RULES FOR

THE CLASSIFICATION AND CONSTRUCTION

PART 4. SPECIAL EQUIPMENT AND SYSTEMS

VOLUME I

RULES FOR

STOWAGE AND LASHING OF CONTAINERS

2012 EDITION

BIRO KLASIFIKASI INDONESIA

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THE CLASSIFICATION AND CONSTRUCTION

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STOWAGE AND LASHING OF CONTAINERS

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Section 1

Explanations

A. Explanations

1. Applications of the Rules

1.1 Ships classed with Biro Klasifikasi Indonesia

1.1.1 Those parts of the container stowage and lashing equipment which are connected to the ship's hull by welding or which may affect its strength are subject to approval within the scope of the Rules for the Classification and Construction of Seagoing Steel Ships (testing of materials, examination of drawings, survey during construction).

The parts mentioned are to be dimensioned in such a way that they do not endanger safety and operation.

Connections of these parts to the hull and their sub-structures are subject to approval too, and shall be dimensioned according to the loads given in Section 3. Corresponding drawings and material properties are to be submitted. The locations of the connections shall be indicated in the documents for approval according to the Rules For Hull, Volume II.

1.1.2 In respect of other elements of the stowage and lashing equipment such as loose lashing elements and removable guide structures, the respective documentation (drawings, calculations) will be examined in connection with the examination of the entire lashing system. These parts shall be fabricated in conformity with the provisions laid down in Section 4 and subjected to strength tests according to Appendix C.

1.1.3 The validity of the Characters of Classification and additional Notations according to 1.1.4 depends on the exclusive use of container lashing and stowing gear approved and tested by BKI in accordance with Section 4 and Appendix A of these Rules, and on the approval of the Container stowage- and –lashing plan. Certificates of the container fittings of the ship shall be included in ship's documents on board. The Container stowage- and –lashing plan has to contain a schedule with the following specification of the Container stowage- and -lashing equipment:

– Number of parts with position no.

– Designation (type)

– Manufacturer

– Breaking load and working load.

In the Class Certificate of the ship a Notation will be entered to this effect.

The manufacturer of the approved stowage and lashing system has to ensure, that clear instructions for the danger free and safe operation of all components of the system are available to the Ship's command.

The responsibility for retaining this condition rests with the owner of the ship.

The Surveyors will satisfy themselves during the periodical Class Surveys that the conditions for granting the Class Notation are still met.

1.1.4 Classification Symbols and Notations

Ships which are intended to exclusively carry containers and which are fitted with the respective equipment complying with the requirements of Section 21, G. of the Rules for Hull Volume II, will be assigned, in addition to their Characters of Classification, the Notation **CONTAINER SHIP**.

Ships, which are intended to carry containers only occasionally or as partial cargo and which are fitted with the respective equipment complying with the requirements of Section 21, G. of The Rules for Hull Volume II, will be assigned, in addition to their Characters of Classification, the Notation **EQUIPPED FOR CARRIAGE OF CONTAINERS** (see Rules for The Classification and Surveys, Volume I).

1.1.5 A stowage and lashing plan stamped by BKI is to be kept on board and made available to the Surveyor on request. A container stowage and lashing plan is also to be kept on board, in case a lashing computer is installed.

1.1.6 In case of a conversion or removal of the container equipment, the BKI Head Office shall be informed accordingly.

Owners and/or the conversion yard will have to submit the relevant drawings for approval.

This refers also to modifications of the stowage arrangement due to an increase in the number of container stowage places on the weather deck and the weather deck hatch covers; including, for instance, the arrangement of additional container layers, an increase of stack loads or modification of the container weights in the individual layers.

1.2 The compliance with the present Rules may be certified by BKI for ships other than covered by 1.1, subsequent to an adequate examination of the respective documentation.

1.3 Type approval

BKI grants type approval of stowage and lashing elements, removable or to be permanently built in and fabricated in series; the approval procedure may consist of examinations of drawings and load tests and serves as a basis for individual approval in connection with the assignment of Class (1.1.2).

If the load test shows satisfactory results, a Type Certificate will be issued.

Note

Where container stowage and lashing elements are intended to be used as loose gear - e.g. lifting pots, lifting foundations on the hatch covers.– "Regulations for the Construction and Survey of Cargo Handling Appliances and other Lifting Appliances", are to be applied.

