Toe boards (or kick plates) should be provided around the sides of elevated lashing bridges and platforms to prevent securing equipment from falling and injuring people. Toe boards should preferably be 150 mm high, however, where this is not possible they should be at least 100 mm high.

6.2.2.6 Any openings in the lashing positions through which people can fall should be possible to be closed.

6.2.2.7 Lashing positions should not contain obstructions, such as storage bins or guides to reposition hatch covers.

6.2.2.8 Lashing positions which contain removable sections should be capable of being temporarily secured.

6.2.3 Fencing design

6.2.3.1 Bridges and platforms, where appropriate, should be fenced. As a minimum, fencing design should take into consideration:

.1 the strength and height of the rails should be designed to prevent workers from falling;

.2 flexibility in positioning the fencing of gaps. A horizontal unfenced gap should not be greater than 300 mm;

.3 provisions for locking and removal of fencing as operational situations change based on stowage anticipated for that area;

.4 damage to fencing and how to prevent failure due to that damage; and

.5 adequate strength of any temporary fittings. These should be capable of being safely and securely installed.

6.2.3.2 The top rail of fencing should be 1 m high from the base, with two intermediate rails. The opening below the lowest course of the guard rails should not exceed 230 mm. The other courses should be not more than 380 mm apart.

6.2.3.3 Where possible fences and handrails should be highlighted with a contrasting colour to the background.

6.2.3.4 Athwartships cargo securing walkways should be protected by adequate fencing if an unguarded edge exists when the hatch cover is removed.

6.2.4 Ladder and manhole design

6.2.4.1 Where a fixed ladder gives access to the outside of a lashing position, the stringers should be connected at their extremities to the guardrails of the lashing position, irrespective of whether the ladder is sloping or vertical.

6.2.4.2 Where a fixed ladder gives access to a lashing position through an opening in the platform, the opening shall be protected with either a fixed grate with a lock back mechanism, which can be closed after access, or fencing. Grabrails should be provided to ensure safe access through the opening.

6.2.4.3 Where a fixed ladder gives access to a lashing position from the outside of the platform, the stringers of the ladder should be opened above the platform level to give a clear width of 700 to 750 mm to enable a person to pass through the stringers.

6.2.4.4 A fixed ladder should not slope at an angle greater than 25° from the vertical. Where the slope of a ladder exceeds 15° from the vertical, the ladder should be provided with suitable handrails not less than 540 mm apart, measured horizontally.

6.2.4.5 A fixed vertical ladder of a height exceeding 3 m, and any fixed vertical ladder, from which a person may fall into a hold, should be fitted with guard hoops, which should be constructed in accordance with Paragraphs 6.2.4.6 and 6.2.4.7.

6.2.4.6 The ladder hoops should be uniformly spaced at intervals not exceeding 900 mm and should have a clearance of 750 mm from the rung to the back of the hoop and be connected by longitudinal strips secured to the inside of the hoops, each equally spaced round the circumference of the hoop.

6.2.4.7 The stringers should be carried above the floor level of the platform by at least 1 m and the ends of the stringers should be given lateral support and the top step or rung should be level with the floor of the platform unless the steps or rungs are fitted to the ends of the stringers.

6.2.4.8 As far as practicable, access ladders and walkways, and work platforms should be designed so that workers do not have to climb over piping or work in areas with permanent obstructions.

6.2.4.9 There should be no unprotected openings in any part of the workplace. Access opening must be protected with handrails or access covers that can be locked back during access.

6.2.4.10 As far as practicable, manholes should not be situated in transit areas, however, if they are, proper fencing should protect them.

6.2.4.11 Access ladders and manholes should be large enough for persons to safely enter and leave.

6.2.4.12 A foothold at least 150 mm deep should be provided.

6.2.4.13 Handholds should be provided at the top of the ladder to enable safe access to the platform to be gained.

6.2.4.14 Manhole openings that may present a fall hazard should be highlighted in contrasting colour around the rim of the opening.

6.2.4.15 Manhole openings at different levels of the lashing bridge should not be located directly below one another, as far as practicable.

6.3 Lashing systems

6.3.1 General provisions

Lashing systems, including tensioning devices, should:

.1 conform to international standards[①], where applicable;
.2 be compatible with the planned container stowages;
.3 be compatible with the physical ability of persons to safely hold, deploy and use such equipment;
.4 be uniform and compatible, e.g., twistlocks and lashing rod heads should not interfere with each other;
.5 be subject to a periodic inspection and maintenance regime. Non-conforming items should be segregated for repair or disposal; and
.6 be according to the CSM.

6.3.2 Twistlock design

6.3.2.1 Shipowners should ensure that the number of different types of twistlocks provided for cargo securing is kept to a minimum and clear instructions are provided for their operation. The use of too many different types of twistlocks may lead to confusion as to whether the twistlocks are locked.

6.3.2.2 The design of twistlocks should ensure the following:
.1 positive locking with easy up and down side identification;
.2 dislodging from corner fitting is not possible even when grazing a surface;
.3 access and visibility of the unlocking device is effective in operational situations;
.4 unlocked positions are easily identifiable and do not relock inadvertently due to jolting or vibration; and
.5 unlocking poles are as light as possible, of a simple design for ease of use.

6.3.2.3 Where it is not feasible to entirely eliminate working on the tops of container stows, the twistlock designs used should minimize the need for such working, e.g., use of SATLs, fully automatic twistlocks or similar design.

6.3.3 Lashing rod design

6.3.3.1 The design of containership securing systems should take into account the practical abilities of the workers to lift, reach, hold, control and connect the components called for in all situations anticipated in the cargo securing plan.

6.3.3.2 The maximum length of a lashing rod should be sufficient to reach the bottom corner fitting of a container on top of two high cube containers and be used in accordance with the instructions provided by the manufacturers.

6.3.3.3 The weight of lashing rods should be minimized as low as possible consistent with the necessary mechanical strength.

6.3.3.4 The head of the lashing rod that is inserted in the corner fitting should be designed with a pivot/hinge or other appropriate device so that the rod does not come out of the corner fitting accidentally.

6.3.3.5 The rod's length in conjunction with the length and design of the turnbuckle should be such that the need of extensions is eliminated when lashing high cube (9'6") containers.

6.3.3.6 Lightweight rods should be provided where special tools are needed to lash high cube containers.

6.3.4 Turnbuckle design

6.3.4.1 Turnbuckle end fittings should be designed to harmonize with the design of lashing rods.

6.3.4.2 Turnbuckles should be designed to minimize the work in operating them.

---

① Refer to standard ISO 3874 -The Handling and Securing of Type 1 Freight Containers, Annex A-D.

6.3.4.3 Anchor points for turnbuckles should be positioned to provide safe handling and to prevent the bending of rods.

6.3.4.4 To prevent hand injury during tightening or loosening motions, there should be a minimum distance of 70 mm between turnbuckles.

6.3.4.5 The turnbuckle should incorporate a locking mechanism which will ensure that the lashing does not work loose during the voyage.

6.3.4.6 The weight of turnbuckles should be minimized as low as possible consistent with the necessary mechanical strength.

6.3.5 Storage bins and lashing equipment stowage design

6.3.5.1 Bins or stowage places for lashing materials should be provided.

6.3.5.2 All lashing gear should be stowed as close to its intended place of use as possible.

6.3.5.3 The stowage of securing devices should be arranged so they can easily be retrieved from their stowage location.

6.3.5.4 Bins for faulty or damaged gear should also be provided and appropriately marked.

6.3.5.5 Bins should be of sufficient strength.

6.3.5.6 Bins and their carriers should be designed to be lifted off the vessel and restowed.

6.4 Lighting design

A lighting plan should be developed to provide for:

.1 the proper illumination of access ways, not less than 10 lux (1 foot candle)*, taking into account the shadows created by containers that may be stowed in the area to be lit, for example different length containers in or over the work area;

.2 a separate fixed or temporary (where necessary) lighting system for each working space between the container bays, which is bright enough, not less than 50 lux (5 foot candle)[①], for the work to be done, but minimizes glare to the deck workers;

.3 such illumination should, where possible, be designed as a permanent installation and adequately guarded against breakage; and

.4 the illumination intensity should take into consideration the distance to the uppermost reaches where cargo securing equipment is utilized.

7 Operational and maintenance procedures

7.1 Introduction

7.1.1 Procedures for safe lashing and securing operations should be included in the ship's Safety Management System as part of the ISM Code documentation.

7.1.2 Upon arrival of the ship, a safety assessment of the lashing positions and the access to those positions should be made before securing work commences.

7.2 Operational procedures

7.2.1 Container deck working

7.2.1.1 Transit areas should be safe and clear of cargo and all equipment.

7.2.1.2 Openings that are necessary for the operation of the ship, which are not protected by fencing, should be closed during cargo securing work. Any necessarily unprotected openings in work platforms (i.e. those with a potential fall of less than 2 m), and gaps and apertures on deck should be properly highlighted.

7.2.1.3 The use of fencing is essential to prevent falls. When openings in safety barriers are

① Refer to Safety and Health in Ports, ILO Code of Practice, section 7.1.5.

necessary to allow container crane movements, particularly with derricking cranes, removable fencing should be used whenever possible.

7.2.1.4 It should be taken into account that when lifting lashing bars that can weigh between 11 and 21 kg and turnbuckles between 16 and 23 kg, there may be a risk of injury and severe illness as a result of physical strain if handled above shoulder height with the arms extended. It is therefore recommended that personnel work in pairs to reduce the individual workload in securing the lashing gear.

7.2.1.5 The company involved with cargo operation should anticipate, identify, evaluate and control hazards and take appropriate measures to eliminate or minimize potential hazards to prevent in particular with harmful lumbar spinal damage and severe illness as a result of physical strain.

7.2.1.6 Personnel engaged in containership cargo operations should wear appropriate Personnel Protective Equipment (PPE) whilst carrying out lashing operations. The PPE should be provided by the company.

7.2.1.7 Manual twistlocks should only be used where safe access is provided.

7.2.1.8 Containers should not be stowed in spaces configured for larger sized containers unless they can be secured under safe working conditions.

7.2.2 Container top working

7.2.2.1 When work on container tops can not be avoided, safe means of access should be provided by the container cargo operation terminal, unless the ship has appropriate means of access in accordance with the CSAP.

7.2.2.2 Recommended practice involves the use of a safety cage lifted by a spreader to minimize the risk to personnel.

7.2.2.3 A safe method of work should be developed and implemented to ensure the safety of lashers when on the top of container stows on deck. Where practical, the use of fall prevention equipment should take precedence over fall arrest equipment.

7.2.3 Failure to provide safe lashing stations on board/carry out lashing by port workers

7.2.3.1 Where there are lashing and unlashing locations on board ship where no fall protection, such as adequate handrails are provided, and no other safe method can be found, the containers should not be lashed or unlashed and the situation should be reported to shoreside supervisor and the master or deck officer immediately.

7.2.3.2 If protective systems cannot be designed to provide safe protected access and lashing work positions, in all cargo configurations then cargo should not be stowed in that location. Neither crew nor shore workers should be subjected to hazardous working conditions in the normal course of securing cargo.

7.3 Maintenance

7.3.1 In line with Section 2.3 (Inspection and maintenance schemes) of the Revised Guidelines for the preparation of the cargo securing manual (MSC.1/Circ.1353) all ships should maintain a record book, which should contain the procedures for accepting, maintaining and repairing or rejecting of cargo securing devices. The record book should also contain a record of inspections.

7.3.2 Lighting should be properly maintained.

7.3.3 Walkways, ladders, stairways and fencings should be subject to a periodic maintenance programme which will reduce/prevent corrosion and prevent subsequent collapse.

7.3.4 Corroded walkways, ladders, stairways and fencings should be repaired or replaced as soon as practicable. The repairs should be effected immediately if the corrosion could prevent safe operations.

7.3.5 It should be borne in mind that turnbuckles covered with grease are difficult to handle when tightening.

7.3.6 Storage bins and their carriers should be maintained in a safe condition.

8 Specialized container safety design

8.1 Temperature controlled unit power outlets should provide a safe, watertight electrical connection.

8.2 Temperature controlled unit power outlets should feature a heavy duty, interlocked and circuit breaker protected electrical power outlet. This should ensure the outlet can not be switched "live" until a plug is fully engaged and the actuator rod is pushed to the "On" position. Pulling the actuator rod to the "Off" position should manually de-energize the circuit.

8.3 The temperature controlled unit power circuit should de-energize automatically if the plug is accidentally withdrawn while in the "On" position. Also, the interlock mechanism should break the circuit while the pin and sleeve contacts are still engaged. This provides total operator safety and protection against shock hazard while eliminating arcing damage to the plug and receptacle.

8.4 Temperature controlled unit power outlets should be designed to ensure that the worker is not standing directly in front of the socket when switching takes place.

8.5 The positioning of the temperature controlled unit feed outlets should not be such that the flexible cabling needs to be laid out in such a way as to cause a tripping hazard.

8.6 Stevedores or ship's crew who are required to handle temperature controlled unit cables and/or connect and disconnect reefer units should be given training in recognizing defective wires and plugs.

8.7 Means or provisions should be provided to lay the temperature controlled unit cables in and protect them from lashing equipment falling on them during lashing operations.

8.8 Defective or inoperative temperature controlled unit plugs/electrical banks should be identified and confirmed as "locked out/tagged out" by the vessel.

Resolution A.1048(27)

Code of Safe Practice for Ships Carrying Timber Deck Cargoes, 2011 (2011 TDC CODE) and its Amendments

CHAPTER 1 – GENERAL

1.1 Purpose

1.1.1 The purpose of the Code is to ensure that timber deck cargoes are loaded, stowed and secured to prevent, as far as practicable, throughout the voyage, damage or hazard to the ship and persons on board as well as loss of cargo overboard(1).

1.1.2 The Code provides:

.1 practices for safe transportation;

.2 methodologies for safe stowage and securing;

.3 design principles for securing systems;

.4 guidance for developing procedures and instructions to be included in ships' cargo securing manuals on safe stowage and securing; and

.5 sample checklists for safe stowage and securing.

1.2 Application

1.2.1 The provisions of this Code apply to all ships of 24 metres or more in length, carrying a timber deck cargo. This Code will be effective from 30 November 2011.

1.2.2 Cargo securing of timber deck cargoes should be in accordance with the requirements in the ship's Cargo Securing Manual (CSM), based on the principles in Chapter 5 or Chapter 6 of Part B of this Code.

1.2.3 The Master should note that national requirements may exist which may restrict the application of either Chapter 5 or Chapter 6, and these may also require third party inspections to ensure that the cargo has been properly secured according to the ship's cargo securing manual.

1.2.4 Cargo securing manuals for timber deck cargoes, approved following the implementation date of this Code, should meet the contents of this Code. Existing cargo securing manuals approved under the previous Timber Deck Cargo Code (Resolution A.715(17)) may remain valid.

1.3 Definitions

1.3.1 The following definitions apply to this Code:

General expressions

.1 *Administration* means the Government of the State whose flag the ship is entitled to fly.

.2 *Company* means the Owner of the ship or any other organization or person such as the Manager, or the Bareboat Charterer, who has assumed the responsibility for operation of the ship from the Ship owner and who, on assuming such responsibility, has agreed to take over all duties and responsibilities imposed by SOLAS(2).

.3 *Load Lines Convention* means the International Convention on Load Lines, 1966, or the 1988 Protocol relating thereto, as applicable.

.4 *Organization* means the International Maritime Organization (IMO).

.5 *Port industries* means the port facilities and/or stevedoring companies serving ships engaged in the stowage of timber deck cargoes.

.6 *Shipper* means any person, organization or Government which prepares or provides a consignment for transport[3].

.7 *SOLAS* means the International Convention for the Safety of Life at Sea, 1974, as amended.

.8 *2008 IS Code* means the International Code on Intact Stability, 2008.

.9 *Restricted sea area* means any sea area in which the weather can be forecast for the entire sea voyage or shelter can be found during the voyage.

Cargo related expressions

.10 *Cant* means a log which is "slab-cut", i.e. ripped lengthwise so that the resulting thick pieces have two opposing, parallel flat sides and, in some cases, a third side which is sawn flat.

.11 *Non -rigid cargo* means sawn wood or lumber, cants, logs, poles, pulpwood and all other types of loose timber or timber in packaged forms not fulfilling specified strength requirement, as defined in Section 4.7.

.12 *Rigid cargo package* means sawn wood or lumber, cants, logs, poles, pulpwood and all other types of timber in packaged forms, fulfilling specified strength requirement, as defined in Section 4.7.

.13 *Round wood* means parts of trees that have not been sawn on more than one long side. The term includes, among others, logs, poles and pulpwood in loose or packed form.

.14 *Sawn wood* means parts of trees that have been sawn so that they have at least two parallel flat long sides. The term includes, among others, lumber and cants in loose or packed form.

.15 *Timber* is used as a collective expression used for all types of wooden material covered by this Code, including both round and sawn wood but excluding wood pulp and similar cargo.

Technically related expressions

.16 *Blocking device* means physical measures to prevent sliding and/or tipping of cargoes and/or collapse of stow.

.17 *Lashing plan* means a sketch or drawing showing the required number and strength of securing items for the timber deck cargo to obtain safe stowage and securing of timber deck cargoes.

.18 *Timber deck cargo* means a cargo of timber carried on an uncovered part of a freeboard or superstructure deck.

.19 *Timber load line* means a special load line assigned to ships complying with certain conditions set out in the International Convention on Load Lines.

.20 *Stowage Factor (SF)* means the volume occupied by one tonne of a cargo when stowed and separated in the accepted manner.

.21 *Weather deck* means the uppermost complete deck exposed to weather and sea.

.22 *Reeving* means the process where a rope, chain or any other type of lashing can freely move through a sheave or over a fulcrum such as a rounded angle piece, in such a manner so as to minimize the frictional effect of such movement.

.23 *Height of cargo* means the distance from the base of the deck cargo stow to the highest part of the cargo.

PART A – OPERATIONAL REQUIREMENTS

CHAPTER 2 – GENERAL RECOMMENDATIONS ON STOWAGE AND SECURING OF TIMBER DECK CARGOES

2.1 Goals

2.1.1 The stowage and cargo securing arrangements for timber deck cargoes should enable a safe yet rational securing of the cargo so that it is satisfactorily prevented from shifting by collapsing, sliding or tipping in any direction, taking into account the acceleration forces the cargo may be subjected to throughout the voyage in the worst sea and weather conditions which may be expected.

2.1.2 This Chapter lists measures and factors that should be taken under consideration in order to achieve such level of cargo securing.

2.1.3 Procedures should be established for the preparation of plans and instructions, including checklists as appropriate, for key shipboard operations[(5)]. Guidance is provided in Annex A to assist the development of such checklists.

2.2 Pre-loading operation

2.2.1 Prior to loading the vessel, relevant cargo information,[(4)] as defined in Chapter 4 of this Code, should be provided by the shipper, according to the custom of the trade.

2.2.2 The master of the vessel should study the relevant cargo information and take the precautions necessary for proper stowage, securing and safe carriage of the cargo as defined in this Code and as prescribed in the vessel's Cargo Securing Manual.

2.2.3 Prior to loading, the stevedoring company should be made aware of specific requirements according to the ship's Cargo Securing Manual regarding stowage and securing of timber deck cargoes.

2.2.4 During loading of deck cargo the master should ensure that all tanks are maintained in such a condition that free surface effects are minimized. Ballast tanks should as far as practicable be either full or empty and ballast movement during loading operations should be avoided.

