ASSEMBLY
27th session
Agenda item 9

A 27/Res.1048
20 December 2011
Original: ENGLISH

Resolution A.1048(27)

Adopted on 30 November 2011
(Agenda item 9)

CODE OF SAFE PRACTICE FOR SHIPS CARRYING TIMBER DECK CARGOES, 2011 (2011 TDC CODE)

THE ASSEMBLY,

RECALLING Article 15(j) of the Convention on the International Maritime Organization regarding the functions of the Assembly in relation to regulations and guidelines concerning maritime safety,

RECALLING ALSO its adoption, by resolution A.715(17), of the Code of Safe Practice for Ships Carrying Timber Deck Cargoes, 1991,

RECOGNIZING the need to improve the provisions contained in the Code in the light of experience gained,

HAVING CONSIDERED the recommendations made by the Maritime Safety Committee at its eighty-ninth session,

1. ADOPTS the Code of Safe Practice for Ships Carrying Timber Deck Cargoes, 2011 (2011 TDC Code), as set out in the annex to the present resolution;

2. RECOMMENDS Governments to use the provisions of the 2011 TDC Code as a basis for relevant safety standards;

3. AUTHORIZES the Maritime Safety Committee to amend the Code as necessary in the light of further studies and experience gained from the implementation of the provisions contained therein;

4. REVOKES resolution A.715(17).

Annex

CODE OF SAFE PRACTICE FOR SHIPS CARRYING TIMBER DECK CARGOES, 2011 (2011 TDC CODE)

PREFACE

The Code of Safe Practice for Ships Carrying Timber Deck Cargoes was first developed by the Organization in 1972 and subsequently amended in 1978.

The Code was revised by IMO resolution A.715(17) – Code of Safe Practice for Ships Carrying Timber Deck Cargoes, 1991, which was adopted on 6 November 1991.

This Code is based on the previous Code, which has been revised and amended in order to reflect the capability of today's ships and the equipment available on board and also taking expected future innovations in mind.

This Code is designed to assist:

.1 shipowners, charterers, operating companies and ships' crew;

.2 port industries, shippers and pre-packaging organizations, which are involved in preparation, loading, and stowing of timber deck cargoes; and

.3 Administrations, manufacturers and designers of ships and equipment associated with the carriage of timber deck cargoes and those developing cargo securing manuals,

in the carriage of timber deck cargoes.

This Code is directed primarily at providing recommendations for the safe carriage of timber deck cargoes.

Status of references

The references given in this consolidated text do not form part of the Code but are inserted for ease of reference.

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 [*to be decided*].

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, chapter A.1.

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].

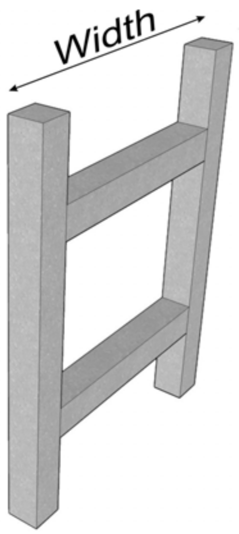
2.9.3 Deck cargo should be stowed so that access is provided to and from designated escape routes and spaces essential to operation of the vessel, such as machinery spaces and crew's quarters, as well as to safety equipment, fire-fighting equipment and sounding pipes[18]. It should not interfere in any 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 x 50	75	53	30	17
50 x 75	113	79	46	26
50 x 100	151	106	61	34
50 x 150	226	159	91	51
75 x 75	186	153	119	85
75 x 100	248	203	159	114
75 x 150		305	238	171
75 x 200			317	227
100 x 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.

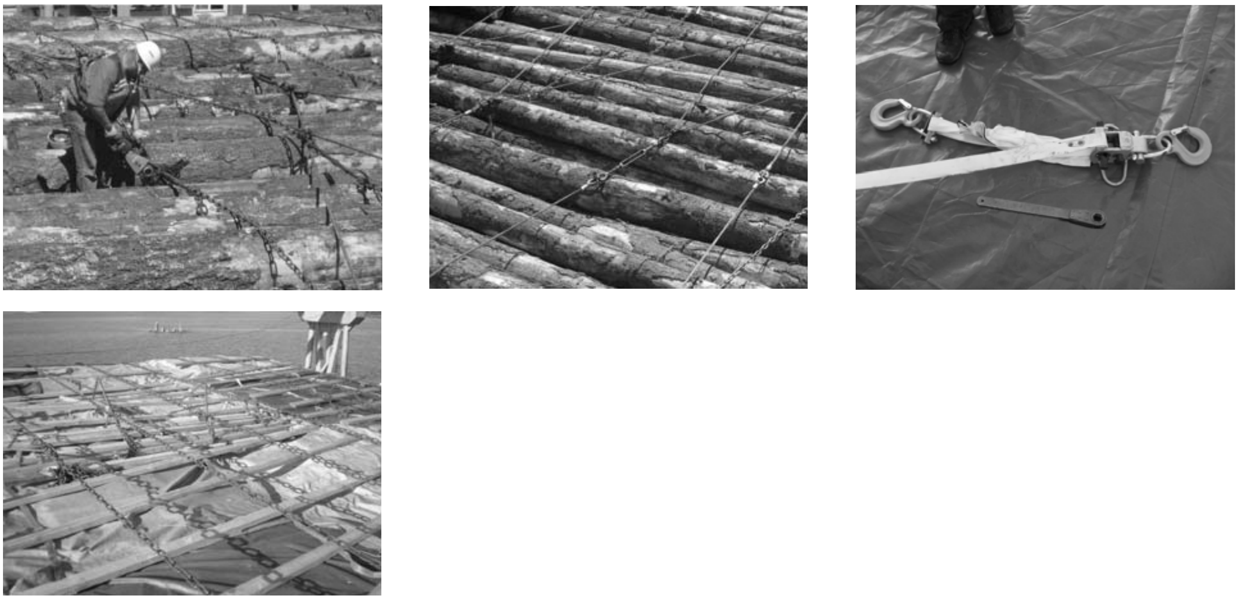
2.10.4 The following three types of lashing equipment with different strength and elongation characteristics are most frequently used for securing timber deck cargoes. Individual suitability should be determined by such factors as ship type, size and area of operation, and as described in this Code and as prescribed in the cargo securing manual:

.1 chain lashings;

.2 wire lashings; and

.3 fabricated web lashings.

Chain lashing *Wire lashing* *Fabricated web lashing*



Chain lashing *Wire lashing* *Fabricated web lashing*

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.

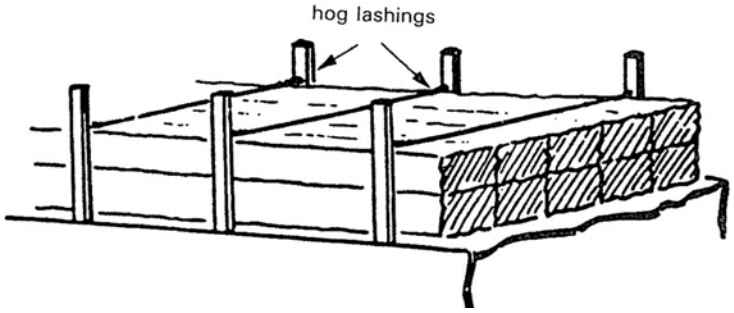


Figure 2.2 Example of hog lashings

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.