1.4 Lashing computers

If a computer for determination of forces in the lashing system used on board, the approval of soft- and hardware by BKI is recommended. For particulars, see Appendix F.

2. Stowage of containers

2.1 General

All equipment on deck and in the holds essential for maintaining the safety of the ship and which are to be accessible at sea, e.g. fire fighting equipment, sounding pipes etc., should not be made inaccessible by containers or their stowing and lashing equipment.

Note

Containers stowed on weather deck on ships, which are under supervision of National Regulation, aside of the hatches an operational walkway of at least 600 mm width and 2000 mm height shall remain. The deck shall be free from any edges which can cause stumbling.

2.2 For transmitting the forces from the container stowing and lashing equipment into the ship's hull adequate welding connections and local reinforcements of structural members are to be provided.

2.3 The hatchway coamings are to be dimensioned according to the loads appearing in way of the connections of transverse and longitudinal struts of cell guide systems.

The cell guide systems are not permitted to be connected to projecting deck plating edges in way of the hatchways. Any flame cutting or welding should be avoided, particularly at the deck roundings in the hatchway corners.

2.4 Where inner bottom, decks, or hatchcovers are loaded with containers, adequate substructures, e.g. carlings, half height girders etc., are to be provided. The plate thickness is to be increased where required. For welded-in parts, see Section 19, B.2 of the Rules for Hull, Volume II. Container foundation and other substructures are to be determined according to Rules for Hull, Volume II, Section 21, G.

2.5 The Rules base on the stowage of containers that correspond in all aspects to the actual ISO Standard. Deviations require special examination and approval of the BKI.

As gross weights of the containers the following weights may be assumed:

20’ minimum 2,5 tons

maximum 30,5 tons

40’ minimum 3,5 tons

maximum 30,5 tons

Other container sizes correspondingly.

2.6 All stowage and lashing fittings (loose or fixed) shall be certified. Corresponding certificates are to be included into documentation on board.

3. Cargo securing manual

According to IMO requirement all ships subject to SOLAS have to be equipped with an approved cargo securing manual from 31 December 1997. Exempted are ships for liquid cargo, bulk cargo respect fishing vessel and offshore units.

The certification of the manuals can be done by BKI.

Section 2

Rules for the Arrangement and Construction

A. Stowage of Containers on the Weather Deck (incl. Hatchway)

1. Seating conditions

A check shall be made whether the seating points of the containers on the ship's deck can shift relatively to one another with the ship at sea. This may be the case, for instance, aboard ships having very large hatch openings where the container rests partly on the hatch cover and partly on supports beside the hatchway. Relative dislocations of container seating points shall also be taken into account where the container is seated on two hatches of a twin-hatch ship.

Where necessary, the alignment steps (cones) at the points of seating shall be given such a configuration that no forces that might result in damages will be transmitted into the container as a consequence of the relative dislocations. Slide plates or foundations with elongated ISO-holes may be provided for instance.

Where such slide plates or other constructional means are provided on supports beside the hatchways in order to relieve the supports of the transverse forces occurring, these forces shall be transmitted into the hatch covers by suitable means. In respect of the design of hatch covers3. and container supports for the carrying of4. containers, see also Section 3, A.4.

2. Stowage without lashing or buttressing

2.1 When stowing containers without lashing or buttressing, the transverse loads occurring will have to be absorbed by the transverse framework of the containers. This racking load occurring in the container transverse framework owing to the motion of the ship shall not exceed 150 kN, and locking devices as to 2.2 through 2.4 are to be used.

The load applied to the upper corner casting of the container may not exceed 848 kN (20' and 40'), 942 kN according to ISO amendment 2005. The limit for the stowage systems is 848 kN.

If 45' Containers are stowed on top of 40' Containers, or vice versa, the corner posts may be loaded with 270 kN maximum. Correspondingly this may be applied for 48', 49' and 53' long containers too.

2.2 Containers in 1 (one) layer

The containers shall be secured against tilting and shifting by locking devices at their lower corner fittings. Where not all of the lower corner fittings of a block of containers are accessible, locking the 2 (two) outer containers at least at 3 (three) corner fittings will do, provided that bridge fitting are arranged.