2.2.5 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 effectively protected and check-valves or similar devices should be examined to ascertain their effectiveness against the entry of water;
- .3 objects which might obstruct cargo stowage on deck should be removed and safely secured in places appropriate for storage;
- .4 the condition of friction-enhancing arrangements, where fitted, should be checked;
- .5 accumulations of ice and snow on such area should be removed;
- .6 it is normally preferable to have all deck lashings, uprights, etc., readily available before loading on that specific area. This will be necessary should a preloading examination of securing equipment be required in the loading port; and
- .7 all sounding pipes on the deck should be reviewed and arrangements made that access to these remain as far as practicable.

2.2.6 Further aspects to be considered during pre-loading operations are given in Annex A,

2.3 Permitted loading weights on decks and hatch covers

2.3.1 The hatch cover securing and support arrangements, chocks, etc., as well as coamings should be designed and reinforced as necessary for carriage of timber deck cargoes. Potential weight increase of timber deck cargoes due to water absorption, icing, etc., should be taken under consideration.

2.3.2 Care should be taken not to exceed the designed maximum permissible loads on weather deck and hatch covers during any stage of the voyage(6).

2.4 Stability

2.4.1 The master should ensure that the ship condition complies with its stability booklet at all times.

2.4.2 A ship carrying timber deck cargo should continue to comply with applicable damage stability requirements (e.g. SOLAS Regulation II-1/4.1 or Load Lines Convention, Regulation 27, as appropriate) and, additionally, the 2008 IS Code(11), particularly the timber deck cargo requirements. Since excessive GM values induce large accelerations, GM should preferably not exceed 3% of the breadth of the vessel, as indicated in Paragraph 3.7.5 of the 2008 IS Code.

2.4.3 Ballast water exchange operations should be carried out in accordance with instructions in the Ballast Water Management Plan, if available(12). The ballast water exchange operation, if required, should be considered when planning the amount of cargo to be loaded on deck.

2.4.4 According to the 2008 IS Code(11), account may be taken of the buoyancy of timber deck cargo when calculating stability curves, assuming that such cargo has a permeability up to 25%. Permeability is defined as the percentage of empty space of the volume occupied by the deck cargo. Additional curves of stability may be required if the Administration considers it necessary to investigate the influence of different permeabilities and/or assumed effective height of the deck cargo. 25% permeability corresponds to sawn wood cargo and 40%-60% permeability corresponds to round wood cargo with increasing permeability with increasing log diameters.

2.5 Load line

2.5.1 Ships assigned and making use of their timber load line should follow relevant regulations of the applicable Load Lines Convention for stowage and securing of timber as prescribed in the ship's Cargo Securing Manual. Special attention should be paid to the requirements concerning the breadth of the stow and voids in the stow (Load Lines Convention, Regulation 44). When timber load lines are utilized, the timber is to be stowed as close as possible to the ship's sides with any gaps not to exceed a mean of 4% of the breadth of the ship.(13)

2.5.2 It should be noted that not all the diagrams provided in this Code assume that timber load lines are being utilized, thus the cargo may not be shown as complying with Load Lines Convention, Regulation 44.

2.6 Timber freeboard

2.6.1 The timber freeboard, if applicable, will be found in the ship's Load Line Certificate.

2.6.2 Instructions on computation of the timber freeboard are given in the applicable Load Lines Convention(14).

2.7 Visibility

2.7.1 Timber deck cargo should be loaded in such a manner as to ensure that the ship complies with the visibility requirements contained in SOLAS Chapter V. National deviations may exist and should be taken into consideration as required dependent on the intended voyage.

2.7.2 The SOLAS requirements on visibility as well as instructions on how to calculate the visibility range are given in Chapter 3.

2.8 Work safety and work environment aspects

2.8.1 The Company should establish procedures by which the ship's personnel receive relevant information on the Safety Management System(16) in a working language or languages understood by them.

2.8.2 When deck cargo is being lashed and secured, special measures may be needed to ensure safe access to the top of, and across, the cargo so that the risk of falling is minimized. Safety helmets, proper footwear and non-obstructive high visibility garments should be worn during work on deck.

2.8.3 The risk of slipping should especially be considered during winter time when loading timber packages covered by plastic wrapping or tarpaulins. Plastic wrapping on packages with lumber of uneven length should be avoided or otherwise clearly identified.

2.8.4 Lighting during loading and discharge operations should be reasonably constant and arranged to minimize glare and dazzle, the formation of deep shadows and sharp contrasts in the level of illumination between one area and another.

2.8.5 Any obstruction such as lashings or securing points in the access way of escape routes and spaces essential to operation of the vessel, such as machinery spaces and crew's quarters, as well as obstructions to safety equipment, fire-fighting equipment and sounding pipes, should be clearly marked. In no case should an obstruction prevent safe access or egress of escape arrangements and spaces referred to above.

2.8.6 During the course of the voyage, if there is no convenient passage for the crew on or below the deck of the ship(18) giving safe means of access from the accommodation to all parts used in the necessary working of the ship, guard lines or rails, not more than 330 mm apart vertically, should be provided on each side of the deck cargo to a height of at least 1 m above the cargo. In addition, a lifeline, preferably wire rope, set up taut with a tightening device should be provided as near as practicable to the centreline of the ship. The stanchion supports to all guardrails or lifelines should be spaced so as to prevent undue sagging. Where the cargo is uneven, a safe walking surface of not less than 600 mm in width should be fitted over the cargo and effectively secured beneath, or adjacent to, the lifeline.

2.8.7 Fencing or means of closing should be provided for all openings in the stow such as at masthouses, winches, etc.

2.8.8 Where uprights are not fitted or where alternative to the provisions of 2.8.6 are permitted, a walkway of substantial construction should be provided having an even walking surface and consisting of two fore and aft sets of guardlines or rails about 1 m apart, each having a minimum of three courses of guardlines or rails to a height of not less than 1 m above the walking surface. Such guardlines or rails should be supported by rigid stanchions spaced not more than 3 m apart and lines should be set up taut by tightening devices.

2.8.9 As an alternative to 2.8.6, 2.8.7 and 2.8.8, a lifeline, preferably wire rope, may be erected above the timber deck cargo such that a crew member equipped with a fall protection system can hook on to it and work about the timber deck cargo. The lifeline should be:

.1 erected about 2 m above the timber deck cargo as near as practicable to the centreline of the ship;

.2 stretched sufficiently taut with a tightening device to support a fallen crew member without collapse or failure.

2.8.10 Properly constructed ladders, steps or ramps fitted with guard lines or handrails should be provided from the top of the cargo to the deck, and in other cases where the cargo is stepped, in order to provide reasonable access.

2.8.11 Personnel safety equipment referred to in this Chapter should be kept in an easily accessible place.

2.8.12 When lashings need to be checked and/or retightened during voyage, the Master should take appropriate actions to reduce the motion of the vessel during such operation.

2.8.13 Additional guidance regarding work safety and work environment aspects can be found in the relevant International Labour Organization (ILO) Conventions(17).

2.8.14 Noting the particular arrangements of a ship loaded with timber deck cargo, pilot boarding arrangements should be carefully considered (see also SOLAS Regulation V/23).

2.9 Stowage

2.9.1 The basic principle for the safe carriage of timber deck cargo is to make the stow as solid, compact and stable as practicable. The purpose of this is to:

.1 prevent movement 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.

2.9.2 Openings in the deck exposed to weather over which cargo is stowed should be securely closed and battened down. The ventilators and air pipes should be effectively protected(19).

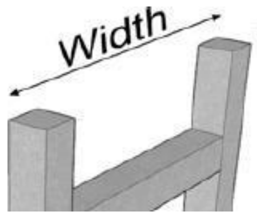
2.9.3 Deck cargo should be stowed so that access is provided to and from designated escape routes and spaces essential to operation of the vessel, such as machinery spaces and crew's quarters, as well as to safety equipment, fire-fighting equipment and sounding pipes(18). It should not interfere in any way with the navigation and necessary work of the ship(19).

2.9.4 When cargo is loaded voids may occur in the stow between packages as well as between bulwarks or gantry crane rails, etc., and other fixed constructions such as the hatch coaming.

2.9.5 Care should be taken to avoid the creation of voids or open spaces when loading cargo. Voids, where created, should be filled with loose timber or blocked by vertical H-frames with required strength to avoid cargo shifting. The MSL for double H-frames of different widths and dimensions are given in the table below. The values apply to H-frames made of sound softwood timber without knots.

Table 2.1. MSL (maximum secure load) of H-frames for different dimensions

Dimensions of battens mm	MSL in kN of double H-frames with different widths			
	0.5 m	1.0 m	1.5 m	2.0 m
50 × 50	75	53	30	17
50 × 75	113	79	46	26



50 × 100	151	106	61	34
50 × 150	226	159	91	51
75 × 75	186	153	119	85
75 × 100	248	203	159	114
75 × 150		305	238	171
75 × 200			317	227
100 × 100		301	256	212

2.9.6 Timber deck cargo which substantially overhangs (one-third of the package length) hatch coamings or other structures in the longitudinal direction, should be supported at the outer end by other cargo stowed on deck or railing or equivalent structure of sufficient strength to support it.
2.9.7 For ships assigned and making use of a timber load line, additional practices apply in accordance with the applicable Load Lines Convention(19).

2.10 Securing

2.10.1 One or more of the following principal methods may be used to secure timber deck cargoes, by themselves or in combination with each other:

- .1 different types of lashing arrangements;
- .2 bottom blocking of the base tier in combination with lashing arrangements;
- .3 blocking over the full height of the cargo by, e.g. uprights alternatively complemented by lashing arrangements;
- .4 frictional securing, taking into account scientific research and appropriate weather and voyage criteria; and
- .5 other practical securing enhancement, (taking into account appropriate weather and voyage criteria), such as:
  - .1 non slip paints on hatch covers;
  - .2 liberal use of dunnage in the stow to shore and bridge gaps;
  - .3 double lashing in exposed areas; and
  - .4 consideration given to the use of locking tiers.

2.10.2 Securing arrangements used should be designed in accordance with Part B and documented in accordance with Section 2.13 of this Code.

Lashings

2.10.3 Different lashing arrangements are described in Part B of this Code.
2.10.4 The following three types of lashing equipment with different strength and elongation characteristics are most frequently used for securing timber deck cargoes. Individual suitability should be determined by such factors as ship type, size and area of operation, and as described in this Code and as prescribed in the cargo securing manual:

- .1 chain lashings;
- .2 wire lashings; and
- .3 fabricated web lashings.

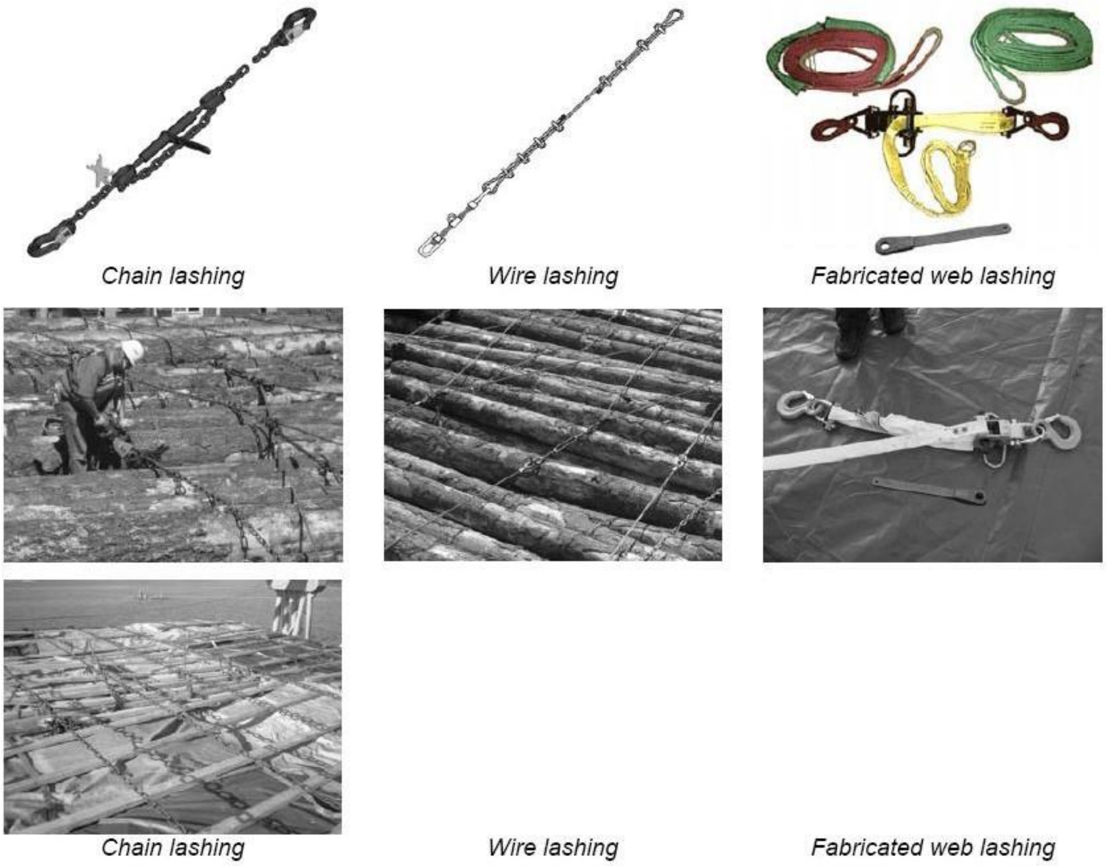


Figure 2.1 – Examples of different types of lashing equipment

Open hooks, which may loosen if the lashing becomes slack, should not be used in securing arrangements for timber deck cargoes. Web lashing should not be used in combination with chain or wire lashing.

2.10.5 The appropriate safety factors for the different types of equipment are described in Annex 13 to the Code of Safe Practice for Cargo Stowage and Securing (CSS Code).

2.10.6 All lashing equipment should be visually examined according to the instruction in the cargo securing manual before use and only equipment fit for purpose should be used for securing of timber deck cargoes.

2.10.7 The necessary pre-tension in the lashings used should be maintained throughout the voyage. 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.

2.10.8 Entries of all examinations and adjustments to lashings should be made in the ship's logbook.

2.10.9 Slip hooks or other appropriate methods may be used for quick and safe adjustment of lashings. Pelican hooks, when used, should be moused.

2.10.10 Corner protectors should be used to prevent lashings from cutting into the cargo and to protect lashings from sharp corners. The latter especially applies to fabricated web lashings.

2.10.11 Every lashing should be provided with a tightening device or system so placed that it can safely and efficiently operate when required.

Uprights

2.10.12 Uprights should be fitted when required by this Code and as prescribed in the ship's cargo securing manual in accordance with the nature, height or character of the timber deck cargo. They should be designed in accordance with the criteria in Chapter 7 of this Code and fitted in accordance with the ship's cargo securing manual. If there is an operational limit of the uprights (in terms of wave heights) this should be indicated in the ship's Cargo Securing Manual.

2.10.13 The uprights should be well fastened to the deck, hatches or coamings of the vessel (where adequate strength exists) and restrained from falling inwards during loading and discharging operations.

Lashing arrangements

2.10.14 In order to achieve a more secure stowage of logs when stowed on deck hog wires may be utilized. Such hog wire should be installed in the following manner:

.1 At approximately three quarters of the height of the stow, 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 2 m. 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.

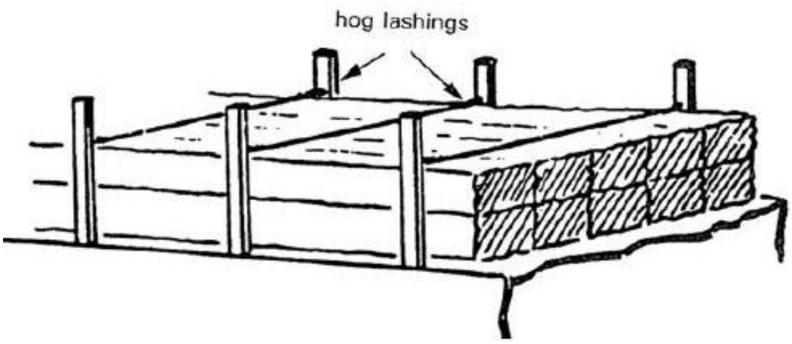


Figure 2.2 Example of hog lashings

2.10.15 In addition to uprights and hog lashings, an arrangement with top-over and continuous wiggle lashings (wiggle wires), as shown in the following figures, may be utilized at each hatch meeting the specifications of Chapter 5.

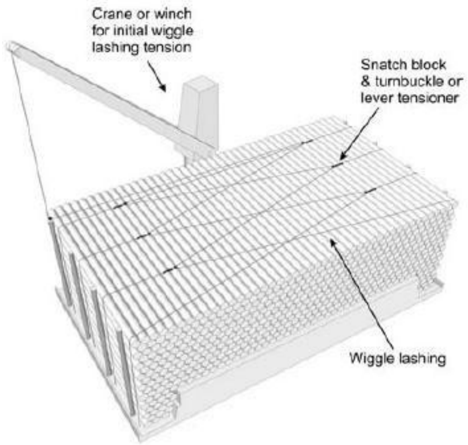


Figure 2.3. Example of wiggle lashings

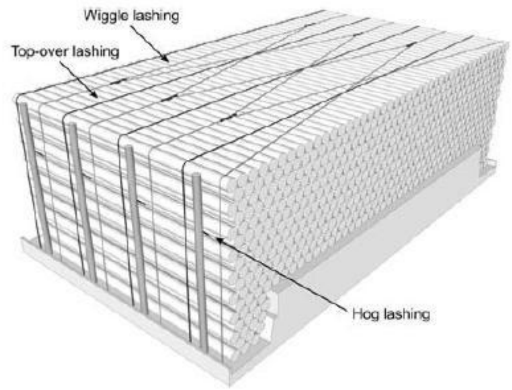


Figure 2.4. Example of an arrangement with hog, top-over and wiggle lashings

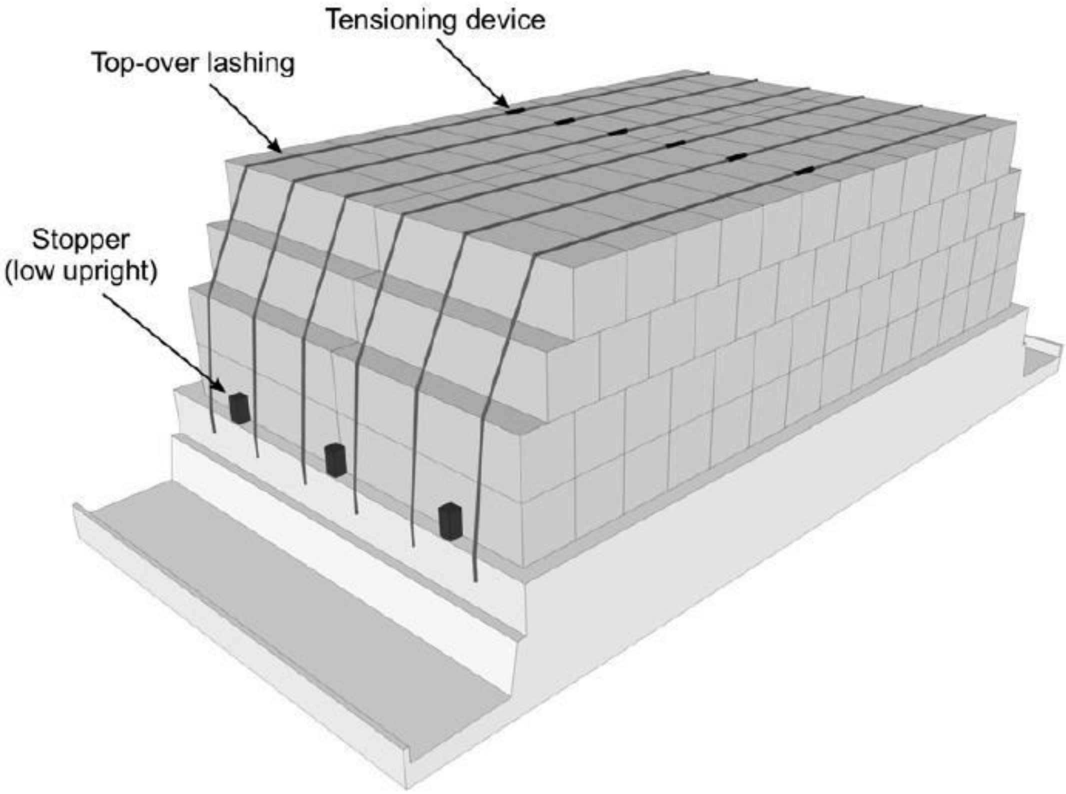


Figure 2.5. Example of an arrangement with top-over lashings and stoppers①

① Notwithstanding the guidance provided in these diagrams, compliance with the relevant timber Load Lines Convention provisions is required, when applicable.