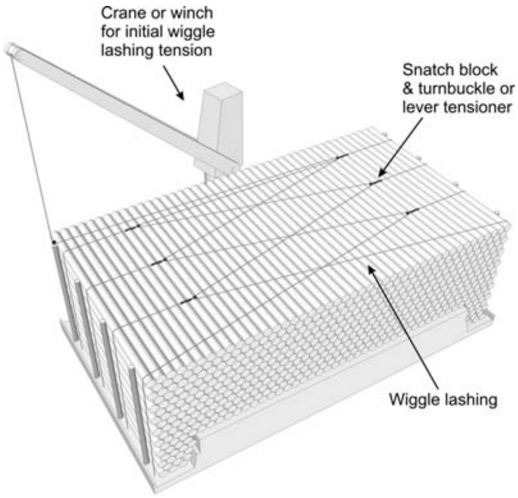


Figure 2.3. Example of wiggle lashings

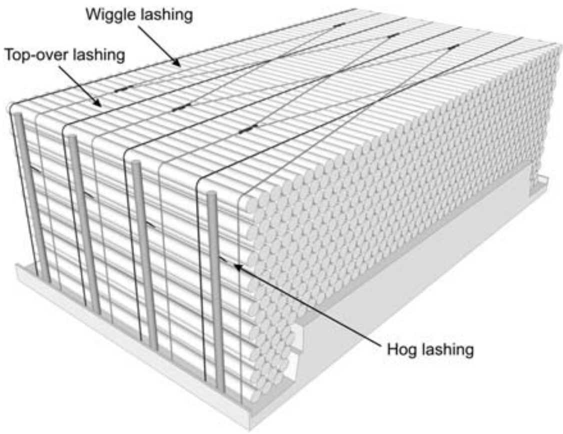


Figure 2.4. Example of an arrangement with hog, top-over and wiggle lashings*

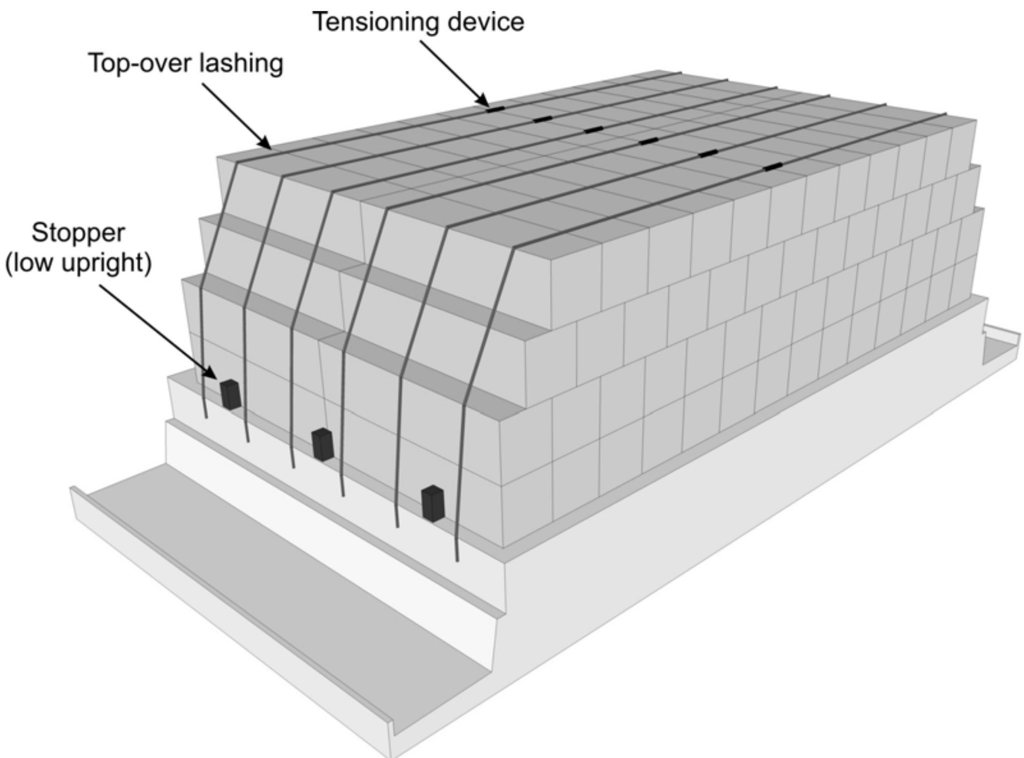


Figure 2.5. Example of an arrangement with top-over lashings and stoppers*

* Notwithstanding the guidance provided in these diagrams, compliance with the relevant timber Load Lines Convention provisions is required, when applicable.

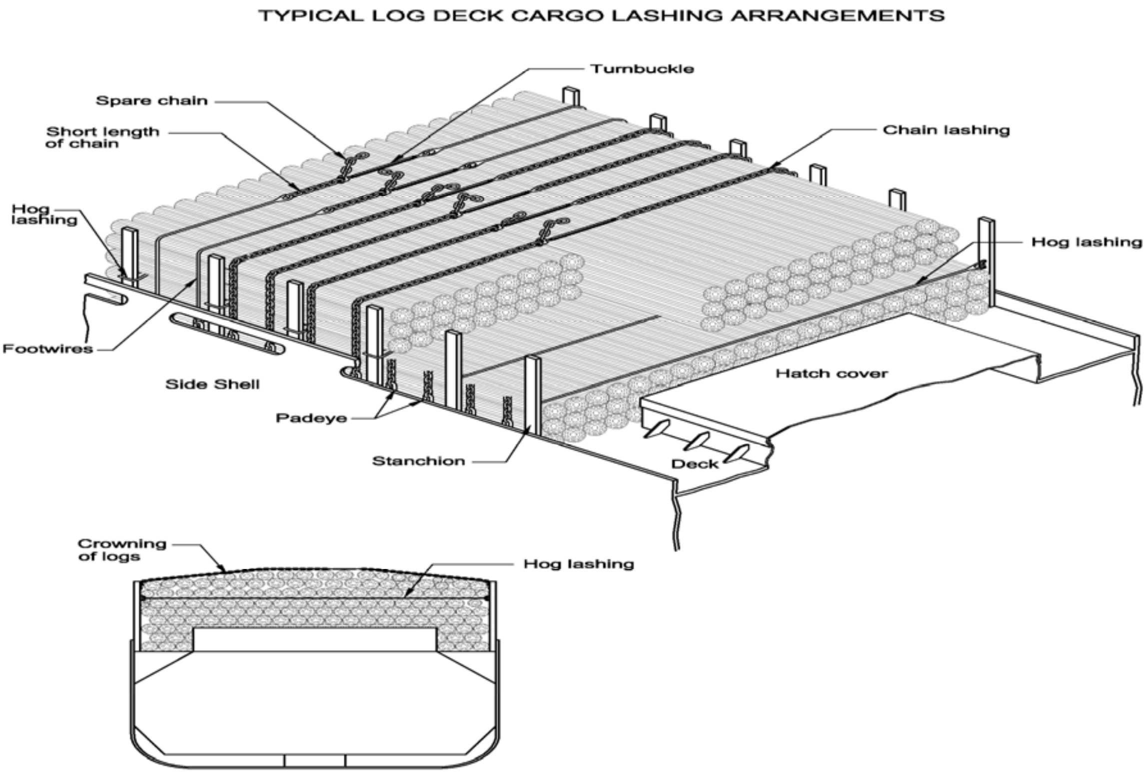


Figure 2.6. Example of chain top over lashings for a log cargo

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:

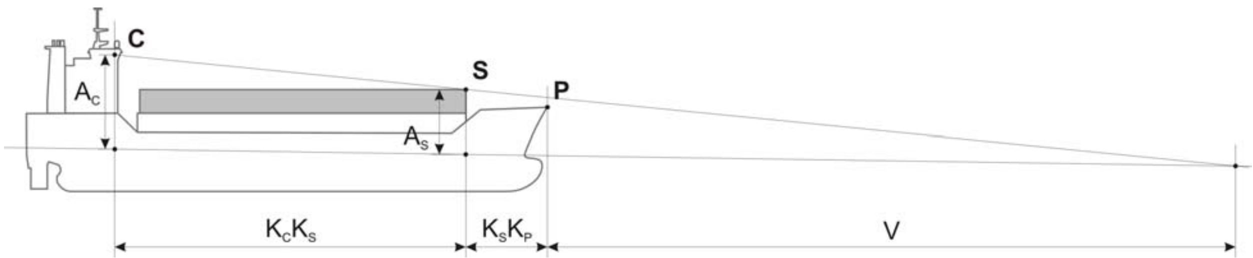


Figure 3.1. *Distances used for calculating the bridge visibility*

$$V = \frac{K_C K_S \cdot A_S}{A_C - A_S} - K_S K_P$$

Where:

$K_C K_S$	*Horizontal distance from conning position to position '**S**'*
$K_S K_P$	*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°.

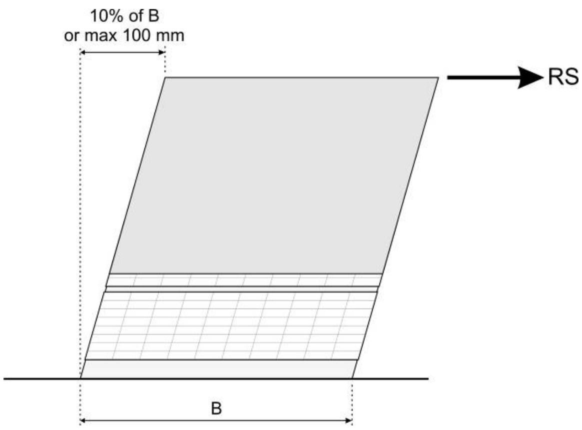


Figure 4.1. Racking strength of timber packages

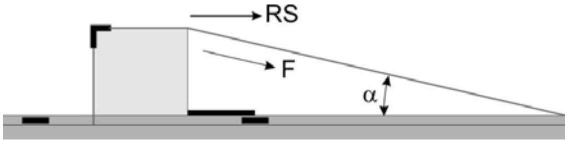


Figure 4.2. Test setup for racking strength

4.7.3 The Racking Strength, RS, is taken as the applied force $F \cdot \cos \alpha$ (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.

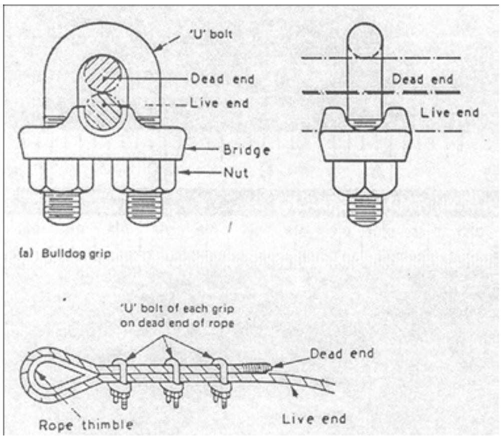


Figure 5.1. Wire rope clips

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 in the transverse direction be designed for accelerations generated as well as forces by wind and sea according to the CSS Code, Annex 13.

6.2.2 Special securing of timber deck cargoes in the longitudinal direction may be dispensed with only if great care is taken to avoid excessive acceleration forces in heavy head seas.

6.2.3 To take account of the factors mentioned in 2.13.4, the acceleration data calculated according to Annex 13 of the CSS Code may be multiplied by a reduction factor ranging from 0 to 1, depending on expected maximum significant wave height during the intended voyage. The reduction factor is obtained by the following formula:

$$f_R = \sqrt[3]{\frac{H_M}{19.6}}$$

Where the variable H_M means the maximum expected significant wave height in metres.

(The value 19.6 is the assumed twenty year wave that will occur in the Northern Atlantic Ocean. Relevant significant wave heights for different sea areas and seasons can be obtained from "Ocean Wave Statistics".)

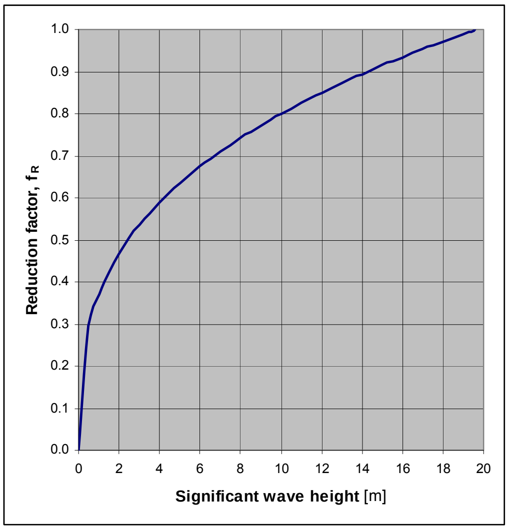


Figure 6.1. Plot of the reduction factor as a function of the expected significant wave height

6.2.4 Reduced acceleration may be used for the design of securing arrangements for timber deck cargoes in any of the following ways:

.1 Required securing arrangements are designed for different wave heights and the securing arrangement is selected according to the maximum expected wave height for each voyage.

.2 The maximum wave height that a particular securing arrangement can withstand is calculated and the vessel is limited to operate in wave heights up to the maximum calculated. Examples on such arrangements are unsecured transversely stowed timber deck cargoes in restricted sea areas.

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

6.2.5 If one of the two first mentioned methods in 6.2.4 are used for decision on securing arrangements, it is important that procedures for forecasting the maximum expected wave height on intended voyages is developed and followed and documented in the ship's approved Cargo Securing Manual.

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:

$$CS \leq \frac{MSL}{1.35}$$

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.