2.3 Containers arranged in several layers

The containers located in the lowermost layer shall be locked at their lower corner fittings. Cone locks shall be arranged between the container layers. If 4 (four) container layers are arranged bridge fitting should be provided athwart-ships on the uppermost layer so far as possible. Tension-pressure-bridge fitting should be used which can be inserted into variable gap distances between the containers, see also 3.4.2.

2.4 Dunnage

Placing containers on dunnage without lashing them is only permissible where effective securing means preventing their shifting and tilting (see 2.2) can be arranged, see also 3.7.

3. On-deck lashing of containers

3.1 The lashings shall be arranged in such a way that 150 kN racking load will not be exceeded in the container transverse framework when taking as basis the load assumptions contained in Section 3, A. "Calculation of the Lashing and Shoring Forces".

Always both container ends shall be lashed. Both ends have to be lashed in the same way. This is not applicable, if one container end is stowed in a cell guide.

In a stowage system all front-ends respectively all door-ends shall be stowed principally in one section. The door- or front-ends can be arranged forward or backwards. If this requirements is not kept, the stack in question shall be examined separately.

3.2 Lashed containers shall be secured against horizontal displacement by cones, locking devices or alignment steps arranged on the hatch covers and/or on deck.

3.3 Containers in 1 (one) layer

Lashing is required only where there are no locking devices at the lower corner fittings of the containers. The lashings shall be arranged vertically.

3.4 Containers in more than 2 (two) layers

3.4.1 Blocks of 3 (three) or more layers of containers may be lashed in accordance with Fig. 2.1 or in a similar way (see, however, 3.5).

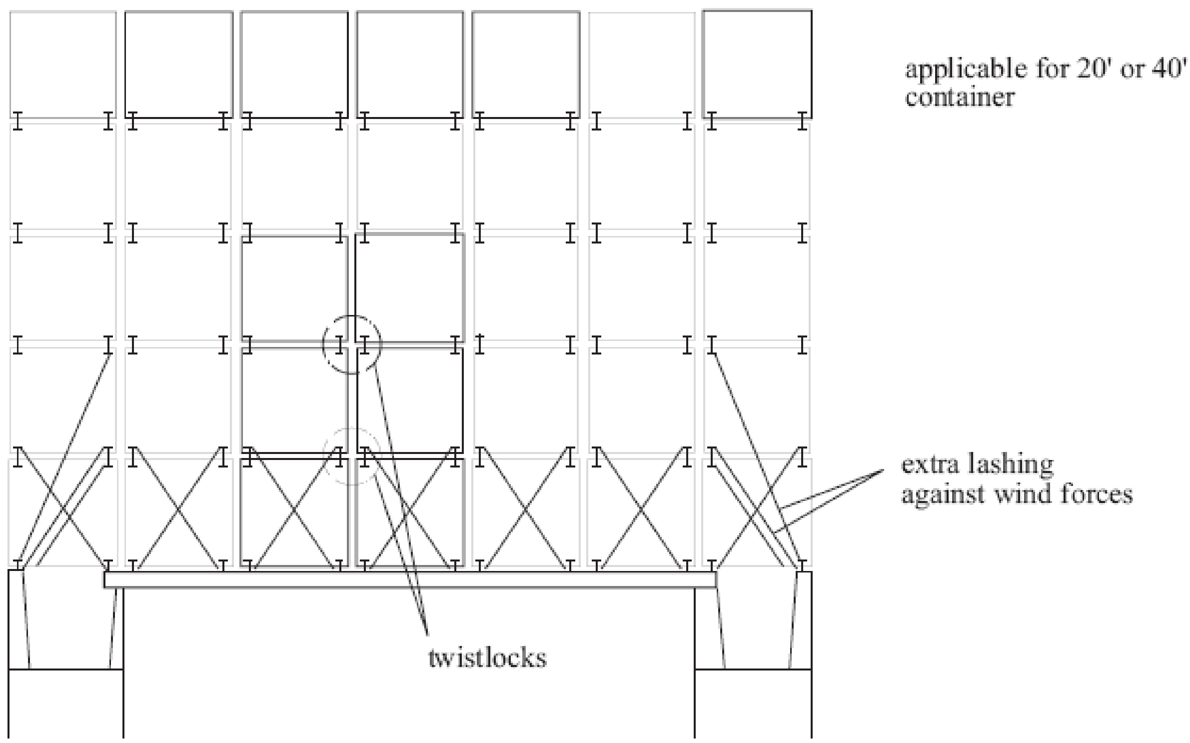


Fig. 2.1 (5 tiers stowage)

3.4.2 Where the uppermost layer of containers need not be lashed, this layer shall be coupled to the 1 (one) immediately below by locking devices.