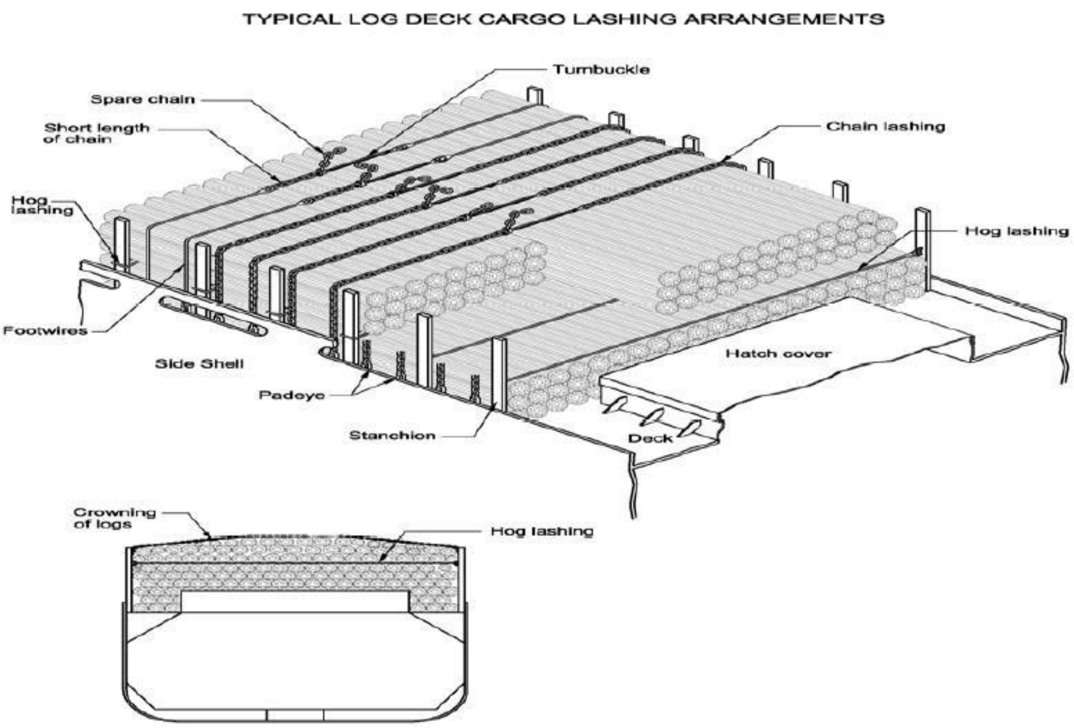


Figure 2.6. Example of chain top over lashings for a log cargo

2.10.16 If a wiggle wire is not fitted, then extra chain or chain/wire combination overlashings should be fitted instead, as described in 5.4.1.

2.11 Post-loading operation

The Company should establish procedures for the preparation of plans and instructions, including checklists as appropriate, for key post loading operations(5).

2.12 Voyage planning

2.12.1 Prior to proceeding to sea, the master should ensure that the intended voyage has been planned using the appropriate nautical charts and nautical publications for the area concerned, taking into account the guidelines and recommendations developed by the Organization(23).

2.12.2 In order to reduce excessive accelerations, the master should plan the voyage so as to avoid potential severe weather and sea conditions. To this effect, weather reports, weather facsimiles or, where available, weather routeing may be consulted and the latest available weather information should always be used(24).

2.12.3 If deviation from the intended voyage plan is considered during the voyage, the same procedure as described in 2.12.1 and 2.12.2 should be followed.

2.12.4 In cases where severe weather and sea conditions are unavoidable, the Master 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 severe weather and sea conditions. There can be no substitute for good seamanship. The following precautions should be observed:

.1 in the case of marked roll resonance with amplitudes above 30° to either side, the cargo securing arrangements could be overstressed. Effective measures should be taken to avoid this condition;

.2 in the case of heading into the seas at high speed with marked slamming shocks, excessive longitudinal and vertical acceleration may occur. An appropriate reduction of speed should be considered; and

.3 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 should be expected with great transverse accelerations as a result. An appropriate change of heading should be considered.

Foreseeable risks

2.12.5 During voyage planning, all foreseeable risks, which could lead to either excessive accelerations causing cargo to shift or conditions leading to water absorption and ice aggregation, should be considered. The following list comprises the most significant situations that should be taken under consideration to that effect:

.1 extreme weather conditions predicted by weather forecasts;

.2 severe wave conditions that have been known to appear in certain navigational areas;

.3 unfavourable directions of encountered waves(25); and

4 swell caused by recent weather phenomena in the vicinity of the area of the intended voyage.

2.13 Cargo Securing Manual

2.13.1 Timber deck cargoes should be loaded, stowed and secured, throughout the voyage, in accordance with the Cargo Securing Manual as required by SOLAS Chapter VI.

2.13.2 The Cargo Securing Manual should be based on the guidelines in this Code and drawn up to a standard at least equivalent to the guidelines developed by the Organization(26), (27) and approved by the Administration(26).

2.13.3 Each cargo securing arrangement for timber deck cargoes should be documented in the ship's Cargo Securing Manual in accordance with the instructions in MSC/Circ.745.

2.13.4 According to the CSS Code and MSC/Circ.745, among others, the following parameters should be taken into account at the design stage of cargo securing systems:

.1 duration of the voyage;

.2 geographical area of the voyage;

.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.

2.13.5 In the Cargo Securing Manual, each stowage and securing arrangements should additionally be documented by a Lashing Plan showing at least the following:

.1 maximum cargo weight for which the arrangement is designed;

.2 maximum stowage height;

.3 required number and strength of blocking devices and lashings as applicable;

.4 required pretension in lashings;

.5 other cargo properties of importance for the securing arrangement such as friction, rigidity of timber packages, etc.;

.6 illustrations of all securing items that might be used; and

.7 any restriction regarding maximum accelerations, weather criteria, for non-winter conditions only, restricted sea areas, etc.

CHAPTER 3 – VISIBILITY

3.1 According to SOLAS Chapter V, the view of the sea surface from the conning position should not be obscured by more than two ship lengths, or 500 m, whichever is the less, forward of the bow to 10° on either side under all conditions of draught, trim and deck cargo. National deviations may exist and should be taken into consideration as required dependent on the intended voyage.

3.2 No blind sector, caused by cargo, cargo gear or other obstructions outside of the wheelhouse forward of the beam which obstructs the view of the sea surface as seen from the conning position, should exceed 10°. The total arc of blind sectors should not exceed 20°. The clear sectors between blind sectors should be at least 5°. However, in the view described in 3.1, each individual blind sector should not exceed 5°.

3.3 The following formula can be used for calculating the bridge visibility:

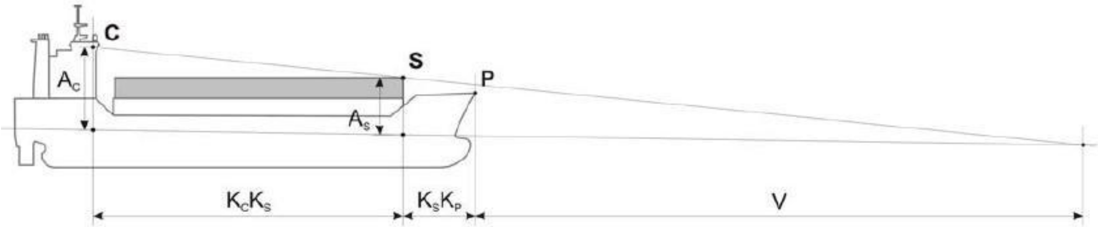


Figure 3.1. Distances used for calculating the bridge visibility

$$V = \frac{K_C K_S \cdot A_S}{A_C - A_S} - K_S K_P$$

Where:

K_CK_S *Horizontal distance from conning position to position '**S**'*

K_SK_P *Horizontal distance from position '**S**' to position '**P**'*

A_C *Airdraft of conning position*

A_S *Airdraft of position '**S**'*

CHAPTER 4 – PHYSICAL PROPERTIES OF TIMBER CARGOES

4.1 Stowage factors

4.1.1 Typical values for density and stowage factors are given in the table below for different types of timber deck cargoes.

Table 4.1. Typical values for density and stowage factors

Type of timber cargo	**Density** [ton / m^3]	**Volume factor** [m^3 hold space /m^3 cargo]	**Stowage factor** [m^3 hold space /ton of cargo]
Sawn wood Packages of sawn wood with even ends	0.5 – 0.8	1.4 – 1.7	1.8 – 3.4
Packages of sawn wood with uneven ends	0.5 – 0.8	1.6 – 1.9	2.0 – 3.8
Packages of planed wood with even ends	0.5	1.2 – 1.4	2.4 – 2.8
Round wood Coniferous round wood, fresh (bark on)	0.9 – 1.1	1.5 – 2.0	1.4 – 2.2
Broad-leaf round wood, fresh (bark on)	0.9 – 1.5	2.0 – 2.5	1.3 – 2.8
Round wood, dried (bark on)	0.65	1.5 – 2.0	2.3 – 3.1
Debarked coniferous round wood, fresh	0.85 – 1.2	1.5 – 2.0	1.2 – 2.4
Debarked broad-leaf round wood, fresh	0.9 – 1.0	1.5 – 2.5	1.5 – 2.8
Debarked round wood, dried	0.6 – 0.75	1.2 – 2.0	1.6 – 3.3

4.1.2 The densities and stowage factors in the table above are presented for information purpose only to aid preplanning operations. The corresponding values for actual loads may vary significantly from those presented in the table depending on the timber type and condition. During actual loading more accurate values of the cargo weight are obtained by repeated checks of the vessel's displacement. The weights of sawn wooden packages are normally more accurate.

4.1.3 The weight of uncovered timber cargo may change during a voyage due to loss or absorption of water (but wrapped bundled cargoes do not). Timber cargo stowed under deck may lose weight whereas timber stowed on deck may gain weight by absorption of water, see special instruction in Annex C. Particular attention should be given to the impact that these and other changing conditions have on stability throughout a voyage.

4.2 Friction factors

4.2.1 Cargo at rest is prevented from sliding by static friction. When movement has been initiated the resistance of the material contact is reduced and sliding is counteracted by dynamic friction, see 4.2.6, instead.

4.2.2 The static friction may be determined by an inclination test. The angle ρ is measured when the timber cargo starts to slide. The static friction is calculated as:

$\mu = \tan(\rho)$.

4.2.3 Five inclination tests should be performed with the same combination of materials. The highest and the lowest values should be disregarded and the friction factor is taken as the average of the three middle values. This average figure should be rounded down to the nearest fraction of 0.05.

4.2.4 If the values are intended to be used for non-winter conditions, the coefficient of friction for both dry and wet contact surfaces should be measured in separate series of tests and the lower of the two values are to be the used when designing cargo securing arrangements.

4.2.5 If the values are intended to be used for winter conditions when exposed surfaces are covered by snow and ice, the lowest coefficient of friction found for either dry, wet or snowy and icy contact surfaces should be used when designing cargo securing arrangements.

4.2.6 If not specially measured the dynamic friction factor may be taken as 70% of the static values.

4.2.7 The following values of static friction for the mentioned conditions may be used when designing securing arrangements for timber deck cargoes unless the actual coefficient of friction is measured and documented as described above.

Table 4.2. Typical values of static friction for different material combinations

Contact surface	**Non-winter Conditions** Dry or wet	**Winter conditions**
Sawn wooden package against painted steel	0.45	0.05
against sawn wood	0.50	0.30
against plastic cover or webbing slings	0.30	0.25
Round wood coniferous round wood (bark on) against painted steel	0.35	
coniferous round wood (bark on) between layers	0.75	

4.2.8 Static friction may be used for tight block stowage arrangements as well as for the design of frictional lashing systems such as top-over lashing systems.

4.2.9 Dynamic friction should be used for non-rigid lashing systems, which due to elasticity of securing equipment allow for minor dislocation of the cargo before full capacity of the securing arrangement is reached.

4.3 Plastic covers

4.3.1 Plastic sheeting is often used on packages of sawn wood to protect the cargo. High friction coatings (friction coefficient 0.5 and above) can be incorporated into plastic sheeting as an important means of improving the safe transport of these cargoes.

4.3.2 Special precautions should be taken to prevent slippery plastic hoods with low friction coefficients, from being used as a sawn wood package cargo covering on deck.

4.4 Package marking

All sawn wooden packages should be clearly marked with the volume of the package. The marking should be clearly visible on the top of the package as well as both long sides. The approximate weight should also be shown[29].

4.5 Water absorption

Sea spray may increase the weight of the timber deck cargo and thus influence the stability. The weight increase of the timber varies with time, exposure and type of timber. The value of increased weight of timber deck cargo due to water absorption should be considered in accordance with the 2008 IS Code and special instructions in Annex C.

4.6 Weight of ice

During cold weather conditions ice may form from sea spray and the stability may be affected as the ice can add weight rapidly. The increase in weight due to icing should be considered in accordance with Section 6.2 of the 2008 IS Code. The increases given in Section 6.3 of that Code for fishing vessels may be considered to be suitable also for timber cargoes, particularly for small ships. Any increase in weight due to water absorption should be considered before calculating the increase due to the weight of ice.

4.7 Rigidity of sawn wood packages

4.7.1 The Racking Strength, RS, of a sawn wood package is defined as the horizontal force that a package can withstand per metre package length without collapsing or deforming more than 10% of its width, B, or a maximum of 100 mm as shown in Figure 4.1.

4.7.2 The racking strength of timber packages can be measured by a test setup as shown in Figure 4.2. The angle α should not be greater than 30^{o} .

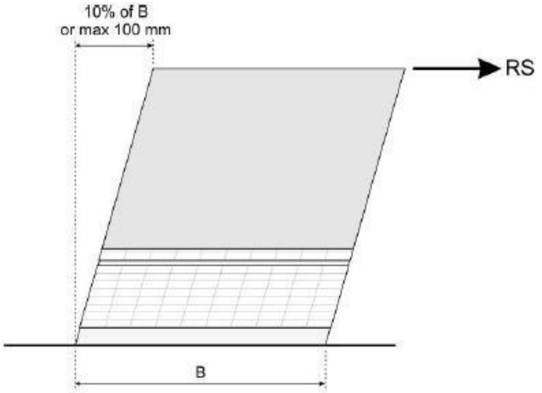


Figure 4.1. Racking strength of timber packages

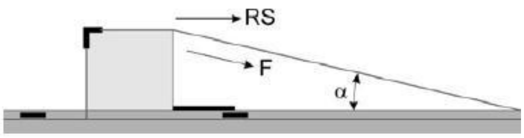


Figure 4.2. Test setup for racking strength

4.7.3 The Racking Strength, RS, is taken as the applied force F ·cos α (see figure above) when the package collapses or when the deflection in the top is 10% of the package width, B, or maximum 100 mm.

4.7.4 Racking strength measurements will have to be carried out by the shipper and the information should be provided to the master as part of the required cargo information mentioned in SOLAS Chapter VI.

PART B – DESIGN OF CARGO SECURING ARRANGEMENTS

To accommodate proven designs and practices but to also embrace advances in technology and materials, Part B has been split into two chapters, each providing different design principles. Chapter 5: (Design Principles) incorporates **prescriptive** requirements. Chapter 6: (Alternative Design Principles) provides for alternative designs and equipment to be developed and includes **functional** requirements.

CHAPTER 5 – DESIGN PRINCIPLES

This Chapter applies primarily, but is not limited to, ships of 24 metres in beam and above engaged in international deep-sea trade and incorporates experience-based prescriptive requirements on the securing of timber deck cargoes. It primarily applies the use of steel components for lashings but is not limited to their sole use. Consideration may be given to allowing Chapter 5 ships to make use of proven alternative technologies in cargo securing design, which provide at least the level of safety as specified in this Chapter. Details of such alternatives should be included in the ship's Cargo Securing Manual.

5.1 General

5.1.1 Every lashing should pass over the timber deck cargo and be secured to suitable eyeplates, lashing bollards or other devices adequate for the intended purpose which are efficiently attached to the deck stringer plate or other strengthened points. 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.

5.1.2 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.

5.1.3 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.

5.1.4 Upon completion and after the initial securing, the tightening device or system should be left with no less than half the threaded length of screw or of tightening capacity available for future use.

5.1.5 Every lashing should be provided with a device or an installation to permit the length of the lashing to be adjusted.

5.1.6 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.

5.1.7 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 three, each spaced at intervals of not less than 150 mm;

.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; and

.3 rope clips should be initially tightened so that they visibly compress the wire rope and subsequently be re-tightened after the lashing has been stressed.

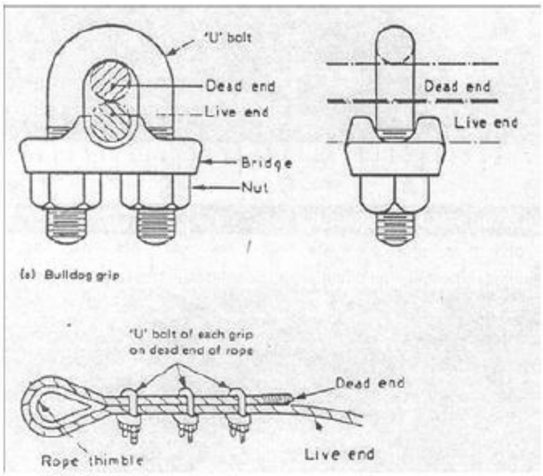


Figure 5.1. Wire rope clips

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

5.1.9 Bulldog grips are only suitable for a standard wire rope of right-hand lay having six strands. Left-hand lay or different construction should not be used with such grips.

5.2 Uprights

5.2.1 Uprights, designed in accordance with Chapter 7, should be used when required by the nature, height or character of the timber deck cargo as outlined in this code.

5.2.2 When uprights are used, they should:

.1 be made of material of adequate strength, taking into account relevant parameters such as; the breadth of the deck cargo, the weight and height of the cargo, the type of timber cargo, friction factors, additional lashings, etc.;

.2 be spaced at intervals between the centrelines of two uprights not exceeding 3 m so that preferably all sections of the stow are supported by at least two uprights; and

.3 be fixed to the deck and/or hatch cover by angles, sockets or equally efficient means and be secured in position as required by the CSM.