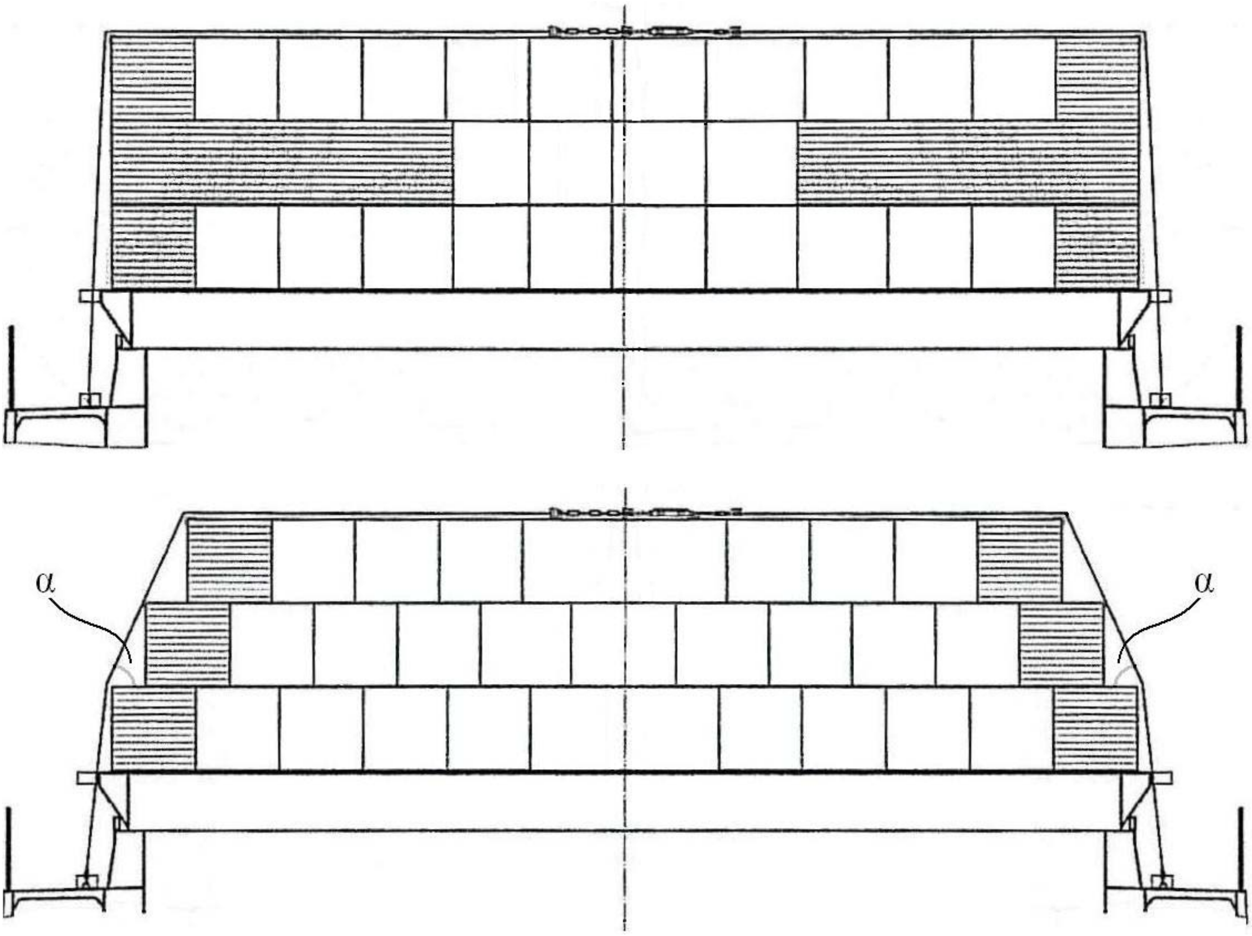


Figure 6.3. Principles for top-over lashing

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.

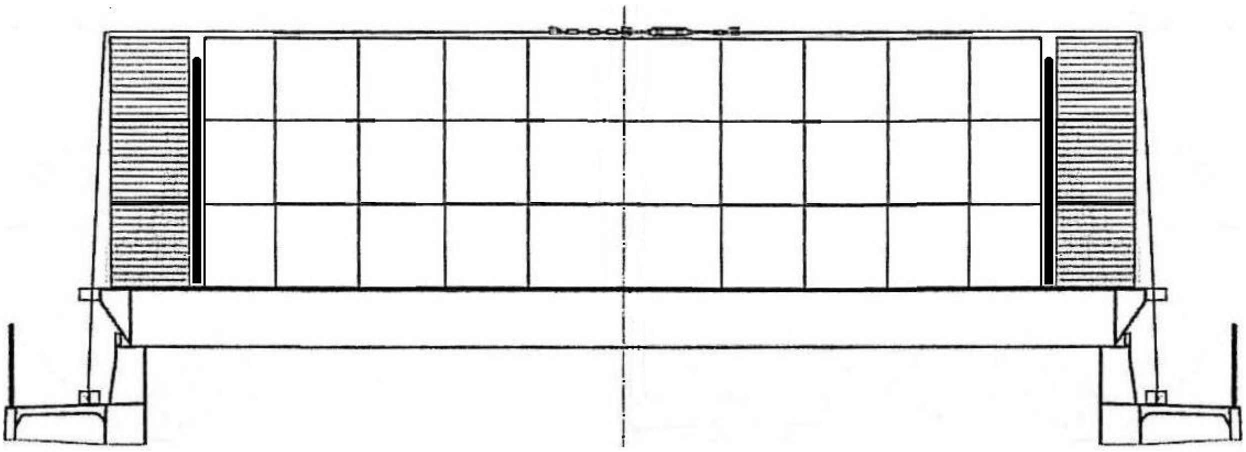


Figure 6.4. Sliding of upper layer prevented by vertical sturdy battens

6.5.8 If sliding between layers is not prevented, sliding between each individual layer should be considered by the following equilibrium of forces:

$$(m_a \cdot g_0 + 2 \cdot n \cdot PT_V \cdot \sin\alpha) \cdot \mu_{static\ a} \geq m_a \cdot a_t + PW_a + PS_a$$

Units denoted with $_{\mathbf{a}}$ 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:

$$n_p \cdot L \cdot RS \geq m_a \cdot (a_t - 0.5g_o) + PW_a + PS_a$$

Units denoted with $_{\mathbf{a}}$ 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.

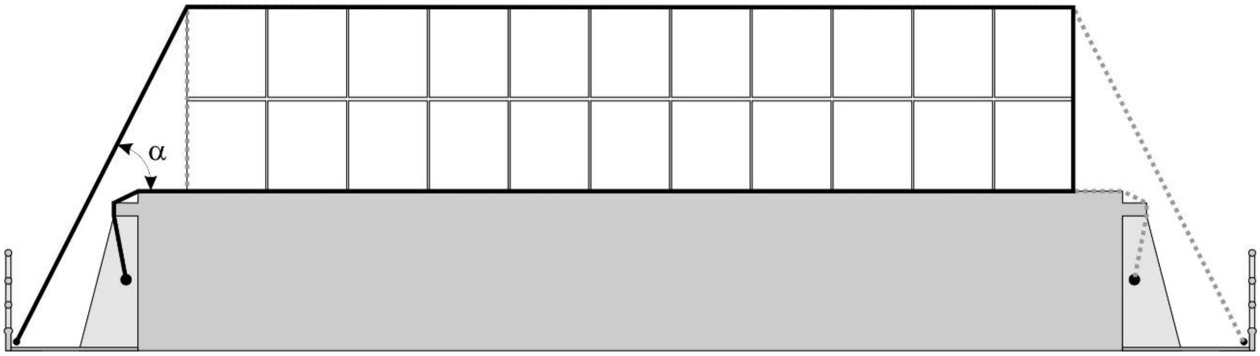


Figure 6.5. Principals of loop lashing alternative 1 (be aware of chafing where lashings are lead around ship's structure as shown in the above figure, see section 2.10.10)