If Containers are stowed in 4 (four) tiers or more, which need not to be lashed, bridge fittings have to be inserted on the uppermost tier. Tension-pressure-bridge fitting are recommended, that can be inserted even if the corner castings are positioned very near to each other.

If the stacks are lashed at both ends, bridge fittings can be deleted.

3.4.3 The lashing force shall, in general, not exceed a SWL of 230 kN for 1st tier top/2nd tier bottom, 270 kN for the 2nd tier top/3rd tier bottom (if lashed from level 1st tier bottom). Higher lashing forces can be approved upon agreement with BKI. Vertical lashing can impose a SWL of 300 kN upon the corner casting.

3.5 Where with 5 (five) container layers and more are placed so close to one another (e.g., 20'-containers on 40' stowing places, leaving a 76 mm clearance between them) that lashing at both ends is not possible (see Fig. 2.2), the use of tension-pressure-bridge fittings on both container ends is recommended (see 3.4.2). If the stacks are lashed of the accessible end, bridge fittings can be deleted there.

3.6 Lashing bridges

To improve the efficiency of the lashing, lashing bridges can be arranged. By this, the lashing, the lashing level is risen by one or more tiers.

The dimensioning of the bridge shall be based on the lashing case from the container lashing plan that reaches the highest lashing forces.

The individual lashing plates and its substructure have to be dimensioned basing on these values. The lashing forces have to be applied with their x- and y- components. Alternatively (if no lashing plan is available) 200 kN per lashing can be applied. The global system of the individual lashing bridge shall be loaded with 70 % of these forces only.

In order to calculate the lashing forces on a lashing bridge, 10 mm deformation for 1 (one) tier high bridges (in direction of the load) and 25 mm deformation for 2 (two) tier high bridges shall be taken into account.

3.7 Coupling elements

If pressure plates or linkage plates are employed, loads should be balanced over a maximum of 3 (three) container stacks only.

Note

Because of operative problems, however, these fittings are not recommended.

3.8 Linear seating of containers

3.8.1 Containers may be stowed in line only in 1 (one) layer at most. In case of stowage in several layers, the total weight of the containers above the 1st layer shall not exceed the following values:

- with 40'-containers 0,8 G
- with 20'-containers 1,0 G

(G = gross container weight according to ISO). This type of seating can be brought about by arranging continuous steel or wooden dunnages below the longitudinal bottom rails of the containers or by directly seating these bottom rails on the hatch covers or the decks with sunk-in pockets being arranged below the container corners. The arrangement of short steel pads placed upon the girders of short hatch covers and serving as dunnage shall be avoided.

3.8.2 The equipment used for obtaining a linear seating shall be of such a configuration that a sufficient clearance (approx. 5 mm) is left between the corner fittings of the container and the hatch covers or decks. For ISO containers, a projecting depth of their corner fittings of from 4 to 17,5 mm as against their bottom longitudinal rails and of from 11 to 17,5 mm as against the bottom transverse girders may be assumed in this connection. Special type containers may require additional dunnage for their transportation.

Special care shall be taken to secure linearly seated containers against their shifting sidewards, in conformity with 3.2.

3.9 Installation tolerances (build-in)

3.9.1 Height tolerances of container foundations The following tolerances in height of container resting levels are recommended by BKI.

Transverse:

1 point is zero, the other ± 3 mm

Longitudinally:

± 6 mm to zero point (see appendix J)

3.9.2 Length-/width tolerances

Length:	5853	+ 3 / - 3	(distance of holecenter-lines for 20')
	11985	+ 4 / - 4	(distance of holecenter-lines for 40')
Width:	2259	+ 3 / - 3	(distance of holecenter-lines for 20' and 40')

Other containers accordingly. See also in standard ISO 668.

4. Buttress system stowage

4.1 Instead of being lashed, containers may also be secured against their shifting sidewards and/or their tilting by means of buttress structures placed on deck (if necessary, on the hatchways) or by a system combined of buttress structures and cone adapters.

4.2 The buttress structures and their connections to the ship's hull are covered by the classification of the ship and shall satisfy Rules for Hull, Volume II.