5.3 Loose or packaged sawn wood

5.3.1 Uprights should be used for loose sawn wood. Uprights or stoppers (low uprights) should also be used to prevent packaged sawn wood loaded on top of the hatch covers only from sliding. The timber deck cargo should in addition be secured throughout its length by independent lashings.

5.3.2 Subject to 5.3.3, 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 2.5 m and below, the maximum spacing should be 3 m;

.2 for heights of above 2.5 m, the maximum spacing should be 1.5 m; and

.3 on the foremost and aft-most sections of the deck cargo the distance between the lashings according to above should be halved.

5.3.3 As far as practicable, long and sturdy packages should be stowed in the outer rows of the stow and the packages stowed at the upper outboard edge should be secured by at least two lashings each.

5.3.4 When the outboard packages of the timber deck cargo are 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.

5.3.5 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.

5.3.6 Timber packages may alternatively be secured by a chain or wire loop lashing system, based on the design principles contained in Chapter 6.

5.4 Logs, poles, cants or similar cargo

5.4.1 The round wood deck cargo should be supported by uprights and secured throughout its length by independent top-over or loop lashings spaced not more than 1.5 m apart.

5.4.2 If the round wood deck cargo is stowed over the hatches and higher, it should, in addition to being secured by the lashings recommended in 5.4.1, be further secured by a system of athwartship lashings (hog lashings as described in Section 2.10.14) joining each port and starboard pair of uprights.

5.4.3 If winches or other adequate tensioning systems are available on board, every other of the lashings mentioned in 5.4.1 may be connected to a wiggle wire system as described in Section 2.10.15.

5.4.4 The recommendation of 5.3.5 should apply to a timber deck cargo of cants.

5.5 Testing, marking, examination and certification

All lashings and components used for the securing of the timber deck cargo should be tested, marked, examined and certified, as per the guidelines in MSC/Circ.745(27), and be specific to the requirements for lashing and components outlined in 5.1.2 and 5.1.3.

5.6 Lashing plans

One or more generic lashing plans complying with the recommendations of this Code should be provided and maintained on board a ship carrying timber deck cargo. Lashing plans should be incorporated in the Cargo Securing Manual and the most relevant lashing plan should be consulted when stowing and securing timber deck cargoes.

CHAPTER 6 – ALTERNATIVE DESIGN PRINCIPLES

This Chapter permits the development (and use) of new designs and securing arrangements by providing functional based requirements on the securing of timber deck cargoes, which may be used as an alternative to the requirements in Chapter 5 for ships of less than 24 metres in beam and for designers considering alternative technologies in cargo securing. Any design risk assessment should be agreed with the Administration before being used. When this Chapter is applied, operational risk assessments should be included within the ship's safety management system.

6.1 General requirements

6.1.1 The construction of deck, bulwarks, uprights, hatches and coamings should be of a design that allows a load of timber deck cargo to be carried in a satisfactory manner.

6.1.2 The goal is to prevent cargo shifting as far as practicable and the securing system should be designed according to the principles laid down in this Chapter.

6.1.3 Loose sawn or round wood should as a general rule be longitudinally stowed and supported on the sides by uprights to the full height of the stow.

6.1.4 Packaged sawn wood deck cargoes may be secured without uprights if the racking strength of the packages has been tested and found sufficient and sliding is prevented by bottom blocking, friction or lashing.

6.1.5 If the friction is sufficient and the expected transverse accelerations are limited, unpackaged sawn wood cargo may be transversely stowed.

6.1.6 All denotations used in the formulae in this Chapter are listed in Section 6.7 of this Code.

6.2 Accelerations and forces acting on the cargo

6.2.1 The cargo securing arrangement should be designed for accelerations as well as forces by wind and sea, calculated in accordance with Annex 13 of the CSS Code.

6.3 Physical properties of timber deck cargoes

6.3.1 Prior to loading of timber deck cargoes, all relevant cargo information, as described in this Section and in Chapter 4, should be provided to the master of the vessel.

Friction

6.3.2 Friction is one of the most important factors preventing cargo from shifting. Deck cargo may shift due to a lack of internal friction. Snow, ice, frost, rain, and other slippery surface conditions drastically affect friction. Special consideration should be given to package materials, contact surfaces, and weather conditions.

6.3.3 Static friction may be used for tight block stowage arrangements as well as for the design of frictional lashing systems such as top-over lashing systems.

6.3.4 Dynamic friction should be used for non-rigid lashing systems, e.g. loop lashings, which due to elasticity of securing equipment allow for minor dislocation, see 6.5.16, of the cargo before full capacity of the securing arrangement is reached.

6.3.5 Test procedures for determining coefficients of friction as well as generic friction values for material contacts common for timber deck cargoes are given in Chapter 4.

Rigidity of timber packages

6.3.6 The rigidity of timber packages is of great importance for the stability of the deck cargo and the racking strength of the timber packages should be taken into consideration when securing systems are designed.

Figure 6.2. Example of poor rigidity

6.3.7 The definition of the rigidity of timber packages for the purpose of this Code as well as methods for determining it are presented in Chapter 4. The racking strength should not be less than 3.5 kN/m of package length.

6.4 Safety factors

6.4.1 Safety factors are to be used when:

.1 calculating the Maximum Securing Load (MSL) of the lashings from the Minimum Breaking Load (MBL); and

.2 calculating the maximum allowed Calculated Strength (CS) in the lashings as function of MSL.

6.4.2 MSL as function of the MBL should be taken according to Annex 13 of the CSS Code, provided inspection and maintenance of the equipment have been carried out in accordance with the ship's Cargo Securing Manual.

6.4.3 The maximum allowed Calculated Strength (CS) in lashings and uprights used in the calculations should be taken from the following formula:

$$CS \le \frac{MSL}{1.35}$$

6.5 Design criteria for different securing arrangements

6.5.1 Securing arrangements for timber deck cargoes should be based on accelerations, physical properties and safety factors as described in 6.4 above.

6.5.2 Design criteria for some different securing arrangements are given below. Other securing arrangements may also be used as long as the system is designed according to the principles given in this code.

6.5.3 In Annex B detailed descriptions and example design calculations are given for some stowage and securing arrangements.

6.5.4 The denotations used in the formulas in this Chapter are listed in Chapter 8.

Top-over lashed longitudinally stowed timber packages

6.5.5 Top-over lashing alone is a frictional lashing method and the effect of the lashing is to apply vertical pressure increasing the friction force between the outer stows of deck cargo and the ship's deck/hatch cover.

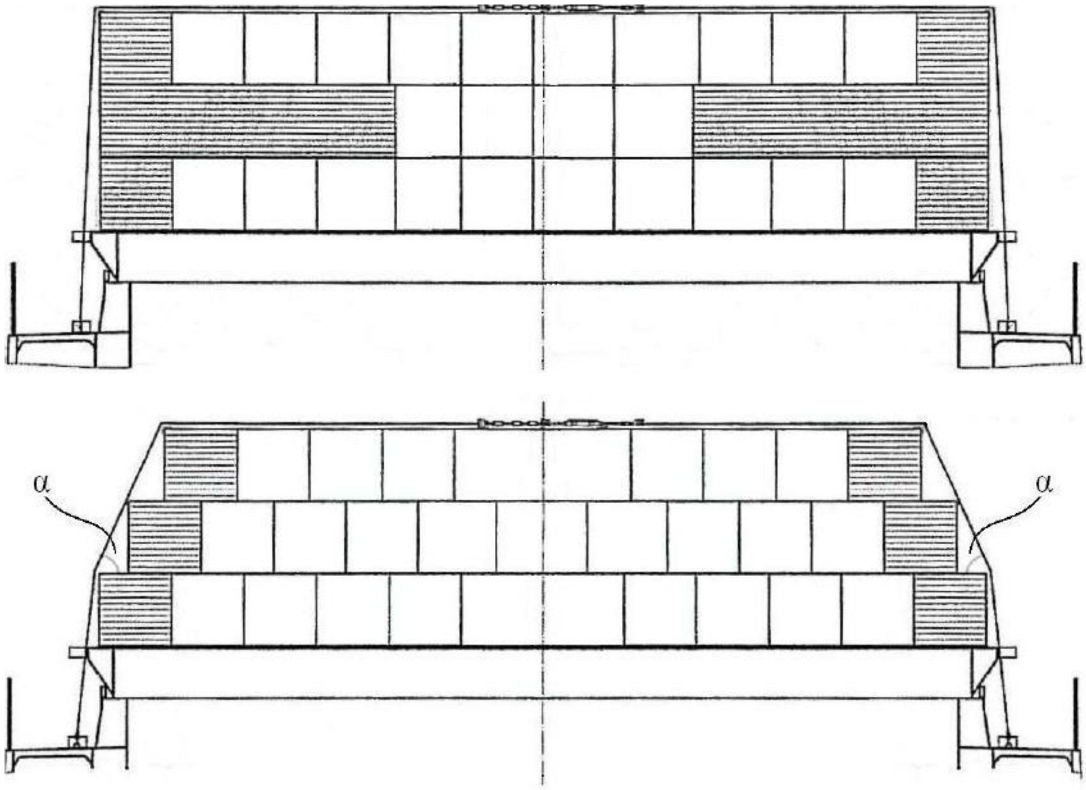


Figure 6.3. Principles for top-over lashing

6.5.6 For pure top-over lashing arrangements the friction alone will have to counteract the transverse forces so that the following equilibrium of forces is satisfied:

$$(m \cdot g_0 + 2 \cdot n \cdot PT_V \cdot sin\alpha) \cdot \mu_{static} \geq m \cdot a_t + PW + PS$$

6.5.7 In practice, sliding between the layers is often prevented due to slightly different heights of the timber packages. Alternatively it may be prevented by inserting vertical sturdy battens of proper dimensions between the columns.

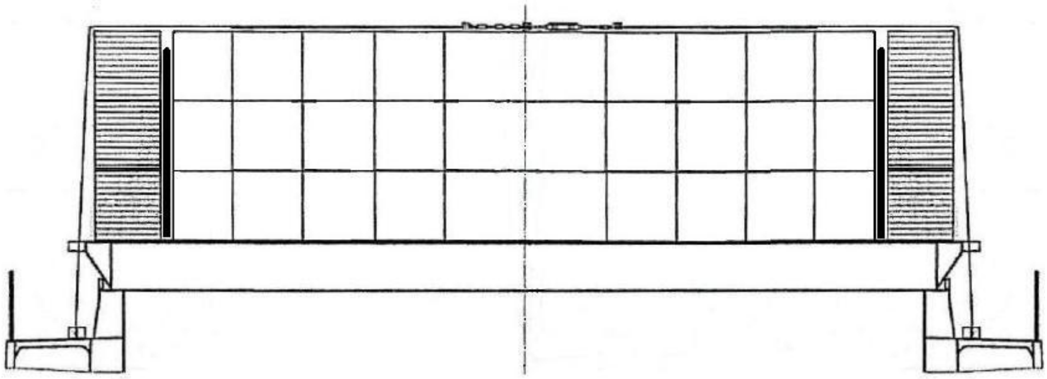


Figure 6.4. Sliding of upper layer prevented by vertical sturdy battens

6.5.8 If sliding between layers is not prevented, sliding between each individual layer should be considered by the following equilibrium of forces:

$$(m_a \cdot g_0 + 2 \cdot n \cdot PT_V \cdot \sin\alpha) \cdot \mu_{\text{static a}} \geq m_a \cdot a_t + PW_a + PS_a$$

Units denoted with $_a$ consider cargo units above the sliding level only.

6.5.9 To prevent the packages in the bottom layer from collapsing due to racking, the weight of the cargo stowed on top of the bottom layer should be limited so that the following equilibrium of forces is satisfied:

$$n_p \cdot L \cdot RS \geq m_a \cdot (a_t - 0.5g_0) + PW_a + PS_a$$

Units denoted with $_a$ consider cargo units above the bottom layer only.

6.5.10 Lashings used should comply with 6.5.20 and 6.5.21. It is extremely important to keep the lashings tight when a top-over lashing arrangement is used as the arrangement is based on the vertical pressure from the lashings.

6.5.11 When top-over lashings are used as the only means of securing longitudinally stowed packages of sawn wood, adequate friction against the hatch covers should be sought and/or the transverse accelerations should if possible be limited.

Loop lashed longitudinally stowed timber packages

6.5.12 Loop lashings are always applied in pairs as shown in the figure below. The lashings are drawn from one side of the cargo, under the cargo to the other side, up over the cargo and back to the same side. Alternatively, the lower part of the lashing may be fastened to a securing point on top of the hatch cover underneath the cargo.

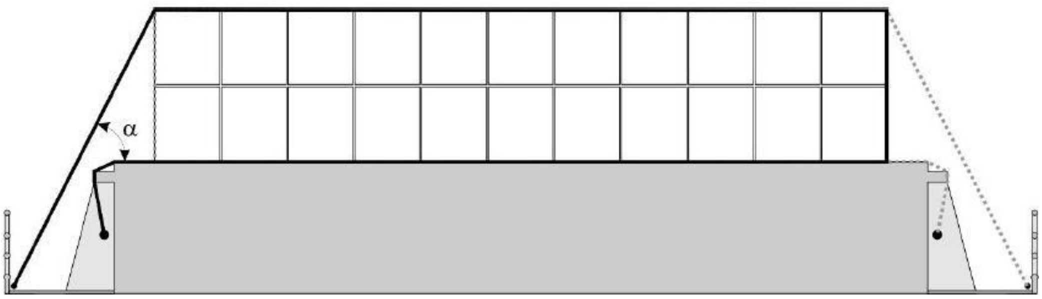


Figure 6.5. Principals of loop lashing alternative 1 (be aware of chafing where lashings are lead around ship's structure as shown in the above figure, see Section 2.10.10)

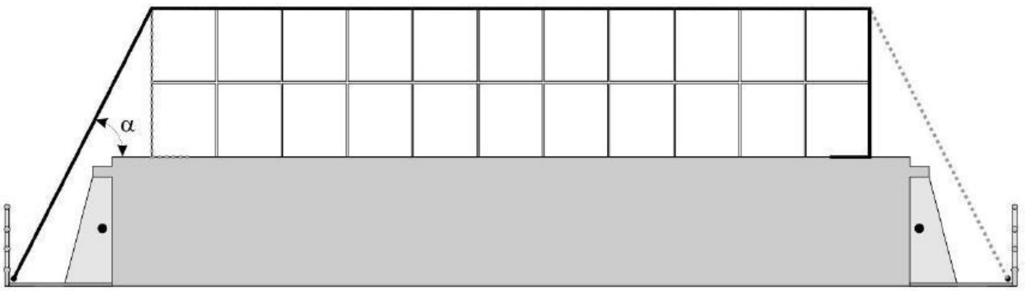


Figure 6.6. Principles for loop lashing alternative 2. The shorter length of the lashing compared to alternative 1 reduces the movement of the cargo due to elongation of the lashing

6.5.13 The number and strength of the lashings are to be chosen so that the following equilibrium is satisfied:

$$(m \cdot g_0 + n \cdot CS \cdot \sin\alpha) \cdot \mu_{\text{dynamic}} + n \cdot CS + n \cdot CS \cdot \cos\alpha \geq m \cdot a_t + PW + PS$$

6.5.14 Sliding between the layers should be prevented (see 6.5.7).

6.5.15 To prevent the packages in the bottom layer from racking, the weight of the cargo stowed on top of the bottom layer should be limited so that the following equilibrium is satisfied:

$$n_p \cdot L \cdot RS + n \cdot CS \cdot \cos\alpha \geq m_a \cdot (a_t - 0.5 g_0) + PW_a + PS_a$$

Units denoted with $_a$ consider cargo units above the bottom layer only.

6.5.16 The transverse movement of the deck cargo due to elongation of the lashings is calculated according to the following formula:

$$\delta = L_L \cdot \frac{(CS - PT_V)}{MSL} \cdot \varepsilon$$

The elongation factor ε should be taken as 2% for chain and wire lashings and 7% for web lashings unless otherwise specified by certificate from the manufacturer.

The maximum heeling angle of the vessel due to a small transverse movement of the cargo should in no case be more than 5°, based on the full timber deck load condition of the vessel calculated according to the following formula:

$$HA = \arctan\left(\frac{HM}{G'M \cdot \Delta}\right)$$

Where:

HA = Heeling angle in degrees;

HM = Heeling moment due to transverse movement of the deck cargo in ton-metres;

G'M = Metacentric height corrected for free surface moments in metres;

Δ = Ship's actual displacement in tons.

Bottom blocked and top-over lashed longitudinally stowed timber packages

6.5.17 Blocking means that the cargo is stowed against a blocking structure or fixture on the ship. If the cargo consists of packages with large racking capacity, bottom blocking should be sufficient in combination with top-over lashings.

Figure 6.7 Example of uprights for bottom blocking

6.5.18 The required strength, MSL, of the bottom blocking devices is calculated by satisfying the following equilibrium:

$$(m \cdot g_0 + 2 \cdot n \cdot PT_V \cdot \sin\alpha) \cdot \mu_{static} + n_b \cdot \frac{MSL}{1.35} \geq m \cdot a_t + PW + PS$$

6.5.19 The spacing between top-over lashings in a longitudinal direction should be maximum 3 m for stowage heights below 2.5 m and maximum 1.5 m for stowage heights above 2.5 m.

6.5.20 The pretension PT_V in the vertical part of the lashings should be not less than 16 kN and the pretension PT_H in the horizontal part of the lashing should not be less than 27 kN.

6.5.21 All lashings and components used for securing in combination with bottom blocking should:

.1 possess a breaking strength MBL 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.

6.5.22 The bottom blocking devices are to be placed on both sides of the deck cargo equally spaced. Two blocking device per side should be used per cargo section and the height should extend to a height of at least 200 mm.

6.5.23 Sliding between the layers should be prevented (see 6.5.7). If no such measures are taken, sliding between layers should be checked by the calculation for equilibrium of forces in 6.5.8.

6.5.24 To prevent the packages in the bottom layer from racking, the weight of the cargo stowed on top of the bottom layer should be limited so that the following equilibrium of forces is satisfied:

$$n_p \cdot L \cdot RS \geq m_a \cdot (a_t - 0.5 g_0) + PW_a + PS_a$$

Units denoted with $_a$ consider cargo units above the bottom layer only.

Uprights blocked and top-over lashed longitudinally stowed sawn wood packages and round wood

6.5.25 Longitudinally stowed sawn wood packages, loose sawn wood or round wood may be supported by uprights in combination depending on trading pattern with or without top-over lashings or hog wires.

6.5.26 The uprights should be designed in accordance with Chapter 7.

6.5.27 The uprights should be placed on both sides of the cargo, equally spaced. Each cargo block of the stow should be supported by at least two uprights per side.

6.5.28 The spacing of top-over lashings should for packaged sawn wood be a maximum of 3 m for stowage heights below 2.5 m and maximum 1.5 m for stowage heights above 2.5 m for round wood the spacing should be 1.5 m irrespective of the height.

6.5.29 The pretension PT_V in the vertical part of the lashings should be not less than 16 kN and the pretension PT_H in the horizontal part of the lashing should not be less than 27 kN.

6.5.30 All lashings and components used for securing in combination with bottom blocking should:

.1 possess a breaking strength MBL 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.

Frictional securing

6.5.31 In restricted sea areas, round wood may be transversely stowed and secured by bottom blocking and/or friction between tiers only. This may be done only if the friction between layers is sufficient and the expected transverse accelerations are limited. When the friction is sufficient between bottom layers and deck/hatch, then the bottom blocking may not be required. If friction only is to be used, information on the maximum heel angle assumed should be included in the Cargo Securing Manual.