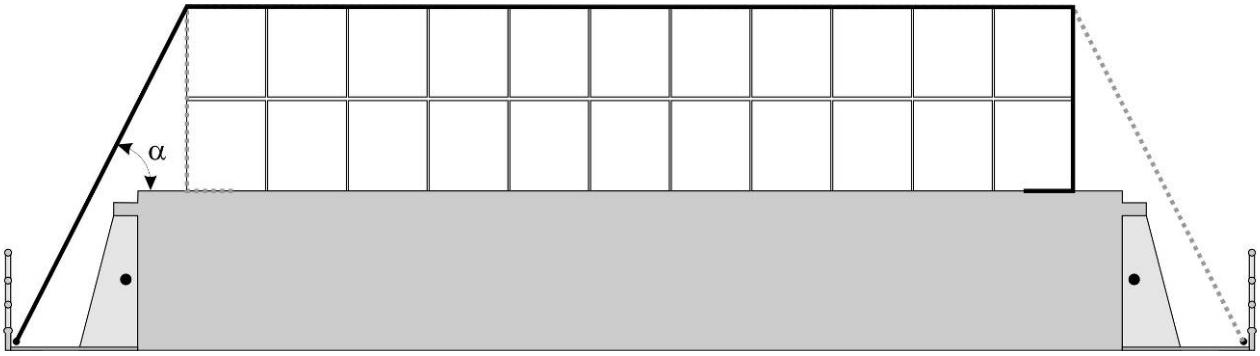


Figure 6.6. Principles for loop lashing alternative 2. The shorter length of the lashing compared to alternative 1 reduces the movement of the cargo due to elongation of the lashing

6.5.13 The number and strength of the lashings are to be chosen so that the following equilibrium is satisfied:

$$(m \cdot g_0 + n \cdot CS \cdot \sin\alpha) \cdot \mu_{dynamic} + n \cdot CS + n \cdot CS \cdot \cos\alpha \geq m \cdot a_t + PW + PS$$

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:

$$n_p \cdot L \cdot RS \geq m_a \cdot \left(a_t - 0.5 g_0\right) + PW_a + PS_a$$

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:

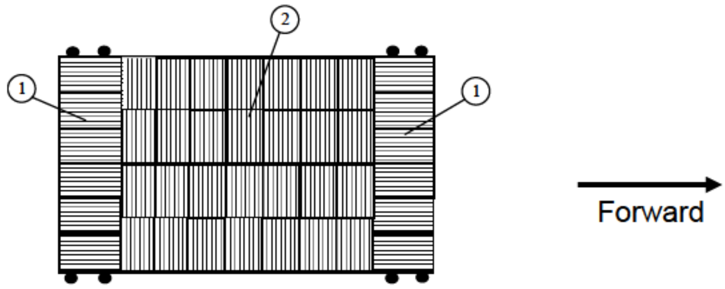
.1 possess a breaking strength MBL of not less than 133 kN;

.2 after initial stressing, show an elongation of not more than 5% at 80% of their breaking strength; and

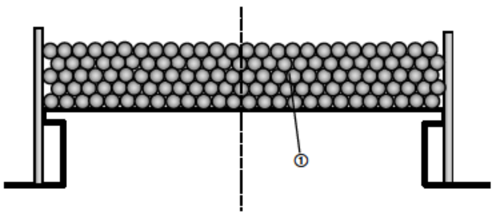
.3 show no permanent deformation after having been subjected to a proof load of not less than 40% of their original breaking strength.

Frictional securing

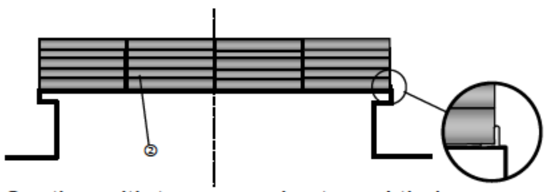
6.5.31 In restricted sea areas, round wood may be transversely stowed and secured by bottom blocking and/or friction between tiers only. This may be done only if the friction between layers is sufficient and the expected transverse accelerations are limited. When the friction is sufficient between bottom 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.



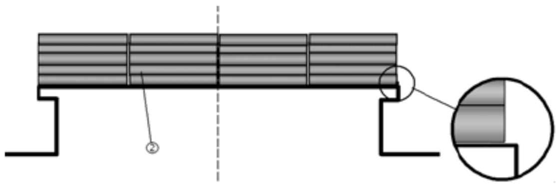
Example of round wood stowage pattern for restricted sea areas.
Sections marked 1 are longitudinally stowed round wood secured by uprights. Section marked 2 are transversely stowed round wood secured by friction in combination with or without bottom blocking.



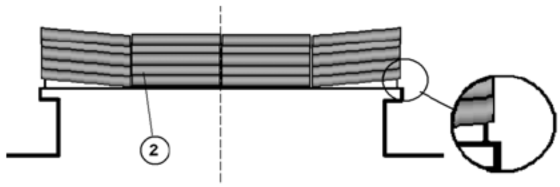
Section with longitudinally stowed round wood secured by uprights.



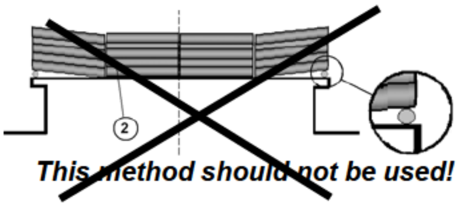
Section with transversely stowed timber cargo secured by friction in combination with bottom blocking.



Section with transversely stowed round wood secured by friction only (Alternative 1). Non-slip paint on hatch cover or non-slip material between hatch cover and round wood should be used.



Section with transversely stowed round wood secured by friction only (Alternative 2). Non-slip paint on hatch cover or non-slip material between hatch cover and round wood should be used.



Section with transversely stowed round wood secured by friction only (Alternative 3).

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:

$$m \cdot g_0 \cdot \mu_{static} + n_b \cdot \frac{MSL}{1.35} \geq m \cdot a_t + PW + PS$$

6.5.33 The required friction between the layers can be calculated by satisfying the following equilibrium:

$$m \cdot g_0 \cdot \mu_{static} \geq m \cdot a_t + PW + PS$$

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:

$$CM_{bending1} = 0.1 \cdot \frac{H^2}{k \cdot B \cdot N} \cdot m \cdot g_0$$

$$CM_{bending2} = \frac{H}{3 \cdot k \cdot N} \cdot \left(m \cdot \left(a_t - 0.6 \cdot \mu_{static} \cdot g_0\right) + PW + PS\right)^*$$

$$M_{bending} \geq 1.35 \cdot \max\left(CM_{bending1},\ CM_{bending2}\right)$$

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%.

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:

$$CM_{bending1} = \frac{m}{n_p \cdot k \cdot N} \cdot \left(a_t \cdot \frac{H}{2} - g_0 \cdot \frac{b}{2}\right) \cdot \frac{1-(1-f_i)^n}{f_i}$$ *(Moment required to prevent tipping)*

where: $f_i = \mu_{internal} \cdot \frac{2b}{H}$ *(f_i = Factor for considering internal moment)*

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* 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.

$$CM_{bending\,2} = \frac{H}{2 \cdot k \cdot N} \cdot m \cdot \left(a_t - \mu_{internal} \cdot g_0\right) \cdot \frac{q-1}{2q}$$ *(Moment required to prevent sliding)*

$$CM_{bending\,3} = \frac{H}{k \cdot N} \cdot \left(m \cdot a_t - \left(n_p - 4\right)\left(q - 2\right) \cdot L \cdot RS\right) \cdot \frac{q-1}{2q}$$ *(Moment required to prevent racking)*

$$M_{bending} \geq 1.35 \cdot \max\left(CM_{bending\,1},\ CM_{bending\,2},\ CM_{bending\,3}\right)$$

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 m^2 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 harbour 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