4.3 The containers shall be shored by the buttress structures in such a way that in admissible deformations of the container framework cannot occur and the permissible container racking loads are not exceeded

4.4 Cell guides on deck

If the container stowage rises above the cell guide, the uppermost container, which is still to some extent within the guide as well as the containers above, are to be secured sufficiently against racking and lifting forces. Vertical lashings are recommended.

20' containers can be stowed in "mixed stowage" mode (see B.1.2.7). However, outer stacks shall be additionally secured against swimming up and wind forces by adequate measurements.

5. Endangered containers by wash of the sea

5.1 Containers stowed in positions especially endangered by the wash of the sea and buoyancy forces by incoming water have to be additionally secured, in an effective manner, by locking devices, alignment steps increased in height and/or reinforced lashings. It shall be assumed for smaller ships that a buoyancy force corresponding to the entire cubic content of a container may become effective

5.2 The action of wind gusts shall be taken into account for detached stacks of containers.

B. Below-Deck Stowage of Containers

1. Stowage in cell guide structures

1.1 Cell guide structures for containers may be permanently installed in (welded to) the ship's hull or be arranged in a detachable manner (screwed connections, suspended structures).

1.2 Vertical guide rails

1.2.1 Vertical guide rails consist in general of equal steel angles. On account of abrasion and local forces e.g. due to jamming, occurring when hoisting and lowering the containers, the thickness of the angle flanges should be at least 12 mm.

1.2.2 The horizontal forces originating from the containers are transmitted through the container corners in a punctiform way to the guide rails.

Where vertical guide rails consist of several steel guide angles, the same should be connected with 1 (one) another by horizontal web plates arranged at the level of the points of attack and additionally at least midway between them.

1.2.3 The top ends of the guide rails shall be fitted with guide heads of sufficiently strong configuration according to operating conditions.

1.2.4 Doubling plates or, aboard ships fitted with an inner bottom ceiling, other suitable means shall be provided at the guide rail lower ends for the purpose of reinforcing the container supporting area (as for reinforcements below the inner bottom, see Rules for Hull, Volume II, Section 21, G.).

1.2.5 Self-supporting rails

Guide rails arranged in a self-supporting manner in the cargo hold shall be sufficiently secured by supports arranged athwart ships and fore-to-aft (transverse and longitudinal ties). These supports shall be fitted, if possible, at the level of the container corners.

In case of too high loads, the guide rails may be formed by core sections (e.g., I beams) to which the steel guide angles are attached.

1.2.6 If 20'-containers are stowed in a 40'-cell, normally the containers have to be side-supported in the 20'-gap.

In case a longitudinal stowage system is used (linkage of two 20'-containers by longitudinal tension/pressure adapter cones to a 40' unit) generally a stack-weight of 1200 kN may not be exceeded. The lowermost container shall have space for shifting.

1.2.7 Mixed stowage

In case that 40' cell guides are provided, 20' container stacks may be stowed in the 40' cell, secured by singlecones between each other and in tank top. This isallowed up to 12 tiers. The permissible 20' containerstack weights may be taken from Table 2.1 (stack-weights in dependence from acceleration and number of tiers).

If the 20' stack is topped by 1 (one) or more 40' containers (also linked by single cones) higher stack weights are allowed. These weights may be taken from Table 2.2.

In case of container stowage in cell guides with only 1 (one) container end in the guide the allowable stack-weights can be calculated by limiting the racking load T_1 of the bottom container to 185 kN for 30' and 170 kN for 40' container stowage.

1.2.8 Guide rails at bulkheads

Vertical guide rails at transverse or longitudinal bulkheads shall be connected to the bulkhead plating or bulkhead stiffeners by horizontal web plates or other elements resistant to shearing and bending loads. A connection as free from notches as possible shall be aimed at especially where tank bulkheads are concerned.

1.3 Clearances

1.3.1 The clearance in the guide rails - related to the basic dimensions of the standard containers -

shall not exceed 25 mm athwart ships and 38 mm fore to aft. In the longitudinal direction of the ship, in connection with the maximum admissible clearance, the deformation of the cell-guide system will have to be considered. Where containers are stowed in less than 6 (six) layers, larger clearances may be chosen with the container strength being taken into account.