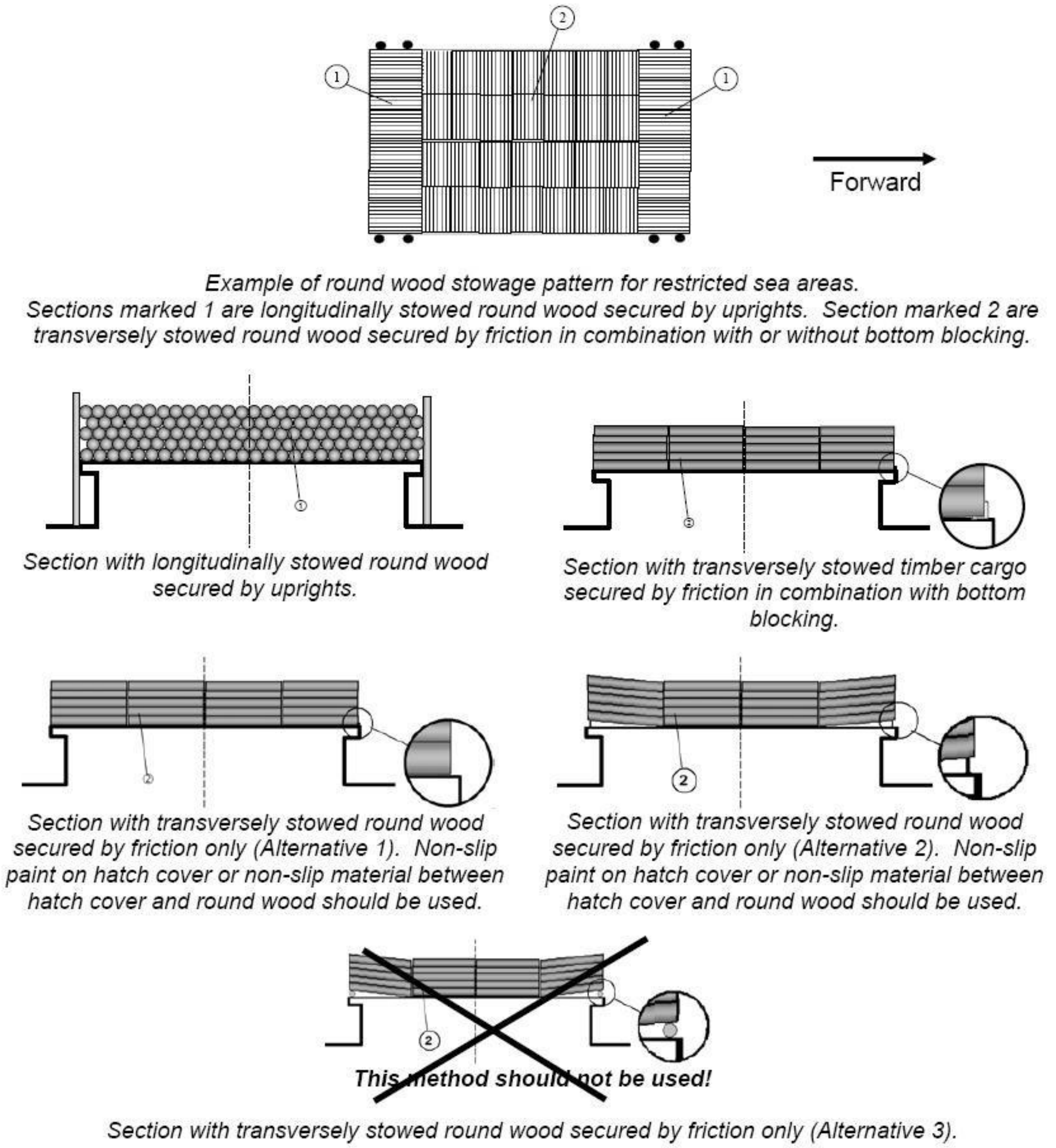


Figure 6.8 Principles for friction securing of round wood in restricted sea areas

6.5.32 The required strength, MSL, of the bottom blocking devices is calculated by satisfying the following equilibrium:

$$m \cdot g_0 \cdot \mu_{\text{static}} + n_b \cdot \frac{MSL}{1.35} \geq m \cdot a_t + PW + PS$$

6.5.33 The required friction between the layers can be calculated by satisfying the following equilibrium:

$$m \cdot g_0 \cdot \mu_{\text{static}} \geq m \cdot a_t + PW + PS$$

CHAPTER 7 – UPRIGHTS

7.1 Longitudinally stowed round wood, loose sawn wood and sawn wood packages with limited racking strength should be supported by uprights at least as high as the stow.

7.2 Uprights should be designed for the forces they have to take up according to the formulas in this Section. The connection of uprights to the deck or hatch is to be to the satisfaction of the Administration. The design of high uprights especially should be such that the deflection is limited. Uprights may be complemented by different lashing arrangements.

Figure 6.9. Uprights for blocking over the entire height of the stow

7.3 For vessels carrying loose sawn wood and round timber, the design bending moment per upright is calculated as the greater of the two moments given by the following formulas:

$$CM_{bending_1} = 0.1 \cdot \frac{H^2}{k \cdot B \cdot N} \cdot m \cdot g_0$$

$$CM_{bending_2} = \frac{H}{3 \cdot k \cdot N} \cdot (m \cdot (a_t - 0.6 \cdot \mu_{static} \cdot g_0) + PW + PS)$$ ①

$$M_{bending} \geq 1.35 \cdot \max\left(CM_{bending1}, CM_{bending2}\right)$$

If **top-over lashings** are applied in accordance with Sections 5.4 or 6.5.28 – 6.5.30, the bending moment of the uprights may be reduced by 12%.

In the table below the required bending resistance for uprights supporting loose sawn wood or round wood have been calculated based on the formulae above and by using typical cargo properties and configurations.

① The factor 0.6 in the formula above is used for considering both rolling and sliding movement of round wood and has been determined through practical tests. It should not be confused with the dynamic friction factor referred to in Paragraph 4.2.6.

Height [m]	**Transverse Acceleration** [m/s²]							
	3.0	**3.5**	**4.0**	**4.5**	**5.0**	**5.5**	**6.0**	**6.5**
2	107	150	193	235	278	321	363	406
3	330	474	618	762	906	1050	1194	1338
4	756	1097	1438	1780	2121	2462	2803	3144
5	1452	2118	2785	3451	4118	4784	5451	6117
6	2486	3638	4790	5941	7093	8245	9396	10548
7	3926	5755	7584	9413	11242	13070	14899	
8	5840	8570	11300	14030	16759			

Table 7.1 Required bending resistance in cm³ on uprights supporting round wood

7.4 The design bending moment per upright supporting timber packages is to be taken as the greatest of the three moments given by the following formulas:

$$CM_{bending_1} = \frac{m}{n_p \cdot k \cdot N} \cdot \left(a_t \cdot \frac{H}{2} - g_0 \cdot \frac{b}{2} \right) \cdot \frac{1-(1-f_i)^n}{f_i} \quad \text{(Moment required to prevent tipping)}$$

$$\text{where: } f_i = \mu_{\text{internal}} \cdot \frac{2b}{H} \quad (fi = \text{Factor for considering internal moment})$$

$$CM_{bending_2} = \frac{H}{2 \cdot k \cdot N} \cdot m \cdot (a_t - \mu_{\text{internal}} \cdot g_0) \cdot \frac{q-1}{2q} \quad \text{(Moment required to prevent sliding)}$$

$$CM_{bending_3} = \frac{H}{k \cdot N} \cdot (m \cdot a_t - (n_p - 4)(q-2) \cdot L \cdot RS) \cdot \frac{q-1}{2q} \quad \text{(Moment required to prevent racking)}$$

$$M_{bending} \geq 1.35 \cdot \max\left(CM_{bending1}, CM_{bending2}, CM_{bending3}\right)$$

In the tables below the required bending resistance for uprights supporting timber packages have been calculated based on the formulae above and by using typical cargo properties and configurations for sturdy timber packages with a racking strength of 7 kN/m and for weaker packages with a racking strength of 3.5 kN/m.

Height [m]	**Transverse Acceleration** [m/s²]						
	3.0	**3.5**	**4.0**	**4.5**	**5.0**	**5.5**	**6.0**
2					26	70	115
3		22	70	118	165	213	378
4	124	237	350	463	576	689	953
5	458	679	900	1120	1341	1562	1927
6	1040	1421	1803	2184	2565	2946	3405
7	1934	2539	3144	3748	4353	4958	5563
8	3202	4104	5007	5909	6812	7714	8617
9	4907	6192	7477	8761	10046	11331	12615

Table 7.2 Required bending resistance in cm³ on uprights supporting sturdy packages of sawn wood

Height [m]	**Transverse Acceleration** [m/s^2]						
	3.0	**3.5**	**4.0**	**4.5**	**5.0**	**5.5**	**6.0**
2	3	32	61	90	118	147	176
3	524	660	797	934	1071	1207	1344
4	724	1095	1466	1837	2208	2579	2950
5	725	1304	2084	2864	3644	4423	5203
6	1645	2248	2982	4393	5804	7215	8626
7	3055	4011	4966	7200	9512	11824	14136

Table 7.3 Required bending resistance in cm^3 on uprights supporting weaker packages of sawn wood

7.5 If hog lashings are used, the required MSL of each hog lashing is calculated by the following formula:

$$MSL \geq \frac{M_{bending}}{2 \cdot h}$$

7.6 The design bending moment should not produce greater stress than 50% of the ultimate stress for the material in any part of the uprights.

CHAPTER 8 – DENOTATIONS USED

The denotations used in the formulas in the design criteria of this code are listed below:

a_t	=	Largest transverse acceleration at the centre of gravity of the deck cargo in the forward or aft end of the stow in m/s^2
B	=	Width of deck cargo in metres
b	=	Width of each individual stack of packages
CS	=	Calculated strength of lashing in kN, see Section 6.4
f_R	=	Reduction factor for accelerations due to expected sea state
g_0	=	Gravity acceleration 9.81 m/s^2
H	=	Height of deck cargo in metres
H_M	=	Maximum significant wave height
h	=	Height above deck at which hoglashings are attached to the uprights in metres
k	=	Factor for considering hog lashings: k = 1 if no hog lashings are used k = 1.8 if hog lashings are used
L	=	Length of the deck cargo or section to be secured in metres
L_L	=	Length of each lashing in metres
$M_{bending}$	=	Design bending moment on uprights in kNm
MSL	=	Maximum Securing Load in kN of cargo securing devices
m	=	Mass of the deck cargo or section to be secured in tonnes, including absorbed water and possible icing
N	=	Number of uprights supporting the considered section on each side
n	=	Number of lashings
n_b	=	Number of bottom blocking devices per side of the deck cargo
n_p	=	Number of stacks of packages abreast in each row
PS	=	Pressure from unavoidable sea sloshing in kN based on 1 kN per m^2 exposed area, see CSS Code, Annex 13
PT_V	=	Pretension in the vertical part of the lashings in kN
PT_H	=	Pretension in the horizontal part of the lashings in kN
PW	=	Wind pressure in kN based on 1 kN per m2 wind exposed area, see CSS Code, Annex 13
q	=	Number of layers of timber packages
RS	=	Racking Strength per metre of timber package in kN/m, see Section 4.7
α	=	Angle between the hatch cover top plating and the lashings in degrees
δ	=	Small transverse movement of deck cargo in metres due to elasticity of lashing arrangement
ε	=	Elasticity factor for lashing equipment, taken as fraction of elongation experienced at the load of MSL for the lashing
$\mu_{dynamic}$	=	Dynamic coefficient of friction between the timber deck cargo and the ship's deck/hatch cover and considered to be 70% of the static friction value
$\mu_{internal}$	=	Coefficient of dynamic friction found internally between the packages of sawn wood
μ_{static}	=	Static coefficient of friction between the timber deck cargo and the ship's deck/hatch cover

ANNEX A – GUIDANCE IN DEVELOPING PROCEDURES AND CHECKLISTS

Items in A.1 to A.5 should be taken into account when developing the checklists for timber deck cargo operations.

A.1 Preparations before loading of timber deck cargoes

General preparations

A.1.1 The following information as applicable for each parcel of cargo should be provided by the shipper and collected by the master or his representative:

.1 total amount of cargo intended as deck cargo;

.2 typical dimensions of the cargo;

.3 number of bundles;

.4 density of the cargo;

.5 stowage factor of the cargo;

.6 racking strength for packaged cargo;

.7 type of cover of packages and whether non-slip type; and

.8 relevant coefficients of friction including covers of sawn wooden packages if applicable.

A.1.2 A confirmation on when the deck cargo will be ready for loading should be received.

A.1.3 A pre-loading plan according to the ship's Trim and Stability Book should be done and the following should be calculated and checked:

.1 stowage height;

.2 weight per m^2;

.3 required amount of water ballast; and

.4 displacement, draught, trim and stability at departure and arrival.

A.1.4 The stability should be within required limits during the entire voyage.

A.1.5 When undertaking stability calculations, variation in displacement, centre of gravity and free surface moments due to the following factors should be considered:

.1 absorption of water in timber carried as timber deck cargo according to special instruction, see Annex C;

.2 ice accretion, if applicable;

.3 variations in consumables; and

.4 ballast water exchange operations, in accordance with approved procedures.

A.1.6 Proper instructions for ballast water exchange operations, if applicable for the intended voyage, should be available in the Ballast Water Management Plan.

A.1.7 A lashing plan according to the ship's Cargo Securing Manual (CSM) should be prepared and the following calculated:

.1 weight and height of stows per hatch;

.2 number of sections in longitudinal direction per hatch;

.3 required number of pieces of lashing equipment; and

.4 required number of uprights, if applicable.

A.1.8 The certificates for the lashing equipment should be available in the ship's Cargo Securing Manual.

A.1.9 When the initial stability calculations and lashing plan have been satisfactorily completed, the maximum cargo intake should be confirmed.

A.1.10 Pre-load, loading and pre-lashing plans should be distributed to all involved parties (i.e. supercargo, stevedores, agent, etc.).

A.1.11 Weather report for loading period and forecasted weather for the sea voyage should be checked.

A.1.12 It should be confirmed that the stevedoring company is aware of the ship's specific requirements regarding stowage and securing of timber deck cargoes.

Ship readiness

A.1.13 All ballast tanks required for the voyage and included in the stability calculations should be filled before the commencement of loading on deck and it should be ensured that free surfaces are eliminated in all tanks intended to be completely full or empty.

A.1.14 Hatch covers and other openings to spaces below deck should be closed, secured and battened down.

A.1.15 Air pipes, ventilators, etc., should be protected and examined to ascertain their effectiveness against entry of water.

A.1.16 Objects which might obstruct cargo stowage on deck should be removed and secured safely in places appropriate for storage.

A.1.17 Accumulation of ice and snow on areas to be loaded and on packaged timber should be removed.

A.1.18 All sounding pipes on the deck should be reviewed and necessary precautions should be taken that safe access to these remains.

A.1.19 Cargo securing equipment should be examined in preparation for use in securing of timber deck cargoes and any defective equipment found should be removed from service, tagged for repair and replaced.

A.1.20 It should be confirmed that uprights utilized are in compliance with the requirements in the ship's Cargo Securing Manual.

A.1.21 A firm and level stowage surface should be prepared. Dunnage, where used, should be of rough lumber and placed in the direction which will spread the load across the ship's hatches or main deck structure and assist in draining.

A.1.22 Extra lashing points, if required, should be approved by the Administration.

A.1.23 It should be ensured that dunnage is readily available and in good condition.

A.1.24 Friction enhancing arrangements, where fitted, should be checked for their condition.

A.1.25 Cranes with wires, brakes, micro switches and signals (if they are to be used) should be controlled.

A.1.26 It should be verified that illumination on deck is working and ready for use.

Ship to shore communication

A.1.27 Radio channels to be used during cargo operations should be assigned and tested.

A.1.28 It should be confirmed that crane drivers and loading stevedores/crew understand signals to be used during cargo operations.

A.1.29 A plan should be worked out to halt loading or unloading operations due to any unforeseen circumstances that may jeopardize safety of ship and/or anyone on board.

A.2 Safety during loading and securing of timber deck cargoes

Lashing equipment

A.2.1 If applicable, uprights should be mounted before loading on deck is commenced.

A.2.2 It should be checked that all lashing equipment is in place.

Ship's safety

A.2.3 All loading operations should be planned to immediately cease if a list develops for which there is no satisfactory explanation.

A.2.4 In the event that the vessel takes up an unexplained list, then no further work should be undertaken until all ship's tanks are sounded and assessment made of the ship's stability condition.

A.2.5 If deemed necessary, samples of the timber cargo should be weighed during loading and their actual weight should be compared to the weight stated by the shipper, in order to correctly assess the ship's stability.

A.2.6 Draught checks should be regularly carried out during the course of loading and the ship's displacement should be calculated to ensure the ship's stability and draft in the final condition are within prescribed limits.

A.2.7 Permitted loading weights on deck and hatches should not be exceeded.

A.2.8 The stability of the ship should at all times be positive and in compliance with the ship's intact stability requirements.

A.2.9 Emergency escape routes should be free and ready for use.

A.2.10 There should be free access to ventilation ducts and valves if required.

A.2.11 Obstructions, such as lashings or securing points, in the access way of escape routes or operational spaces and to safety equipment, fire-fighting equipment or sounding pipes should be avoided. Where they are unavoidable they should be clearly marked[(11)].

A.2.12 Instructions on how to calculate the GM of the vessel will be provided in the approved stability manual and these instructions should be followed to determine the GM of the ship. An approximation of the GM may be obtained (when safe to do so) from the rolling period or static list at a late stage of loading. Rolling or static list may be initiated by quick or slow (as appropriate) shifting of cargo with the deck cranes or lowering cargo bundles onto other deck cargo at one side of the ship.

Stowage

A.2.13 The stow of the deck cargo should be as solid, compact and stable as practicable. Slack in the stow should be prevented as such could cause lashings to slacken and/or water to accumulate.

A.2.14 A binding effect should, as far as practicable, be obtained within the stow to enhance the stability of stack structure and to minimize the risk of cargo shifting during the sea voyage.

A.2.15 Stowage of damaged timber packages should not be allowed. Timber packages that have deformed or are found with broken bands should be returned to shore for rectification.

A.2.16 Cargo should not be stowed overhanging the ship's side.

A.2.17 Timber deck cargo which overhangs the outer side of hatch coamings or other structures, should be supported at the outer end by other cargo stowed on deck or railing or equivalent structure of sufficient strength to support it (refer to 2.9.6).

Avoid the risk of sliding in the stow

A.2.18 Ice and snow accretions should be cleared from the hatches and deck cargo before placing further cargo layers in order to obtain a high coefficient of friction in the stow.

A.2.19 Sliding between the layers should if possible be prevented by stowing timber packages of different heights in the same layer or by inserting vertical, sturdy battens between the layers.

Transverse tipping of wooden packages could be prevented by overlapping packages in successive tiers so as to create a binding stow (refer to 6.5.7).

Work safety

A.2.20 Personnel involved in the loading process should be equipped with protective clothing, i.e. hardhats, proper footwear, gloves, etc., according to ship's and harbour requirements.

A.2.21 Personnel working on cargo stowed at heights 2 m and above, within 1 m of an unguarded edge, should if deemed necessary be protected from falls with fall restraint equipment such as a safety harness or other fall restraining devices approved by the Administration.

A.2.22 While working on the cargo there should be provisions to attach a safety harness.

A.2.23 Safe access should be available to the top of, and across, the cargo stow.