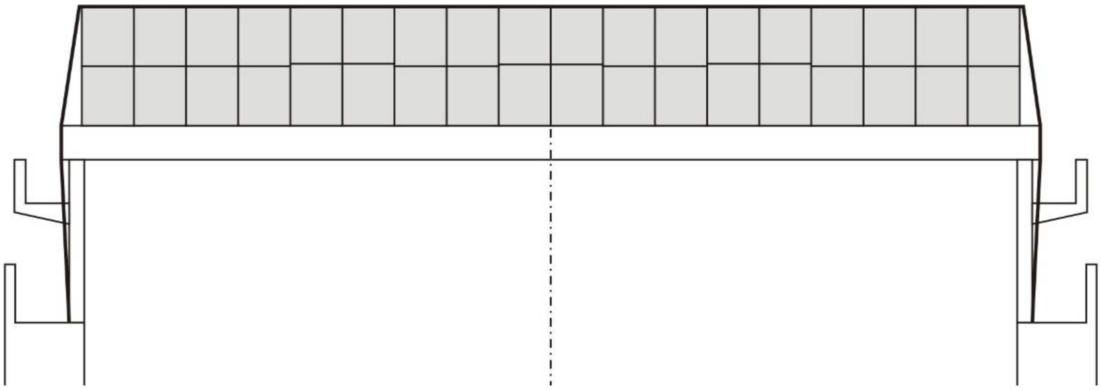


Figure B.1. *Midship section of 16,600 DWT ship with packages of sawn wood in two layers secured with top-over lashings*

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:

$$n \geq \frac{\frac{m \cdot a_t + PW + PS}{\mu_{static}} - m \cdot g_0}{2 \cdot PT_V \cdot \sin\alpha} = \frac{\frac{1600 \cdot 5.3 + 192 + 160}{0.45} - 1600 \cdot 9.81}{2 \cdot 16 \cdot \sin 85} = 123 \ pcs$$

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:

$$RS \geq \frac{m_a \cdot (a_t - 0.5 \cdot g_0) + PW_a + PS_a}{n_p \cdot L} =$$

$$= \frac{800 \cdot (5.3 - 0.5 \cdot 9.81) + 96 + 64}{18 \cdot 80} = 0.33 \ kN/m = 0.034 \ ton/m$$

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

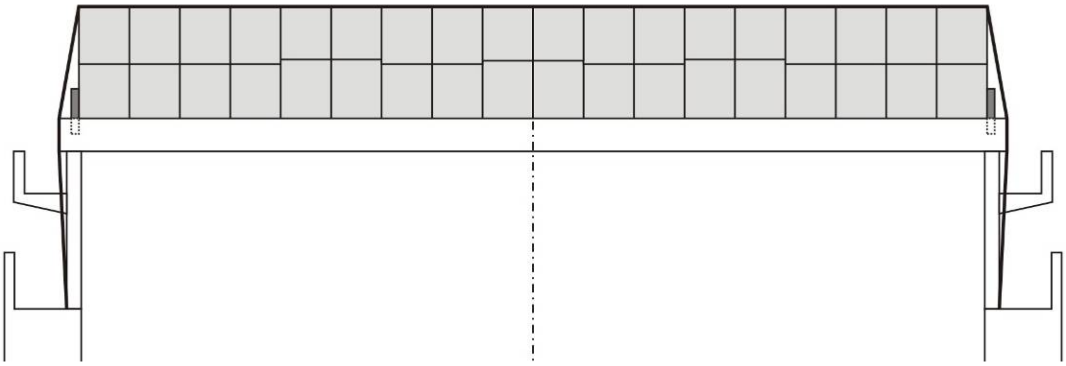


Figure B.2. Midship section of 16,600 DWT ship with packages of sawn wood in two layers secured with bottom blocking devices and top-over lashings

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:

$$(m \cdot g_0 + 2 \cdot n \cdot PT_V \cdot \sin\alpha) \cdot \mu_{static} + n_b \frac{MSL}{1.35} \geq m \cdot a_t + PW + PS$$

$$MSL \geq \frac{1.35}{n_b}\left(m \cdot a_t + PW + PS - (m \cdot g_0 + 2 \cdot n \cdot PT_V \cdot \sin\alpha) \cdot \mu_{static}\right)$$

$$MSL \geq \frac{1.35}{26}\left(2000 \cdot 5.3 + 192 + 160 - (2000 \cdot 9.81 + 2 \cdot 26 \cdot 16 \cdot \sin 85) \cdot 0.45\right) = 91kN$$

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

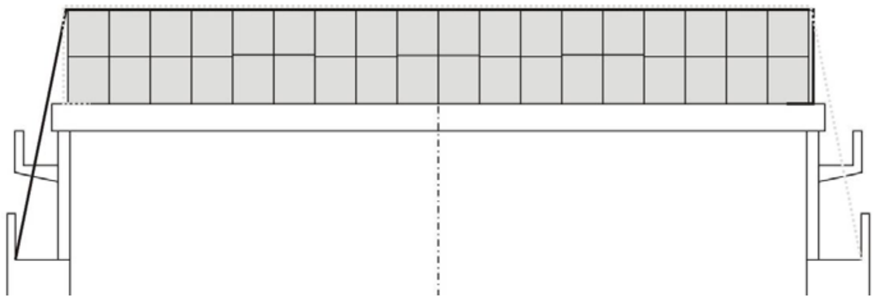


Figure B.3. Midship section of 16,600 DWT ship with packages of sawn wood secured with loop lashings

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:

$$CS \geq \frac{m \cdot (a_t - g_0 \cdot \mu_{dynamic}) + PW + PS}{n \cdot (\sin\alpha \cdot \mu_{dynamic} + 1 + \cos\alpha)} = \frac{1600 \cdot (5.3 - 9.81 \cdot 0.32) + 192 + 160}{36 \cdot (\sin 70 \cdot 0.32 + 1 + \cos 70)} = 64\ kN$$

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:

$$\delta = L_L \cdot \frac{(CS - PT_V)}{MSL} \cdot \varepsilon = 25 \cdot \frac{(64 - 16)}{86} \cdot 0.02 = 0.28\ m$$

If web lashings are used the elongation factor is set to ε = 0.07, and the transverse movement is calculated as:

$$\delta = L_L \cdot \frac{(CS - PT_V)}{MSL} \cdot \varepsilon = 25 \cdot \frac{(64 - 16)}{86} \cdot 0.07 = 0.98\ m$$

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:

$$RS \geq \frac{m_a \cdot (a_t - 0.5 \cdot g_0) + PW_a + PS_a - n \cdot CS \cdot \cos\alpha}{n_p \cdot L} =$$

$$= \frac{800 \cdot (5.3 - 0.5 \cdot 9.81) + 96 + 64 - 46 \cdot 62 \cdot \cos 70}{13 \cdot 80} < 0\ kN/m$$