1.3.2 Athwart ships, the spacings of the cell guide system shall be such that any damage to the longitudinal supports of the structures or to the containers by deformed container side walls is prevented.

1.4 Cross ties

Depending on the cell guide system construction (see Figs. 3.5 and 3.6), the cross ties serve for shoring the guide rails athwart ships or for distributing the local loads among all rails. If ever possible, they shall be arranged at the level of the container corner fittings so as to allow a direct absorption of the horizontal forces. Where they are sufficiently dimensioned, the cross ties may also serve for absorbing the longitudinal forces. Hull deformations, if any, shall also be taken into account.

1.5 Longitudinal ties

Where the longitudinal forces cannot be absorbed by the cross ties, longitudinal ties shall be provided for staying the vertical guide rails.

When steel wire pendants are used for the longitudinal ties, they shall be provided with adjusting devices. Where bars are used, their end connections shall be such as to exclude any compressive stressing.

2. Stowage and lashing without cell guide structures

2.1 Stowage without lashings

2.1.1 Where containers are to be stowed below deck (e.g. 20' -containers in a 40' -cell), without making use of special cell guide structures or lashings, every block of containers (containers placed beside, and on top of, 1 (one) another and coupled to each other by suitable appliances such as cone adapters and bridgefitting) shall be laterally shored at its ends, through the container corner fittings, against sufficiently strong structural elements of the ship (such as decks, web frames). When determining the shoring forces, hull deformations, if significant, shall also be taken into account.

The number of lateral shoring points shall be determined so that the corner fitting loads (see Section 3, A.6.1) and racking loads permitted for the containers will not be exceeded. Where necessary, the shoring force shall be distributed, by a special configuration of the shoring element, among the 2 (two) corner fittings located 1 (one) atop the other at any 1 (one) shoring point.

The shoring force occurring may also be reduced by splitting up the inertia forces acting athwart ships into a compressive load on the 1 (one) and a simultaneously effective tensile load on the other side of the ship at the respective shoring points there. This may be attained by an adequate construction of the shoring element (see 2.1.2) and splitting up the containers to be shored into 2 (two) separate blocks of containers. Naturally a securing of the containers by twistlocks and lashing is allowed too.

2.1.2 Shoring element construction

The shoring element may be so constructed as to be able to transmit both compressive and tensile loads. It may be arranged in a permanent or removable manner. Both types of construction shall be of such a configuration that the clearance between their contact faces and the container corner fittings is as small as possible.

Wedges shall be sufficiently secured against their inadvertently getting loose (e.g., on account of vibrations).

The shoring elements shall be easily accessible. The weight and number of loose parts shall be restricted to a minimum.

2.1.3 The container stacks placed beside 1 (one) another be coupled by dual cone adapters or equivalent devices. Bridge fitting shall be provided on the upper most layer of containers if there is a lateral shoring point at this level. These bridgefitting shall be suitable for pressing the containers against each other and against the lateral shoring points. Where the containers are divided into two separate blocks (see 2.1.1), bridgefitting for tension and compression are to be arranged at the support level. The lowest container layer has to be secured against shifting at all 4 (four) corner castings.

2.2 Lashing in the cargo hold

In place of rigidly shoring the blocks of containers as described in 1., they may also be secured by ropes or lashing bars, e.g. in those cases where shoring them by means of shoring elements as to 2.1.1 is impossible for lack of suitable shoring points in the ship's hull. The provisions in A.3. shall apply analogously.