A.2.24 Personnel should exercise caution when working or moving on timber packages covered by plastic wrapping or tarpaulins.

A.3 Securing of timber deck cargoes

Basic requirements on the securing

A.3.1 The stevedoring company and the crew should be informed about the requirements on the securing arrangements.

A.3.2 Uprights, when used, should be well fastened and protected from falling inwards during loading and discharging operations.

A.3.3 If required by this Code and as prescribed in the Cargo Securing Manual, uprights should be connected by hog lashings, running between each pair of uprights on opposing sides of the stow.

Repair or replacement of damaged securing equipment

A.3.4 Only undamaged cargo securing equipment should be used for securing timber deck cargo.

A.3.5 Damaged equipment that is beyond repair should be marked as unserviceable and removed from the vessel.

A.3.6 If any damage is noted on any of the uprights or their support on deck, coamings or hatches, this should immediately be repaired.

A.3.7 If any damage is noted on the fixed lashing equipment this should immediately be repaired.

A.3.8 If any damage is noted on the portable lashing equipment this should immediately be repaired or the equipment should be exchanged by new certified equipment.

Tightening of lashings

A.3.9 Threads on turnbuckles should be greased to increase pre-tension in the lashings.

A.3.10 All lashings should be thoroughly tightened and all bolts and screws on shackles and turnbuckles should be tightly fastened.

A.3.11 Turnbuckles should have sufficient threads remaining to permit lashings to be tightened during the voyage as needed.

A.3.12 Lashings should be tensioned as specified in this Code and as prescribed in the cargo securing manual.

A.3.13 Edge protectors should be used when required according to this code and as prescribed in the ship's Cargo Securing Manual to obtain good pretension in both vertical and horizontal parts of the lashings.

Provision of catwalk

A.3.14 If there is no convenient passage on or below the deck of the ship, a sturdy catwalk with strong railings should be provided above the deck cargo (refer to 2.8.6).

Securing according to the ship's Cargo Securing Manual

A.3.15 The timber deck cargo should be stowed and secured according to this code and as prescribed in the ship's Cargo Securing Manual.

A.3.16 Number and strength of uprights and lashing equipment used for the securing of the timber deck cargo should be in accordance with this code and as prescribed in the ship's Cargo Securing Manual.

A.4 Actions to be taken during the voyage

Voyage planning

A.4.1 During voyage planning, all foreseeable risks which could lead to either excessive accelerations causing cargo to shift or sloshing sea causing water absorption and ice aggregation, should be taken under consideration.

A.4.2 Before the ship proceeds to sea, the following should be verified:

- .1 The ship is upright;
- .2 The ship has an adequate metacentric height;
- .3 The ship meets the required stability criteria; and
- .4 The cargo is properly secured.

A.4.3 Soundings of tanks should be regularly carried out throughout the voyage.

A.4.4 The rolling period of the ship should be regularly checked in order to establish that the metacentric height is still within the acceptable range.

A.4.5 In cases where severe weather and sea conditions are unavoidable, the Master 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.

A.4.6 If deviation from the intended voyage plan is considered during the voyage, a new plan should be made.

Cargo safety inspections during sea voyages

A.4.7 Cargo safety inspections, in accordance with the items below, should be frequently conducted throughout the voyage.

A.4.8 Prior to any inspections being commenced on deck, the Master should take appropriate actions to reduce the motions of the ship during such operations.

A.4.9 Close attention should be given to any movement of the cargo which could compromise the safety of the ship.

A.4.10 When safety permits fixed and portable lashing equipment should be visually examined for any abnormal wear and tear or other damages.

A.4.11 Since vibrations and working of the ship will cause the cargo to settle and compact, lashing equipment should be retightened to produce the necessary pre-tension, as needed.

A.4.12 Uprights should be checked for any damage or deformation.

A.4.13 Supports for upright should be undamaged.

A.4.14 Corner protections should still be in place.

A.4.15 All examinations and adjustments to cargo securing equipment during the voyage should be entered in the ship's logbook.

List during voyage

A.4.16 If a list occurs that cannot be attributed to normal use of consumables the matter should be immediately investigated. This should consider that the cause may be due to one or more of the following:

.1 cargo shift;

.2 water ingresses; and

.3 an angle of loll (inadequate GM).

A.4.17 Even if no major shift of the deck cargo is apparent, it should be examined whether the deck cargo has shifted slightly or if there has been a shift of cargo below deck. However, prior to entering any closed hold that contains timber the atmosphere should be checked to make sure that the hold atmosphere has not been oxygen depleted by the timber.

A.4.18 It should be considered whether the weather conditions are such that sending the crew to release or tighten the lashings on a moving or shifted cargo present a greater hazard than retaining an overhanging load.

A.4.19 The possibility of water ingress should be determined by sounding throughout the vessel. In the event that unexplained water is detected, all available pumps, as appropriate, should be used to bring the situation under control.

A.4.20 An approximation of the current metacentric height should be determined by timing the rolling period.

A.4.21 If the list is corrected by ballasting and deballasting operations, the order in which tanks are filled and emptied should be decided with consideration to the following factors:

.1 when the draft of the vessel increases, water ingress may occur through openings and ventilation pipes;

.2 if ballast has been shifted to counteract a cargo shift or water ingress, a far greater list may rapidly develop to the opposite side;

.3 if the list is due to the ship lolling, 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; and

.4 free surface moments should be kept at a minimum by operating only one tank at a time.

A.4.22 As a final resort when all other options have been exhausted if the list is to be corrected by jettisoning deck cargo, the following aspects should be noted:

.1 jettisoning is unlikely to improve the situation entirely as the whole stack would probably not fall at once;

.2 severe damage may be sustained by the propeller if it is still turning when the timber is jettisoned;

.3 it will be inherently dangerous to anyone involved in the actual jettison procedure; and

.4 the position of the jettisoning procedure and estimated navigational hazard must be immediately reported to coastal authorities.

A.4.23 If the whole or partial timber deck load is either jettisoned or accidentally lost overboard, the information on a direct danger to navigation[28] should be communicated by the master by all means at his disposal to the following parties:

.1 ships in the vicinity; and

.2 competent authorities at the first point on the coast with which he can communicate directly.

Such information is to include the following:

.3 the kind of danger;

.4 the position of the danger when last observed; and

.5 the time and date (coordinated universal time) when the danger was last observed.

A.5 Safety during discharge of timber deck cargoes

Cargo securing equipment

A.5.1 The cargo securing equipment should be collected and examined and damaged equipment should be either repaired or scrapped.

A.5.2 Uprights, when used, should be well fastened to the deck, hatches or coamings of the vessel and protected from falling inwards during discharging operations.

Ship's safety

A.5.3 All discharge operations should be planned to immediately cease if a list develops for which there is no satisfactory explanation and it would be imprudent to continue loading.

A.5.4 The stability of the ship should, at all times, be positive and in compliance with the vessels intact stability requirements.

A.5.5 Emergency escape routes should be free and ready for use.

Work safety

A.5.6 Personnel involved in the discharge process should be dressed with protective clothing, i.e. hardhats, proper footwear, gloves, etc., according to ship's and harbor requirements.

A.5.7 While working on the cargo there should be provisions to attach a safety harness.

A.5.8 Correct signals should be agreed and used with crane operator(s).

A.5.9 Safe access should be available to the top of, and across the cargo stow.

A.5.10 All possible actions should be taken to minimize the risk of slipping on the cargo (i.e. when plastic wrapping or tarpaulins are used as covers).

A.5.11 Illumination should be used when required during the cargo operation.

ANNEX B – SAMPLES OF STOWAGE AND SECURING ARRANGEMENTS

B.1 Example calculation – Top-over lashings

In the examples below, the number of lashings required to secure packages of sawn wood on deck as well as the required racking strength in the packages in the bottom layer are calculated for a 16,600 DWT ship.

Example B.1.1 – Top-over lashings on a 16,600 DWT ship

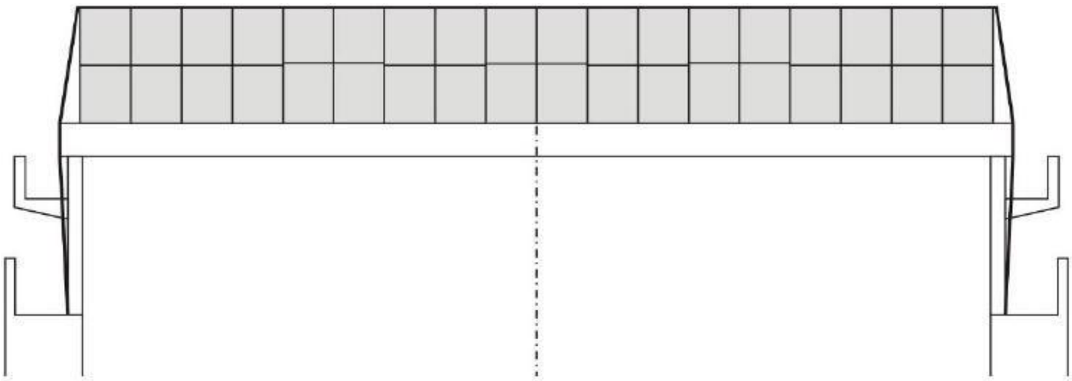


Figure B.1. Midship section of 16,600 DWT ship with packages of sawn wood in two layers secured with top-over lashings

Ship particulars

Length between perpendiculars, LPP:	134 metres
Moulded breadth, BM:	22 metres
Service speed:	14.5 knots
Metacentric height, GM:	0.70 metres

The deck cargo has the dimensions L × B × H = 80 × 19.7 × 2.4 metres. The total weight of the deck cargo is taken as 1,600 tons. Sliding between the layers is prevented by packages of different heights in the bottom layer.

Dimensioning transverse acceleration

With ship particulars as above and considering a stowage position on deck low, Annex 13 of the CSS Code gives a transverse acceleration of $a_t = 5.3\ m/s^2$, using the following basic acceleration and correction factors:

$a_{t\ basic}$	=	6.5 m/s^2	=	Basic transverse acceleration
f_{R1}	=	0.81	=	Correction factor for length and speed
f_{R2}	=	1.00	=	Correction factor for B_M/GM

$$a_t = a_{t\ basic} \cdot f_{R1} \cdot f_{R2} = 6.5 \cdot 0.81 \cdot 1.00 = 5.3\ m/s^2$$

Cargo properties

m	=	1,600 ton	=	Mass of the section to be secured in tons, including absorbed water and possible icing
μ_{static}	=	0.45	=	Coefficient of static friction between the timber deck cargo and the ship's deck/hatch cover
H	=	2.4 m	=	Height of deck cargo in metres
B	=	19.7 m	=	Width of deck cargo in metres
L	=	80 m	=	Length of the deck cargo or section to be secured in metres

PW	=	192 kN	=	Wind pressure in kN based on 1 kN per m^2 wind exposed area, see CSS Code, Annex 13
PS	=	160 kN	=	Pressure from unavoidable sea sloshing in kN based on 1 kN per m^2 exposed area, see CSS Code, Annex 13
PT_V	=	16 kN	=	Pretension in the vertical part of the lashings in kN
α	=	85°	=	Angle between the horizontal plane and the lashings in degrees
n_p	=	18 pcs	=	Number of stacks of packages abreast in each row

Number of required top-over lashings

For pure top-over lashing arrangements with no bottom blocking, the friction alone will have to counteract the transverse forces so that the following equilibrium of forces is satisfied:

$$(m \cdot g_0 + 2 \cdot n \cdot PT_V \cdot \sin\alpha) \cdot \mu_{static} \geq m \cdot a_t + PW + PS$$

Units denoted with $_a$ consider cargo units above the bottom layer only.

Thus the required number of top-over lashings can be calculated as:

$$n \geq \frac{\frac{m \cdot a_t + PW + PS}{\mu_{static}} - m \cdot g_0}{2 \cdot PT_V \cdot \sin\alpha} = \frac{\frac{1600 \cdot 5.3 + 192 + 160}{0.45} - 1600 \cdot 9.81}{2.16 \cdot \sin 85} = 123\, pcs$$

Racking strength

To prevent the packages in the bottom layer from collapsing due to racking, the weight of the cargo stowed on top of the bottom layer should be limited so that the following equilibrium of forces is satisfied:

$$n_p \cdot L \cdot RS \geq m_a \cdot (a_t - 0.5 g_0) + PW_a + PS_a$$

Units denoted with $_a$ consider cargo units above the bottom layer only.

Thus the required racking strength can be calculated to 0.33 kN/metre:

$$RS \geq \frac{m_a \cdot (a_t - 0.5 \cdot g_0) + PW_a + PS_a}{n_p \cdot L} = \frac{800 \cdot (5.3 - 0.5 \cdot 9.81) + 96 + 64}{18.80} = 0.33 kN/m = 0.034\ ton/m$$

B.2 Example calculation – Bottom blocking and top-over lashings

In the example below, the required strength of the bottom blocking devices are calculated for a deck load of packages of sawn wood. The number of lashings used and the pretension of the lashings have been taken in accordance with Sections 6.5.19 and 6.5.20 of this Code.

Example B.2.1 – Bottom blocking and top-over lashings on a 16,600 DWT ship

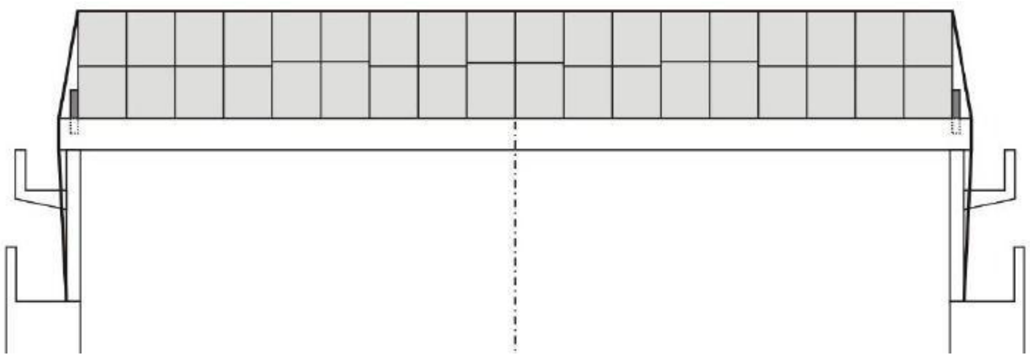


Figure B.2. Midship section of 16,600 DWT ship with packages of sawn wood in two layers secured with bottom blocking devices and top-over lashings

Ship particulars

Length between perpendiculars, LPP:	134 metres
Moulded breadth, BM:	22 metres
Service speed:	14.5 knots
Metacentric height, GM:	0.70 metres

The deck cargo has the dimensions L × B × H = 80 × 19.7 × 2.4 metres. The total weight of the deck cargo is taken as 1,600 tons. Sliding between the layers is prevented by packages of different heights in the bottom layer.

Dimensioning transverse acceleration

With ship particulars as above and considering a stowage position on deck low, Annex 13 of the CSS Code gives a transverse acceleration of a_t = 5.3 m/s^2, using the following basic acceleration and correction factors:

$a_{t\ basic}$	=	6.5 m/s^2	=	Basic transverse acceleration
f_{R1}	=	0.81	=	Correction factor for length and speed
f_{R2}	=	1.00	=	Correction factor for B_M/GM

$a_t = a_{t\ basic} \cdot f_{R1} \cdot f_{R2} = 6.5 \cdot 0.81 \cdot 1.00 = 5.3\ m/s^2$

Cargo properties

m	=	1,600 ton	=	Mass of the section to be secured in tons, including absorbed water and possible icing
μ_{static}	=	0.45	=	Coefficient of static friction between the timber deck cargo and the ship's deck/hatch cover
H	=	2.4 m	=	Height of deck cargo in metres
B	=	19.7 m	=	Width of deck cargo in metres
L	=	80 m	=	Length of the deck cargo or section to be secured in metres
PW	=	192 kN	=	Wind pressure in kN based on 1 kN per m^2 wind exposed area, see CSS Code, Annex 13
PS	=	160 kN	=	Pressure from unavoidable sea sloshing in kN based on 1 kN per m^2 exposed area, see CSS Code, Annex 13
n	=	26 pcs	=	Number of top-over lashings
PT_V	=	16 kN	=	Pretension in the vertical part of the lashings in kN
α	=	85°	=	Angle between the horizontal plane and the lashings in degrees
n_p	=	18 pcs	=	Number of stacks of packages abreast in each row
n_b	=	26 pcs	=	Number of bottom blocking devices per side of the deck cargo

Required strength of the bottom blocking

The required strength, MSL, of the bottom blocking devices is given by the following equilibrium:

$$(m \cdot g_0 + 2 \cdot n \cdot PT_V \cdot \sin\alpha) \cdot \mu_{static} + n_b \frac{MSL}{1.35} \geq m \cdot a_t + PW + PS$$

$$MSL \geq \frac{1.35}{n_b}(m \cdot a_t + PW + PS - (m \cdot g_0 + 2 \cdot n \cdot PT_V \cdot \sin\alpha) \cdot \mu_{static})$$

$$MSL \geq \frac{1.35}{26}(2000 \cdot 5.3 + 192 + 160 - (2000 \cdot 9.81 + 2 \cdot 26 \cdot 16 \cdot \sin 85) \cdot 0.45) = 91\ kN$$

B.3 Example calculation – Loop lashings

In the example below, the required strength in loop lashings used for secure packages of sawn wood on deck is calculated.

Example B.3.1 – Loop lashings on a 16,600 DWT ship

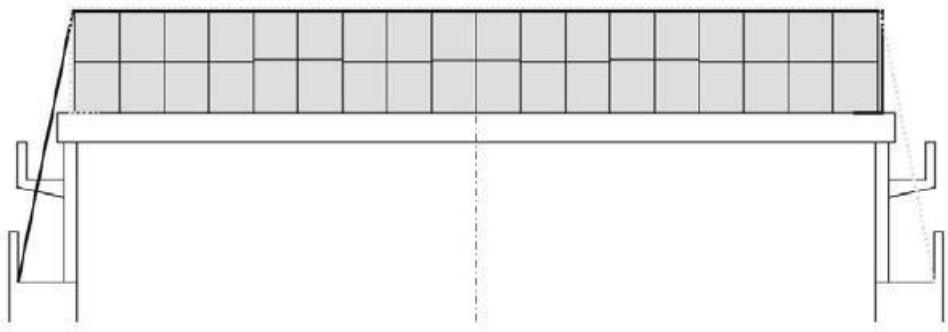


Figure B.3. Midship section of 16,600 DWT ship with packages of sawn wood secured with loop lashings

Ship particulars

Length between perpendiculars, LPP:	134 metres
Moulded breadth, BM:	22 metres
Service speed:	14.5knots
Metacentric height, GM:	0.70metres

The deck cargo has the dimensions L × B × H = 80 × 19.7 × 2.4 metres. The total weight of the deck cargo is taken as 1,600 tons. Sliding between the layers is prevented by packages of different heights in the bottom layer.