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

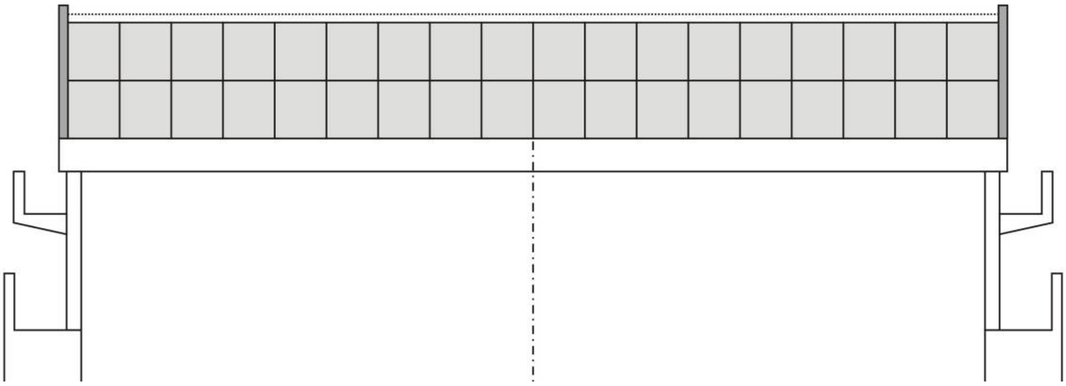


Figure B.4. Midship section of ship with timber packages secured with uprights

Ship particulars

Length between perpendiculars, LPP:	134	metres
Moulded breadth, B_M:	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}	=	0.80	=	*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:

$$CM_{bending1} = \frac{m}{n_p \cdot k \cdot N} \cdot \left(a_t \cdot \frac{H}{2} - g_0 \cdot \frac{b}{2}\right) \cdot \frac{1-(1-f_i)^{n_p}}{f_i}$$ *(Moment required to prevent tipping)*

where $f_i = \mu_{internal} \cdot \frac{2b}{H}$ *(f_i = Factor for considering internal moment)*

$$CM_{bending2} = \frac{H}{2 \cdot k \cdot N} \cdot m \cdot (a_t - \mu_{internal} \cdot g_0) \cdot \frac{q-1}{2q}$$ *(Moment required to prevent sliding)*

$$CM_{bending3} = \frac{H}{k \cdot N} \cdot \left(m \cdot a_t - (n_p - 4)(q-2) \cdot L \cdot RS\right) \cdot \frac{(q-1)}{2q}$$ *(Moment required to prevent racking)*

With cargo properties and acceleration as given above, the following bending moments are calculated:

$$f_i = 0.3 \cdot \frac{2 \cdot 1.1}{2.4} = 0.275$$

$$CM_{bending1} = \frac{1600}{18 \cdot 1.8 \cdot 36} \cdot \left(5.3 \cdot \frac{2.4}{2} - 9.81 \cdot \frac{1.1}{2}\right) \cdot \frac{1-(1-0.275)^{18}}{0.275} = 4.8\ kNm$$

$$CM_{bending\,2} = \frac{2.4}{2 \cdot 1.8 \cdot 36} \cdot 1600 \cdot (5.3 - 0.30 \cdot 9.81) \cdot \frac{2-1}{2 \cdot 2} = 17.5\ kNm$$

$$CM_{bending\,3} = \frac{2.4}{1.8 \cdot 36} \cdot (1600 \cdot 5.3 - (18-4)(2-2) \cdot 80 \cdot 3.5) \cdot \frac{(2-1)}{2 \cdot 2} = 78.5\ kNm$$

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:

$$M_{bending} \geq 1.35 \cdot \max(CM_{bending\,1},\ CM_{bending\,2},\ CM_{bending\,3}) = 1.35 \cdot 78.5 = 106\ kNm$$

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:

$$W = \frac{M_{bending}}{50\%\ of\ 360MPa} = \frac{106 \cdot 10^6}{180} = 589 \cdot 10^3\ mm^3 = 589\ cm^3$$

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:

$$MSL \geq \frac{M_{bending}}{2 \cdot h} = \frac{106}{2 \cdot 3.5} = 15\ kN \approx 1.5\ ton$$

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

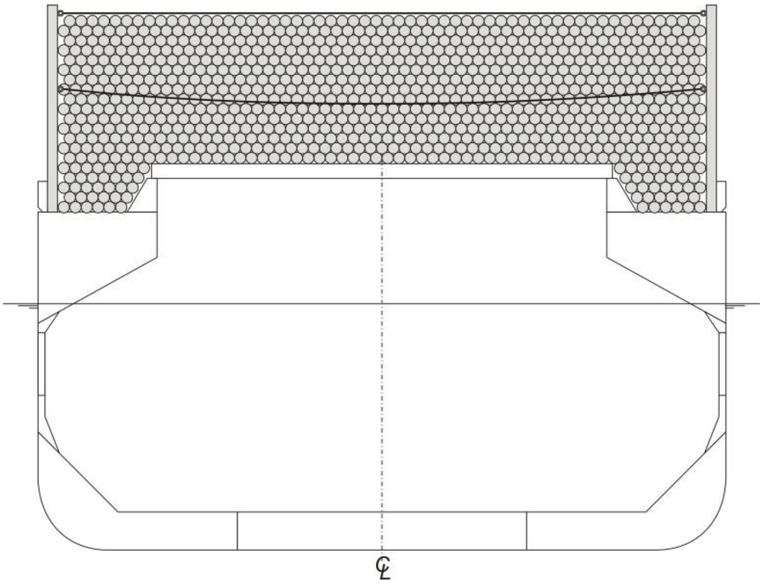


Figure B.5. Midship section of 28,400 DWT ship with round wood secured with uprights

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 / 6.7*	*m*	=	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:

$$CM_{bending1} = 0.1 \cdot \frac{H^2}{k \cdot B \cdot N} \cdot m \cdot g_0$$

$$CM_{bending2} = \frac{H}{3 \cdot k \cdot N} \cdot \left(m \cdot \left(a_t - 0.6 \cdot \mu_{static} \cdot g_0\right) + PW + PS\right)$$

With cargo properties and acceleration as given above, the following bending moments are calculated:

$$CM_{bending1} = 0.1 \cdot \frac{7^2}{1.8 \cdot 25.6 \cdot 42} \cdot 10500 \cdot 9.81 = 260\ kNm$$

$$CM_{bending2} = \frac{7}{3 \cdot 1.8 \cdot 42} \cdot \left(10500 \cdot \left(4.6 - 0.6 \cdot 0.35 \cdot 9.81\right) + 770 + 220\right) = 854\ kNm$$

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:

$$M_{bending} \geq 88\% \cdot 1.35 \cdot \max\left(CM_{bending1}, CM_{bending2}\right) = 0.88 \cdot 1.35 \cdot 854 = 1015\ kNm$$

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:

$$W = \frac{M_{bending}}{50\%\ of\ 360MPa} = \frac{1015 \cdot 10^6}{180} = 5639 \cdot 10^3\ mm^3 = 5639\ cm^3$$

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:

$$MSL \geq \frac{M_{bending}}{2 \cdot h \cdot n_{hog}} = \frac{1015}{2 \cdot 5.2 \cdot 2} = 49\ kN \approx 4.9\ ton$$

Example B.5.2 – Uprights for round wood on a 16 600 DWT ship

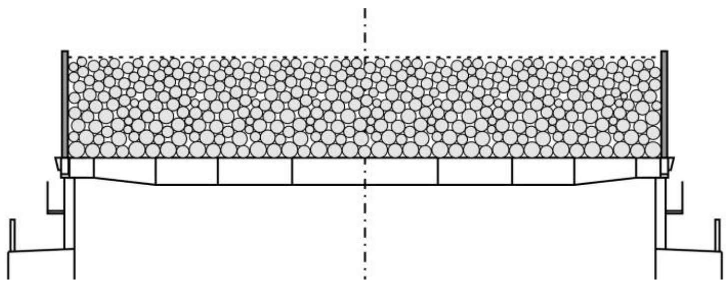


Figure B.6. Midship section of 16 600 DWT ship with round wood secured with uprights

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:

$$CM_{bending1} = 0.1 \cdot \frac{H^2}{k \cdot B \cdot N} \cdot m \cdot g_0$$

$$CM_{bending2} = \frac{H}{3 \cdot k \cdot N} \cdot \left(m \cdot \left(a_t - 0.6 \cdot \mu_{static} \cdot g_0\right) + PW + PS\right)$$