Table 2.1 20'-Containers in 40'-Cell Guides connected with single cones

$k \cdot b_q$ / tiers	0,40	0,41	0,42	0,43	0,44	0,45	0,46	0,47	0,48	0,49	0,50	0,51	0,52	0,53	0,54
12	127,2	124,3	121,5	118,6	115,7	112,9	110,6	108,3	106,0	103,7	101,4	99,5	97,6	95,8	93,9
11	126,9	124,0	121,2	118,3	115,4	112,6	110,3	108,0	105,7	103,4	101,1	99,3	97,4	95,5	93,7
10	126,5	123,7	120,8	118,0	115,1	112,3	110,0	107,7	105,4	103,2	100,9	99,0	97,2	95,3	93,5
9	126,2	123,3	120,5	117,7	114,8	112,0	109,7	107,4	105,2	102,9	100,6	98,8	96,9	95,1	93,2
8	125,8	122,9	120,1	117,3	114,4	111,6	109,3	107,1	104,8	102,5	100,3	98,4	96,6	94,7	92,9
7	125,2	122,3	119,5	116,7	113,9	111,1	108,8	106,6	104,3	102,0	99,8	98,0	96,1	94,3	92,5
6	124,3	121,5	118,7	115,9	113,1	110,4	108,1	105,9	103,6	101,4	99,1	97,3	95,5	93,7	91,9
5	123,2	120,4	117,6	114,9	112,1	109,3	107,1	104,9	102,6	100,4	98,2	96,4	94,6	92,8	91,0
4	121,8	119,1	116,3	113,6	110,9	108,1	105,9	103,7	101,5	99,3	97,1	95,3	93,6	91,8	90,0
3	91,4	91,4	91,4	91,4	91,4	91,4	91,4	91,4	91,4	91,4	91,4	90,5	89,5	88,5	87,5
2	61,0	61,0	61,0	61,0	61,0	61,0	61,0	61,0	61,0	61,0	61,0	61,0	61,0	61,0	61,0

$k \cdot b_q$ / tiers	0,55	0,56	0,57	0,58	0,59	0,60	0,61	0,62	0,63	0,64	0,65	0,66	0,67	0,68	0,69
12	92,0	90,5	88,9	87,4	85,8	84,3	83,0	81,7	80,4	79,1	77,7	76,6	75,5	74,4	73,3
11	91,8	90,3	88,7	87,2	85,6	84,1	82,8	81,5	80,2	78,7	77,6	76,4	75,3	74,2	73,1
10	91,6	90,1	88,5	87,0	85,5	83,9	82,6	81,3	80,0	78,7	77,4	76,3	75,2	74,1	72,9
9	91,4	89,8	88,3	86,8	85,2	83,7	82,4	81,1	79,8	78,5	77,2	76,1	75,0	73,9	72,8
8	91,1	89,5	88,0	86,5	84,9	83,4	82,1	80,8	79,5	78,2	76,9	75,8	74,7	73,6	72,5
7	90,6	89,1	87,6	86,1	84,5	83,0	81,7	80,4	79,2	77,9	76,6	75,5	74,4	73,3	72,2
6	90,0	88,5	87,0	85,5	84,0	82,5	81,2	79,9	78,6	77,4	76,1	75,0	73,2	72,1	70,3
5	89,2	87,7	86,2	84,7	83,2	81,7	80,4	79,2	77,9	76,6	75,4	74,3	73,2	72,1	71,0
4	88,2	86,7	85,3	83,8	82,3	80,8	79,6	78,3	77,0	75,8	74,5	73,5	72,4	71,3	70,3
3	86,6	85,1	83,6	82,2	80,7	79,3	78,0	76,8	75,6	74,4	73,1	72,1	71,0	70,0	68,9
2	61,0	61,0	61,0	61,0	61,0	61,0	61,0	61,0	61,0	61,0	61,0	61,0	61,0	61,0	61,0

Table 2.1 20'-Containers in 40'-Cell Guides connected with single cones (continued)

$k \cdot b_q$ / tiers	0,70	0,71	0,72	0,73	0,74	0,75	0,76	0,77	0,78	0,79	0,80
12	92,0	90,5	88,9	87,4	85,8	84,3	83,0	81,7	80,4	79,1	77,7
11	91,8	90,3	88,7	87,2	85,6	84,1	82,8	81,5	80,2	78,7	77,6
10	91,6	90,1	88,5	87,0	85,5	83,9	82,6	81,3	80,0	78,7	77,4
9	91,4	89,8	88,3	86,8	85,2	83,7	82,4	81,1	79,8	78,5	77,2
8	91,1	89,5	88,0	86,5	84,9	83,4	82,1	80,8	79,5	78,2	76,9
7	90,6	89,1	87,6	86,1	84,5	83,0	81,7	80,4	79,2	77,9	76,6
6	90,0	88,5	87,0	85,5	84,0	82,5	81,2	79,9	78,6	77,4	76,1
5	89,2	87,7	86,2	84,7	83,2	81,7	80,4	79,2	77,9	76,6	75,4
4	88,2	86,7	85,3	83,8	82,3	80,8	79,6	78,3	77,0	75,8	74,5
3	86,6	85,1	83,6	82,2	80,7	79,3	78,0	76,8	75,6	74,4	73,1
2	61,0	61,0	61,0	61,0	61,0	61,0	61,0	61,0	61,0	61,0	61,0