Dimensioning transverse acceleration

With vessel particulars as above and considering a stowage position on deck low, Annex 13 of the CSS Code gives a transverse acceleration of $a_t = 5.3\ m/s^2$, using the following basic acceleration and correction factors:

$a_{t\ basic}$	=	6.5 m/s^2	=	Basic transverse acceleration
f_{R1}	=	0.81	=	Correction factor for length and speed
f_{R2}	=	1.00	=	Correction factor for B_M/GM

$a_t = a_{t\ basic} \cdot f_{R1} \cdot f_{R2} = 6.5 \cdot 0.81 \cdot 1.00 = 5.3$ m/s^2

Cargo properties

m	=	1,600 ton	=	Mass of the section to be secured in tons, including absorbed water and possible icing
$\mu_{dynamic}$	=	0.32	=	Coefficient of dynamic friction between the timber deck cargo and the ship's deck/hatch cover
H	=	2.4 m	=	Height of deck cargo in metres
B	=	19.7 m	=	Width of deck cargo in metres
L	=	80 m	=	Length of the deck cargo or section to be secured in metres
PW	=	192 kN	=	Wind pressure in kN based on 1 kN per m^2 wind exposed area, see CSS Code, Annex 13
PS	=	160 kN	=	Pressure from unavoidable sea sloshing in kN based on 1 kN per m^2 exposed area, see CSS Code, Annex 13
α	=	70°	=	Angle between the horizontal plane and the lashings in

				degrees
n	=	36 pcs	=	Number of loop lashings pairs
L_L	=	25 m	=	Length of each lashing in metres
PT_V	=	16 kN	=	Pretension in the vertical part of the lashings in kN
n_p	=	13 pcs	=	Number of stacks of packages abreast in each row

Number of required loop lashings

The number and strength of the lashings are to be chosen so that the following equilibrium is satisfied:

$$(m \cdot g_0 + n \cdot CS \cdot \sin\alpha) \cdot \mu_{dynamic} + n \cdot CS + n \cdot CS \cdot \cos\alpha \geq m \cdot a_t + PW + PS$$

If the number of loop lashings pairs is 36 then the required strength in the lashings can be calculated as:

$$CS \geq \frac{m \cdot (a_t - g_0 \cdot \mu_{dynamic}) + PW + PS}{n \cdot (\sin\alpha \cdot \mu_{dynamic} + 1 + \cos\alpha)} = \frac{1600 \cdot (5.3 - 9.81 \cdot 0.32) + 192 + 160}{36 \cdot (\sin 70 \cdot 0.32 + 1 + \cos 70)} = 64 \text{ kN}$$

The required MSL in the lashings is calculated as:

$MSL = CS \cdot 1.35 = 64 \cdot 1.35 = 86\ kN = 8.8\ ton$

Transverse movement of cargo due to elongation in lashings

The transverse movement of the deck cargo due to elongation of the lashings is calculated according to the formula below. If chains are used the elongation factor is set to ε = 0.02, and the transverse movement is calculated as:

$$\delta = L_L \cdot \frac{(CS - PT_V)}{\text{MSL}} \cdot \varepsilon = 25 \cdot \frac{(64-16)}{86} \cdot 0.02 = 0.28\,m$$

If web lashings are used the elongation factor is set to ε = 0.07, and the transverse movement is calculated as:

$$\delta = L_L \cdot \frac{(CS - PT_V)}{\text{MSL}} \cdot \varepsilon = 25 \cdot \frac{(64-16)}{86} \cdot 0.07 = 0.98\,m$$

In accordance with 6.5.16 the transverse movement of the cargo should not generate a greater heeling angle than 5 degrees. In order to comply with this requirement significantly more and/or stronger lashings than described above have to be used.

Racking strength

To prevent the packages in the bottom layer from collapsing due to racking, the weight of the cargo stowed on top of the bottom layer should be limited so that the following equilibrium of forces is satisfied:

$$n_p \cdot L \cdot RS + n \cdot CS \cdot \cos\alpha \geq m_a \cdot (a_t - 0.5 g_0) + PW_a + PS_a$$

Units denoted with $_a$ consider cargo units above the bottom layer only.

Thus the required racking strength can be calculated as:

$$\text{RS} \geq \frac{M_a \cdot (a_t - 0.5 \cdot g_0) + PW_a + PS_a - n \cdot CS \cdot \cos\alpha}{n_p \cdot L}$$

$$= \frac{800 \cdot (5.3 - 0.5 \cdot 9.81) + 96 + 64 - 46.62 \cdot \cos 70}{13.80} < 0\ kN/m$$

There is no requirement on the racking strength of the packages, since the calculated value is less than zero.

B.4 Example Calculation – Uprights for packages of sawn wood

In the example below, the dimensioning moment for uprights supporting packages of sawn wood on deck is calculated for a 16,600 DWT ship.

Example B.4.1 – Uprights on a 16,600 DWT Vessel

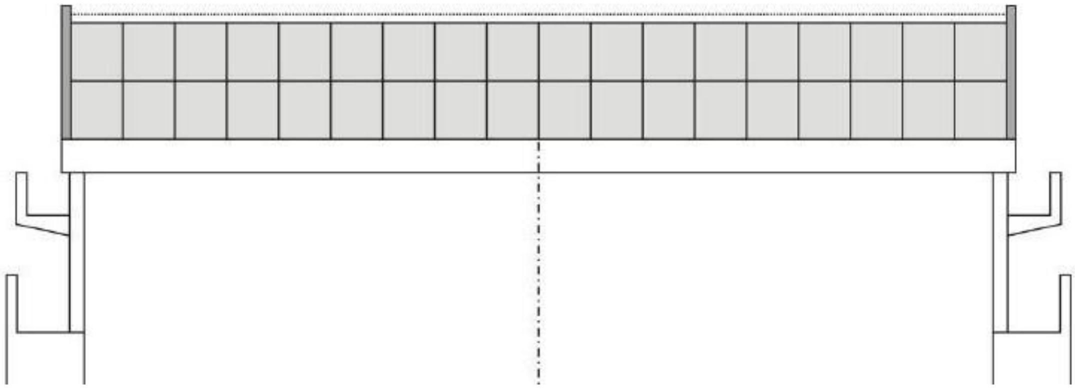


Figure B.4. Midship section of ship with timber packages secured with uprights

Ship particulars

Length between perpendiculars, LPP: 134 metres

Moulded breadth, BM: 22 metres

Service speed: 14.5 knots

Metacentric height, GM: 0.7 metres

The deck cargo has the dimensions L × B × H = 80 × 19.7× 2.4 metres. The total weight of the deck cargo is taken as 1,600 tons.

With ship particulars as above and considering a stowage position on deck low, Annex 13 of the CSS Code gives a transverse acceleration of a_t = 5.3 m/s^2, using the following basic acceleration and correction factors:

$a_{t\ basic}$	=	6.5 m/s^2	=	Basic transverse acceleration
f_{R1}	=	0.81	=	Correction factor for length and speed
f_{R2}	=	1.00	=	Correction factor for B_M/GM

$a_t = a_{t\ basic} \cdot f_{R1} \cdot f_{R2} = 6.5 \cdot 0.81 \cdot 1.00 = 5.3\ m/s^2$

Cargo properties

m	=	1,600 ton	=	Mass of the section to be secured in tons, including absorbed water and possible icing
$\mu_{internal}$	=	0.30	=	Coefficient of internal friction between the timber packages
H	=	2.4 m	=	Height of deck cargo in metres
b	=	1.1 m	=	Width of each individual stack of packages
n_p	=	18 pcs	=	Number of stacks of timber packages abreast in each row
q	=	2 pcs	=	Number of layers of timber packages
RS	=	3.5 kN/M	=	Racking Strength per timber package in kN/m
N	=	36 pcs	=	Number of uprights supporting the considered section on each side
h	=	2.4 m	=	Height above deck at which hoglashings are attached to the uprights in metres
k	=	1.8	=	Factor for considering hog lashings k = 1 if no hog lashings are used k = 1.8 if hog lashings are used

Bending moment in uprights

The design bending moment per upright supporting timber packages is to be taken as the greatest of the three moments given by the following formulas:

$$CM_{bending_1} = \frac{m}{n_p \cdot k \cdot N} \cdot \left(a_t \cdot \frac{H}{2} - g_0 \cdot \frac{b}{2} \right) \cdot \frac{1-(1-f_i)^{n_p}}{f_i} \quad \text{(Moment required to prevent tipping)}$$

$$\text{Where} \quad f_i = \mu_{\text{int ernal}} \cdot \frac{2b}{H} \quad \text{(fi =Factor for considering internal moment)}$$

$$CM_{bending_2} = \frac{H}{2 \cdot k \cdot N} \cdot m \cdot (a_t - \mu_{\text{int ernal}} \cdot g_0) \cdot \frac{q-1}{2q} \quad \text{(Moment required to prevent sliding)}$$

$$CM_{bending_3} = \frac{H}{k \cdot N} \cdot \left(m \cdot a_t - (n_p - 4)(q-2) \cdot L \cdot RS \right) \cdot \frac{(q-1)}{2q} \quad \text{(Moment required to prevent racking)}$$

With cargo properties and acceleration as given above, the following bending moments are calculated:

$$f_i = 0.3 \cdot \frac{2 \cdot 1.1}{2.4} = 0.275$$

$$CM_{bending_1} = \frac{1600}{18 \cdot 1.8 \cdot 36} \cdot \left(5.3 \cdot \frac{2.4}{2} - 9.81 \cdot \frac{1.1}{2} \right) \cdot \frac{1-(1-0.275)^{18}}{0.275} = 4.8 \text{ kNm}$$

$$CM_{bending_2} = \frac{2.4}{2 \cdot 1.8 \cdot 36} \cdot 1600 \cdot (5.3 - 0.30 \cdot 9.81) \cdot \frac{2-1}{2 \cdot 2} = 17.5 \text{ kNm}$$

$$CM_{bending_3} = \frac{2.4}{1.8 \cdot 36} \cdot (1600 \cdot 5.3 - (18-4)(2-2) \cdot 80 \cdot 3.5) \cdot \frac{(2-1)}{2 \cdot 2} = 78.5 \text{ kNm}$$

The design bending moment, taken as the maximum bending moment calculated by the three formulae above multiplied with the safety factor of 1.35, thus becomes 106 kNm:

$$M_{bending} \geq 1.35 \cdot \max(CM_{bending\ 1}, CM_{bending\ 2}, CM_{bending\ 3}) = 1.35 \cdot 78.5 = 106 \text{ kNm}$$

Suitable dimensions for uprights

With MSL taken as 50% of the MBL for steel with the ultimate strength 360 MPa (N/mm^2), the required bending resistance, W, can be calculated as:

$$W = \frac{M_{bending}}{50\% \text{ of } 360 \text{ MPa}} = \frac{106 \cdot 10^6}{180} = 589 \cdot 10^3 \text{ mm}^3 = 589 \text{ cm}^3$$

Thus, uprights made from either HE220A profiles or a cylindrical profile with an outer diameter of 324 mm and a wall thickness of 10.3 mm are suitable (see Section B.7).

Strength in hoglashings

The required MSL of each hog lashing is calculated by the following formula:

$$MSL \geq \frac{M_{bending}}{2 \cdot h}$$

In this case, the hoglashings are attached at a height of h = 3.5 m and the required strength is calculated as:

$$\text{MSL} \geq \frac{M_{bending}}{2 \cdot h} = \frac{106}{2 \cdot 3.5} = 15kN \approx 1.5ton$$

B.5 Example Calculation – Uprights for round wood

In the examples below, the dimensioning moments for uprights supporting round wood on deck are calculated for three different ships of varying sizes.

Example B.5.1 – Uprights for round wood on a 28,400 DWT ship

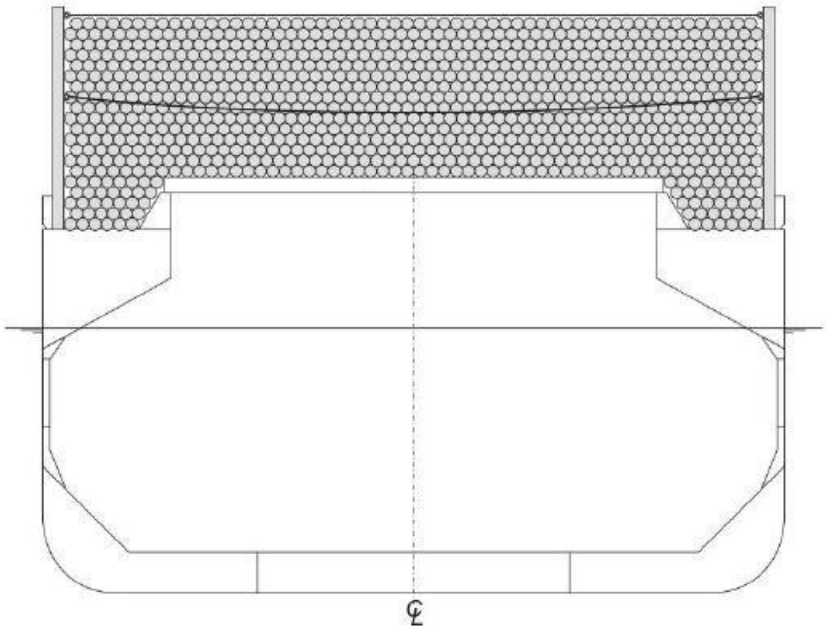


Figure B.5 Midship section of 28,400 DWT ship with round wood secured with uprights

Ship particulars

Length between perpendiculars, LPP: 160 metres
Moulded breadth, BM: 27 metres
Service speed: 14 knots
Metacentric height, GM: 0.80 metres

The deck cargo has the dimensions L × B × H = 110 × 25.6 × 7 metres and is supported by 42 uprights on each side. The total weight is taken as 10,500 tons.

In addition to the uprights and hog-lashings, the cargo has been secured with top-over lashings applied in accordance with Sections 5.4 and 6.5.28 – 6.5.30 .

With ship particulars as above and considering a stowage position on deck low, Annex 13 of the CSS Code gives a transverse acceleration of a_t = 4.6 m/s^2, using the following basic acceleration and correction factors:

$a_{t\ basic}$	=	6.5 m/s^2	=	Basic transverse acceleration
f_{R1}	=	0.71	=	Correction factor for length and speed
f_{R2}	=	1.00	=	Correction factor for B_M/GM

$a_t = a_{t\ basic} \cdot k_1 \cdot k_2 = 6.5 \cdot 0.71 \cdot 1.00 = 4.6\ m/s^2$

Cargo properties

M	=	10,500 ton	=	Mass of the section to be secured in tons, including absorbed water and possible icing
μ_{static}	=	0.35	=	Coefficient of static friction between the timber deck cargo and the ship's deck/hatch cover
H	=	7 m	=	Height of deck cargo in metres
B	=	25.6 m	=	Width of deck cargo in metres
L	=	110 m	=	Length of the deck cargo or section to be secured in metres
PW	=	770 kN	=	Wind pressure in kN based on 1 kN per m^2 wind exposed

				area, see CSS Code, Annex 13
PS	=	220 kN	=	Pressure from unavoidable sea sloshing in kN based on 1 kN per m^2 exposed area, see CSS Code, Annex 13
N	=	42 pcs	=	Number of uprights supporting the considered section on each side
h	=	3.7 /m 6.7	=	Height above deck at which hog lashings are attached to the uprights in metres
n_{hog}	=	2 pcs	=	Number of hog lashings for each upright
k		1.8		Factor for considering hog lashings; k = 1 if no hog lashings are used k = 1.8 if hog lashings are used

Bending moment in uprights

For ships carrying loose sawn wood and round wood, the design bending moment per upright is calculated as the greater of the two moments given by the following formulas:

$$CM_{bending_1} = 0.1 = \frac{H^2}{k \cdot B \cdot N} \cdot m \cdot g_0$$

$$CM_{bending2} = \frac{H}{3 \cdot k \cdot N} \cdot (m \cdot (a_t - 0.6 \cdot \mu_{static} \cdot g_0) + PW + PS)$$

With cargo properties and acceleration as given above, the following bending moments are calculated:

$$CM_{bending1} = 0.1 \cdot \frac{7^2}{1.8 \cdot 25.6 \cdot 42} \cdot 10500 \cdot 9.81 = 260kNm$$

$$CM_{bending2} = \frac{7}{3 \cdot 1.8 \cdot 42} \cdot (10500 \cdot (4.6 - 0.6 \cdot 0.35 \cdot 9.81) + 770 + 220) = 854kNm$$

The design bending moment, taken as the maximum bending moment calculated by the formulae above multiplied with a safety factor of 1.35 and considering the 12% reduction allowed for by the use of properly applied top-over lashings, thus becomes:

$$M_{bending} \geq 88\% \cdot 1.35 \cdot \max\left(CM_{bending1}, CM_{bending2}\right) = 0.88 \cdot 1.35 \cdot 854 = 1015kNm$$

Suitable dimensions for uprights

With MSL taken as 50% of the MBL for steel with the ultimate strength 360 MPa (N/mm^2), the required bending resistance, W, can be calculated as:

$$W = \frac{M_{bending}}{50\%\ of\ 360MPa} = \frac{1015 \cdot 10^6}{180} = 5639 \cdot 10^3 mm^3 = 5639m^3$$

Thus, uprights made from either HE 600 B profiles or a cylindrical profile with an outer diameter of 610 mm and a wall thickness of 24.6 mm are suitable (see Section B.7).

Strength in hog lashings

The required MSL of each hog lashing is calculated by the following formula:

$$MSL \geq \frac{M_{bending}}{2 \cdot h \cdot n_{hog}}$$

In this case, the hog lashings are attached at the heights 3.7 and 6.7 metres (mean height=5.2) and the required strength is calculated as:

$$MSL \geq \frac{M_{bending}}{2 \cdot h \cdot n_{hog}} = \frac{1015}{2 \cdot 5.2 \cdot 2} = 49kN \approx 4.9ton$$

Example B.5.2 – Uprights for round wood on a 16 600 DWT ship

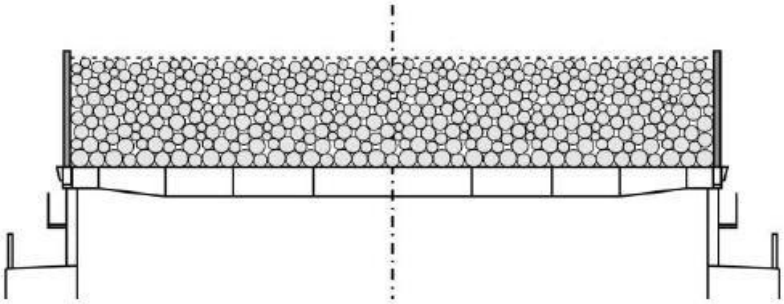


Figure B.6. Midship section of 16 600 DWT ship with round wood secured with uprights

Ship particulars

Length between perpendiculars, LPP: 134 metres
Moulded breadth, BM: 22 metres
Service speed: 14.5 knots
Metacentric height, GM: 0.70 metres

The deck cargo has the dimensions L × B × H = 80 ×19.7 × 3.7 metres and is supported by 30 uprights on each side. The weight of the cargo is taken as 3,000 tons.