With cargo properties and acceleration as given above, the following bending moments are calculated:

$$CM_{bending1} = 0.1 \cdot \frac{3.7^2}{19.7 \cdot 30} \cdot 3000 \cdot 9.81 = 68\ kNm$$

$$CM_{bending2} = \frac{3.7}{3 \cdot 2 \cdot 30} \cdot \left(3000 \cdot \left(5.3 - 0.6 \cdot 0.35 \cdot 9.81\right) + 296 + 160\right) = 209\ kNm$$

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:

$$M_{bending} \geq 1.35 \cdot \max\left(CM_{bending1},\ CM_{bending2}\right) = 1.35 \cdot 209 = 282\ kNm$$

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:

$$W = \frac{M_{bending}}{50\%\ of\ 360MPa} = \frac{282 \cdot 10^6}{180} = 1568 \cdot 10^3\ mm^3 = 1568\ cm^3$$

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:

$$MSL \geq \frac{M_{bending}}{2 \cdot h \cdot n_{hog}} = \frac{282}{2 \cdot 3.7 \cdot 1} = 38\ kN \approx 3.9\ ton$$

Example B.5.3 – Uprights for round wood on a 6,000 DWT ship on the Baltic Sea

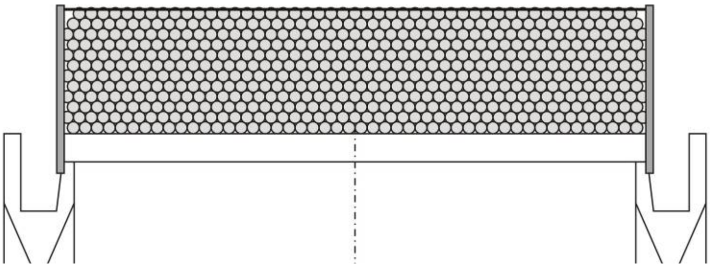


Figure B.7. Midship section of 6,000 DWT ship with round wood secured with uprights

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 where the maximum expected significant wave height on a 20-year basis can be taken as 8.5 metres. Thus, the reduction factor for operation in restricted waters is taken as:

$$f_R = \sqrt[3]{\frac{H_M}{19.6}} = \sqrt[3]{\frac{8.5}{19.6}} = 0.76$$

$$a_t = a_{t\ basic} \cdot f_{R1} \cdot f_{R2} \cdot f_R = 6.5 \cdot 0.93 \cdot 1.00 \cdot 0.76 = 4.6\, m/s^2$$

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:

$$CM_{bending1} = 0.1 \cdot \frac{H^2}{k \cdot B \cdot N} \cdot m \cdot g_0$$

$$CM_{bending2} = \frac{H}{3 \cdot k \cdot N} \cdot \left(m \cdot \left(a_t - 0.6 \cdot \mu_{static} \cdot g_0\right) + PW + PS\right)$$

With cargo properties and acceleration as given above, the following bending moments are calculated:

$$CM_{bending1} = 0.1 \cdot \frac{3.1^2}{14.5 \cdot 25} \cdot 1500 \cdot 9.81 = 39\ kNm$$

$$CM_{bending2} = \frac{3.1}{3 \cdot 1.8 \cdot 25} \cdot \left(1500 \cdot \left(4.6 - 0.6 \cdot 0.35 \cdot 9.81\right) + 202 + 130\right) = 95\ kNm$$

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:

$$M_{bending} \geq 1.35 \cdot \max\left(CM_{bending1},\ CM_{bending2}\right) = 1.35 \cdot 95 = 128\ kNm$$

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:

$$W = \frac{M_{bending}}{50\%\ of\ 360 MPa} = \frac{128 \cdot 10^6}{180} = 713 \cdot 10^3\ mm^3 = 713\ cm^3$$

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:

$$MSL \geq \frac{M_{bending}}{2 \cdot h \cdot n_{hog}} = \frac{128}{2 \cdot 3.1 \cdot 1} = 20.6\ kN \approx 2.1\ ton$$

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

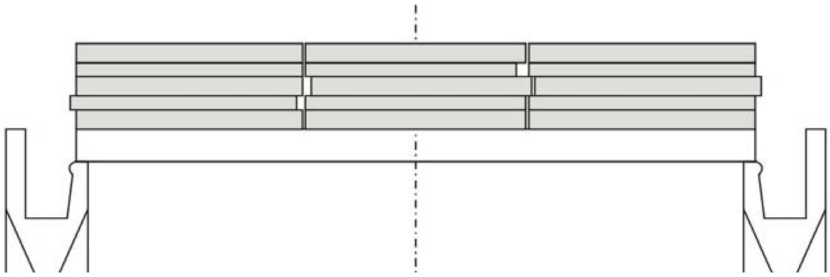


Figure B.8. Midship section of 6,000 DWT ship frictional secured wood secured

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 considered 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/s² as shown below:

$$a_t \le \frac{m \cdot g_0 \cdot \mu_{static} - PW - PS}{m}$$

$$a_t \le \frac{1500 \cdot 9.81 \cdot 0.35 - 202 - 130}{1500} = 3.2 m/s^2$$

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/s²*	=	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 with this stowage arrangement is calculated to 2.9 m according to the following:

$$a_t = a_{t\ basic} \cdot f_{R1} \cdot f_{R2} \cdot f_R$$

$$f_R = \frac{a_t}{a_{t\ basic} \cdot f_{R1} \cdot f_{R2}} = \frac{3.2}{6.5 \cdot 0.93 \cdot 1.00} = 0.53 m/s^2$$

$$f_R = \sqrt[3]{\frac{H_M}{19.6}}$$

$$H_M = 19.6 \cdot f_R^{\ 3} = 19.6 \cdot 0.53^3 = 2.9m$$

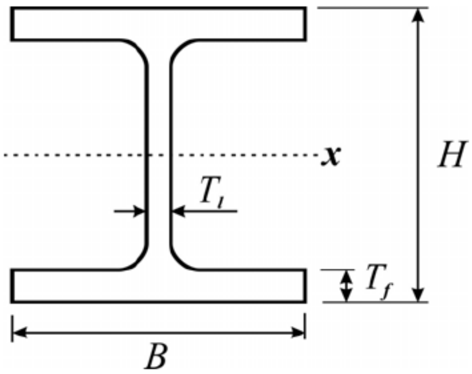
B.7 Maximum bending resistance in common profiles for uprights

HE-A beams

Size	**H** [mm]	**B** [mm]	**T_l** [mm]	**T_f** [mm]	**Maximum bending resistance** **W_x** [cm³]
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, W_x [cm^3]
HE 220 B	210	220	9.5	16	736
HE 240 B	230	240	10	17	938
HE 260 B	250	260	10	17.5	1150
HE 280 B	270	280	10.5	18	1380
HE 300 B	290	300	11	19	1680
HE 320 B	310	300	11.5	20.5	1930
HE 340 B	330	300	12	21.5	2160
HE 360 B	350	300	12.5	22.5	2400
HE 400 B	390	300	13.5	24	2880
HE 450 B	440	300	14	26	3550
HE 500 B	490	300	14.5	28	4290
HE 550 B	540	300	15	29	4970
HE 600 B	590	300	15.5	30	5700
HE 650 B	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:

$$\delta P,\% = T_{pl} \cdot \delta P_{day},\%$$

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 **δP = 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.

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