With ship particulars as above and considering a stowage position on deck low, Annex 13 of the CSS Code gives a transverse acceleration of a_t = 5.3 m/s^2, using the following basic acceleration and correction factors:

$a_{t\ basic}$	=	6.5 m/s^2	=	Basic transverse acceleration
f_{R1}	=	0.81	=	Correction factor for length and speed
f_{R2}	=	1.00	=	Correction factor for B_M/GM

$a_t = a_{t\ basic} \cdot k_1 \cdot k_2 = 6.5 \cdot 0.81 \cdot 1.00 = 5.3\ m/s^2$

Cargo properties

M	=	3,000 ton	=	Mass of the section to be secured in tons, including absorbed water and possible icing
μ_{static}	=	0.35	=	Coefficient of static friction between the timber deck cargo and the ship's deck/hatch cover
H	=	3.7 m	=	Height of deck cargo in metres
B	=	19.7 m	=	Width of deck cargo in metres
L	=	80 m	=	Length of the deck cargo or section to be secured in metres
PW	=	296 kN	=	Wind pressure in kN based on 1 kN per m^2 wind exposed area, see CSS Code, Annex 13
PS	=	160 kN	=	Pressure from unavoidable sea sloshing in kN based on 1 kN per m^2 exposed area, see CSS Code, Annex 13
N	=	30 pcs	=	Number of uprights supporting on each side
h	=	3.7 m	=	Height above deck at which hog lashings are attached to the uprights in metres
n_{hog}	=	1 pcs	=	Number of hog lashings for each uprights
k	=	1.8	=	Factor for considering hog lashings; k = 1 if no hog lashings are used k = 1.8 if hog lashings are used

Bending moment in uprights

For ships carrying loose sawn wood and round timber, the design bending moment per upright is calculated as the greater of the two moments given by the following formulas:

$$CM_{bending_1} = 0.1 = \frac{H^2}{k \cdot B \cdot N} \cdot m \cdot g_0$$

$$CM_{bending2} = \frac{H}{3 \cdot k \cdot N} \cdot (m \cdot (a_t - 0.6 \cdot \mu_{static} \cdot g_0) + PW + PS)$$

With cargo properties and acceleration as given above, the following bending moments are calculated:

$$CM_{bending_1} = 0.1 \cdot \frac{3.7^2}{19.7 \cdot 30} \cdot 3000 \cdot 9.81 = 68 \text{ kNm}$$

$$CM_{bending_2} = \frac{3.7}{3 \cdot 2 \cdot 30} \cdot (3000 \cdot (5.3 - 0.6 \cdot 0.35 \cdot 9.81) + 296 + 160) = 209 \text{ kNm}$$

The design bending moment, taken as the maximum bending moment calculated by the formulae above multiplied with a safety factor of 1.35, thus becomes 282 kNm:

$$M_{bending} \geq 1.35 \cdot \max(CM_{bending\ 1}, CM_{bending\ 2}) = 1.35 \cdot 209 = 282 \text{ kNm}$$

Suitable dimensions for uprights

With MSL taken as 50% of the MBL for steel with the ultimate strength 360 MPa (N/mm^2), the required bending resistance, W, can be calculated as:

$$W = \frac{M_{bending}}{50\% \text{ of } 360 \text{ MPa}} = \frac{282 \cdot 10^6}{180} = 1568 \cdot 10^3 \text{ mm}^3 = 1568 \text{ cm}^3$$

Thus, uprights made from either HE320B profiles or a cylindrical profile with an outer diameter of 406 mm and a wall thickness of 16.7 mm are suitable (see Section B.7).

Strength in hog lashings

The required MSL of each hog lashing is calculated by the following formula:

$$MSL \geq \frac{M_{bending}}{2 \cdot h \cdot n_{hog}}$$

In this case, the hog lashings are attached at a height of 3.7 metres and the required strength is calculated as:

$$\text{MSL} \geq \frac{M_{bending}}{2 \cdot h \cdot n_{hog}} = \frac{282}{2 \cdot 3.7 \cdot 1} = 38kN \approx 3.9ton$$

Example B.5.3 – Uprights for round wood on a 6,000 DWT ship on the Baltic Sea

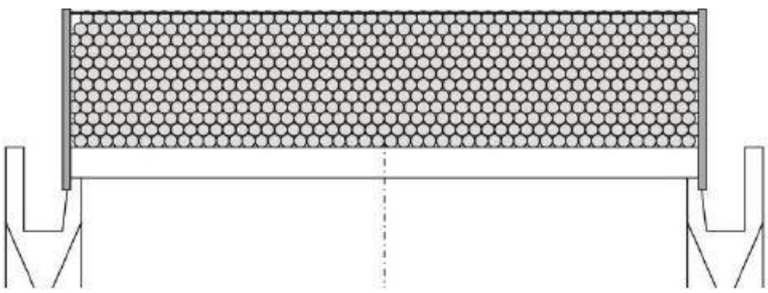


Figure B.7. Midship section of 6,000 DWT ship with round wood secured with uprights

Ship particulars

Length between perpendiculars, LPP: 101 metres

Moulded breadth, BM: 17.5 metres

Service speed: 13 knots

Metacentric height, GM: 0.50 metres

The deck cargo has the dimensions L× B × H = 65 × 14.5 × 3.1 metres and is supported by 25 uprights on each side. The weight of the cargo is taken as 1,500 tons.

With ship particulars as above and considering a stowage position on deck low, Annex 13 of the CSS Code gives the following basic transverse acceleration and correction factors:

$a_{t\ basic}$	=	6.5 m/s^2	=	Basic transverse acceleration
f_{R1}	=	0.93	=	Correction factor for length and speed
f_{R2}	=	1.00	=	Correction factor for B_M/GM

The ship is trading in the Baltic Sea with a weather forecast predicting a significant wave height up to 5.5 meters. Thus, the reduction factor for operation in restricted waters is taken as:

$$f_R = 1 - (H_s - 13)^2 / 240 = 1 - (5.5 - 13)^2 / 240 = 0.76$$

$a_t = a_{t\ basic} \cdot f_{R1} \cdot f_{R2} \cdot f_R = 6.5 \cdot 0.93 \cdot 1.00 \cdot 0.76 = 4.6\ m/s^2$

Cargo properties

M	=	1,500 ton	=	Mass of the section to be secured in tons, including absorbed water and possible icing
μ_{static}	=	0.35	=	Coefficient of static friction between the timber deck cargo and the ship's deck/hatch cover
H	=	3.1 m	=	Height of deck cargo in metres
B	=	14.5 m	=	Width of deck cargo in metres
L	=	65 m	=	Length of the deck cargo or section to be secured in metres
PW	=	202 kN	=	Wind pressure in kN based on 1 kN per m^2 wind exposed area, see CSS Code, Annex 13
PS	=	130 kN	=	Pressure from unavoidable sea sloshing in kN based on 1 kN per m^2 exposed area, see CSS Code, Annex 13
N	=	25 pcs	=	Number of uprights supporting the considered section on each side
h	=	3.1 m	=	Height above deck at which hog lashings are attached to the uprights in metres
n_{hog}	=	1 pcs	=	Number of hog lashings for each uprights
k	=	1.8	=	Factor for considering hog lashings; k = 1 if no hog lashings are used; k = 1.8 if hog lashings are used

Bending moment in uprights

For ships carrying loose sawn wood and round timber, the design bending moment per upright is calculated as the greater of the two moments given by the following formulas:

$$CM_{bending_1} = 0.1 = \frac{H^2}{k \cdot B \cdot N} \cdot m \cdot g_0$$

$$CM_{bending2} = \frac{H}{3 \cdot k \cdot N} \cdot (m \cdot (a_t - 0.6 \cdot \mu_{static} \cdot g_0) + PW + PS)$$

With cargo properties and acceleration as given above, the following bending moments are calculated:

$$CM_{bending\,1} = 0.1 \cdot \frac{3.1^2}{14.5 \cdot 25} \cdot 1500 \cdot 9.81 = 39 \text{ kNm}$$

$$CM_{bending\,2} = \frac{3.1}{3 \cdot 1.8 \cdot 25} \cdot (1500 \cdot (4.6 - 0.6 \cdot 0.35 \cdot 9.81) + 202 + 120) = 95 \text{ kNm}$$

The design bending moment, taken as the maximum bending moment calculated by the formulae above multiplied with a safety factor of 1.35, thus becomes 128 kNm:

$$M_{bending} \geq 1.35 \cdot \max(CM_{bending\,1}, CM_{bending\,2}) = 1.35 \cdot 95 = 128 \text{ kNm}$$

Suitable dimensions for uprights

With MSL taken as 50% of the MBL for steel with the ultimate strength 360 MPa (N/mm^2), the required bending resistance, W, can be calculated as:

$$W = \frac{M_{bending}}{50\% \text{ of } 360 \text{ MPa}} = \frac{128 \cdot 10^6}{180} = 713 \cdot 10^3 \text{ mm}^3 = 713 \text{ cm}^3$$

Thus, uprights made from either HE220 B profiles or a cylindrical profile with an outer diameter of 324 mm and a wall thickness of 10 mm are suitable (see Section B.7).

Strength in hog lashings

The required MSL of each hog lashing is calculated by the following formula:

$$MSL \geq \frac{M_{bending}}{2 \cdot h \cdot n_{hog}}$$

In this case, the hog lashings are attached at a height of 3.7 m and the required strength is calculated as:

$$\text{MSL} \geq \frac{M_{bending}}{2 \cdot h \cdot n_{hog}} = \frac{128}{2 \cdot 3.1 \cdot 2} = 20.6kN \approx 2.1ton$$

B.6 Example calculation – frictional securing of transversely stowed round wood

Example B.6.1 – Frictional securing of round wood on a 6,000 DWT ship

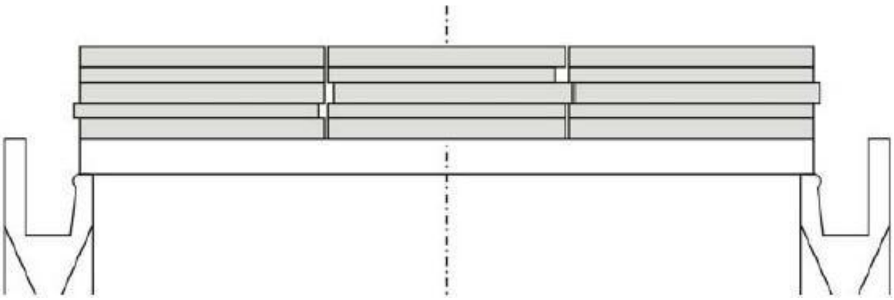


Figure B.8. Midship section of 6,000 DWT ship frictional secured wood secured

Ship particulars

Length between perpendiculars, LPP: 101 metres

Moulded breadth, BM: 17.5 metres

Service speed: 13 knots

Metacentric height, GM: 0.50 metres

The deck cargo has the dimensions L× B × H = 65 × 14.5 × 3.1 metres. The weight of the cargo is taken as 1,500 tons.

Cargo properties

M = 1,500 ton = Mass of the section to be secured in tons, including absorbed water and possible icing

μ_{static}	=	0.35	=	Coefficient of static friction between the timber deck cargo and the ship's deck/hatch cover
H	=	3.1 m	=	Height of deck cargo in metres
B	=	14.5 m	=	Width of deck cargo in metres
L	=	65 m	=	Length of the deck cargo or section to be secured in metres
PW	=	202 kN	=	Wind pressure in kN based on 1 kN per m^2 wind exposed area, see CSS Code, Annex 13
PS	=	130 kN	=	Pressure from unavoidable sea sloshing in kN based on 1 kN per m^2 exposed area, see CSS Code, Annex 13

Transverse acceleration

With a static friction of 0.35 between the layers of wood and between the wood and the hatch cover the maximum acceptable transverse acceleration can be calculated by satisfying the following equilibrium:

$m \cdot g_0 \cdot \mu_{static} \geq m \cdot a_t + PW + PS$

In this case transverse acceleration cannot exceed 3.2 m/s^2 as shown below:

$$a_t \leq \frac{m \cdot g_0 \cdot \mu_{static} - PW - PS}{m}$$

$$a_t \leq \frac{1500 \cdot 9.81 \cdot 0.35 - 202 - 130}{1500} = 3.2 \text{ m/s}^2$$

With vessel particulars as above and considering a stowage position on deck low, Annex 13 of the CSS Code gives the following basic acceleration and correction factors:

$a_{t\ basic}$	=	6.5 m/s^2	=	Basic transverse acceleration
f_{R1}	=	0.93	=	Correction factor for length and speed
f_{R2}	=	1.00	=	Correction factor for B_M/GM

The maximum allowed significant wave height H_S with this stowage arrangement is calculated as 2.4 m according to the following:

$$a_t = a_{t\ basic} \cdot f_{R1} \cdot f_{R2} \cdot f_R$$

$$f_R = \frac{a_t}{a_{t\ basic} \cdot f_{R1} \cdot f_{R2}} = \frac{3.2}{6.5 \cdot 0.93 \cdot 1.00} = 0.53 \text{ m/s}^2$$

$f_R = 1 - (H_S - 13)^2 / 240$

$H_S = 13 - \sqrt{(1-0.53) \cdot 240} = 2.4$ m

B.7 Maximum bending resistance in common profiles for uprights

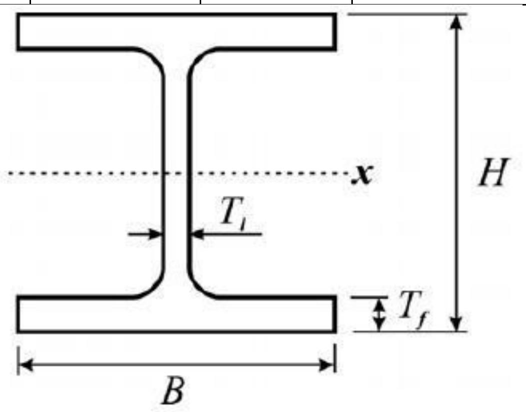
HE-A beams

Size	**H** [mm]	**B** [mm]	**T_l** [mm]	**T_f** [mm]	**Maximum bending resistance Wx,** [cm^3]
HE 220 A	210	220	7	11	515
HE 240 A	230	240	7.5	12	675
HE 260 A	250	260	7.5	12.5	836
HE 280 A	270	280	8	13	1010
HE 300 A	290	300	8.5	14	1260
HE 320 A	310	300	9	15.5	1480
HE 340 A	330	300	9.5	16.5	1680
HE 360 A	350	300	10	17.5	1890
HE 400 A	390	300	11	19	2310

HE 450 A	440	300	11.5	21	2900
HE 500 A	490	300	12	23	3550
HE 550 A	540	300	12.5	24	4150
HE 600 A	590	300	13	25	4790
HE 650 A	640	300	13.5	27	5470

HE-B beams

Size	**H** [mm]	**B** [mm]	T_l [mm]	T_f [mm]	**Maximum bending resistance,Wx** [cm^3]
HE 220 A	210	220	9.5	16	736
HE 240 A	230	240	10	17	938
HE 260 A	250	260	10	17.5	1150
HE 280 A	270	280	10.5	18	1380
HE 300 A	290	300	11	19	1680
HE 320 A	310	300	11.5	20.5	1930
HE 340 A	330	300	12	21.5	2160
HE 360 A	350	300	12.5	22.5	2400
HE 400 A	390	300	13.5	24	2880
HE 450 A	440	300	14	26	3550
HE 500 A	490	300	14.5	28	4290
HE 550 A	540	300	15	29	4970
HE 600 A	590	300	15.5	30	5700
HE 650 A	640	300	16	31	6480



Pipes

Size	**Schedule**	**Outer diameter** [mm]	**Wall thickness** [mm]	**Bending resistance, W** [cm^3]
8"	40	219.1	8.2	276
	60	219.1	10.3	337
	80	219.1	12.7	402
12"	40	323.9	10.3	772
	60	323.9	14.3	1029
	80	323.9	17.5	1223
16"	40	406.4	12.7	1499
	60	406.4	16.7	1910

	80	406.4	21.4	2371
18"	40	457.2	14.3	2132
	60	457.2	19.1	2758
	80	457.2	23.8	3342
20"	40	508.0	15.1	2797
	60	508.0	20.6	3697
	80	508.0	26.2	4542
	100	508.0	32.5	5433
24"	40	610.0	17.5	4686
	60	610.0	24.6	6368
	80	610.0	31.0	7761

ANNEX C

INSTRUCTION TO A MASTER ON CALCULATION OF MASS CHANGE OF A TIMBER DECK CARGO DUE TO WATER ABSORPTION

C.1 Mass increase due to water absorption for a timber deck cargo in protective packaging or covered by a protective awning or timber that has been immersed in water until loaded on board should not be taken into account in the ship's stability calculation for arrival at the port of destination.

C.2 Calculation of mass change P of a timber deck cargo should be done by the formula:

δP, % = $T_{pl} \cdot \delta P_{\text{day}}$, %

where:

T_{pl} – planned duration of the voyage, days;

δP_{day}, % – wood mass change per day, to be chosen from Table C.1

C.3 Corresponding line in Table C.1 should be chosen by means of comparison of the forthcoming voyage with the timber cargo transportation lines specified in the leftmost column "Line".

C.4 With calculation value being $\delta P \leq 2$ %, water absorption of a timber deck cargo should not be taken into account in the ship's stability calculations as it is commensurable with initial calculation data determination errors.

C.5 With calculation value being $\delta P \geq 10\%$, water absorption of a timber deck cargo $\delta P = 10\%$ should be taken into account.

Table C.1. Daily wood mass change

Line	Deck cargo mass change per day, δP_{day}, %	
	Sawn wood	Round wood cargo
Vladivostok – ports of Japan	1.00	0.14
Ports of Malaysia – ports of Japan	0.73	0.10
Ports of Canada, USA – ports of Japan	1.00	0.14
Saint-Petersburg – London	0.83	0.11
Arkhangelsk – Manchester	1.16	0.15
Australasia – North Asia	–	– 0.10

ANNEX D

REFERENCES

(1) SOLAS – Chapter VI, Regulation 5, Paragraph 1

(2) ISM Code – Part A, Paragraph 1.1.2

(3) IMDG Code – Part 1, Chapter 1.2, Paragraph 1.2.1 (Definitions)

(4) SOLAS – Chapter VI, Regulation 2 (Cargo information)

(5) ISM Code – Part A, Paragraph 7

(6) Load Lines, 1966 – Annex I, Chapter II, Regulation 16

(7) SOLAS – Chapter II-1, Part B-1, Regulation 5-1 (Stability information)

(8) 2008 IS Code – Part A, Section 3.3 (Cargo ships carrying timber deck cargoes)

(9) 2008 IS Code – Part B, Section 3.6 (Stability booklet)

(10) 2008 IS Code – Part B, Section 3.7 (Operational measures for ships carrying timber deck cargoes)

(11) 2008 IS Code – Part B, Paragraph 3.7.5

(12) MEPC.127(53) – Development of Ballast Water Management Plans

(13) Load Lines Convention, 1966 – Annex I, Chapter IV, Regulation 44 (Stowage)

(14) Load Lines Convention, 1966 – Annex I, Chapter IV, Regulation 45 (Computation for freeboard)

(15) SOLAS – Chapter V, Regulation 22 (Navigational bridge visibility)

(16) ISM Code – Part A, Paragraph 6.6

(17) ILO Convention No.152 – Convention Concerning Occupational Safety and Health in Dock Work

(18) Load Lines Convention, 1966 – Annex I, Chapter II, Regulation 25 (Protection of the crew)

(19) Load Lines Convention, 1966 – Annex I, Chapter IV, Regulation 44 (Stowage)

(20) CSS Code – Annex 13, Section 4 (Strength of securing equipment)

(21) ISM Code – Part A, Paragraph 7

(22) STCW Code – Section A, Chapter VIII/2, Part 2 (Voyage planning)

(23) SOLAS – Chapter V, Regulation 34 (Safe navigation)

(24) CSS Code – Chapter 6 (Actions which may be taken in heavy weather)

(25) MCS/Circ.1228 – Revised guidance to the master for avoiding dangerous situations in adverse weather and sea conditions

(26) SOLAS – Chapter VI, Regulation 5, Paragraph 2

(27) MSC.1/Circ.1353 – Revised Guidelines for the preparation of the Cargo Securing Manual

(28) SOLAS – Chapter V, Regulation 31 (Danger messages)

(29) ILO Convention No.27 – Marking of weight (packages transported by vessels) Convention, 1929.