$k \cdot b_q$ = transverse acceleration factor (see Section 3, A.2)

For ships with acceleration factors below 0,50 individual calculations of the lateral accelerations are required

Permissible 20' container stack weights [t] for stowage in hold cell guides
Shown container stack weights are not to be exceeded. Inside the container stack the single container weights may differ from each other. Calculated acceleration factors are to be rounded up to two decimal places maximum

Table 2.2 20'-Container-stack "topped" with minimum one 40'-container on single cones

$k \cdot b_q$ / tiers	0,40	0,41	0,42	0,43	0,44	0,45	0,46	0,47	0,48	0,49	0,50	0,51	0,52	0,53	0,54
12	203,5	199,2	194,9	190,6	186,3	182,0	178,1	174,3	170,5	166,7	162,9	159,9	156,9	154,0	151,0
11	200,3	196,1	191,8	187,5	183,2	179,0	175,2	171,5	167,8	164,1	160,3	157,4	154,5	151,6	148,7
10	197,5	193,0	188,5	184,0	179,5	174,9	171,4	168,0	164,5	161,0	157,5	154,6	151,8	148,9	146,0
9	193,2	188,9	184,5	180,1	175,7	171,3	167,9	164,5	161,1	157,7	154,3	151,5	148,7	145,9	143,1
8	188,3	184,2	180,0	175,8	171,6	167,5	164,1	160,8	157,4	154,1	150,7	148,0	145,3	142,5	139,8
7	182,6	178,6	174,5	170,5	166,5	162,4	159,2	155,9	152,7	149,5	146,2	143,6	140,9	138,3	135,7
6	176,3	172,4	168,5	164,6	160,7	156,8	153,7	150,6	147,5	144,3	141,2	138,7	136,1	133,6	131,0
5	152,4	151,9	151,5	151,0	150,6	150,1	147,1	144,2	141,2	138,2	135,2	132,8	130,4	127,9	125,5
4	121,9	121,9	121,9	121,9	121,9	121,9	121,9	121,9	121,9	121,9	121,9	120,8	119,7	118,6	117,5
3	91,4	91,4	91,4	91,4	91,4	91,4	91,4	91,4	91,4	91,4	91,4	91,4	91,4	91,4	91,4
2	61,0	61,0	61,0	61,0	61,0	61,0	61,0	61,0	61,0	61,0	61,0	61,0	61,0	61,0	61,0

2.3 To secure a block of containers, a combined shoring/lashing system may be used if necessary.

3. Hatchcoverless container ships

3.1 Longitudinal and transverse acceleration
The accelerations are to be determined in general according to Section 3, A.

For a ship's length of 120 meters 4 (four) tiers, for a ship's length of 270 meters 9 (nine) tiers are to be considered as containers under deck. Lengths in between are to be interpolated linearly.

The transverse loads shall be increased by the values given in Section 3, A. for 2nd tier and higher accordingly for containers which side walls are exposed to wind pressure.

3.2 Stackability

According to ISO 1496/1 the lowermost container in hold may be over stowed with 192.000 kg (vertical acceleration of 1,8 g included). This value can be converted in accordance with the vertical acceleration given in these Rules. However, a special safety factor of 1,2 shall persist. A maximum number of tiers is not given.

Section 3

Design Principles

A. Stowage of Containers on the Weather Deck (incl. Hatchway)

1. Assumptions for the determination of the forces

1.1 The forces acting on the containers can be subdivided into two groups:

– static forces

– dynamic forces

The static forces result from the components of the container gross weights with the ship heeling and from the pre-stressing of the lashings, if any. Pre-stressing shall be kept as small as possible and can be neglected in calculations.

The dynamic forces acting upon the containers mainly result from the ship's pitching, heaving and rolling as well as the action of the wind. These forces shall be taken into account and calculated while applying the formulae contained in 2., 3. and 4.

1.2 Any shifting of the containers increases the load acting upon some lashing elements. Owing to the clearance at the cone adapters and the lower shifting locks, displacement of the individual container is possible on principle. Where more than 3 (three) stacks of containers coupled to each other by double cone adapters are located side by side, it may in general be assumed, however, that no shifting will take place as the clearance will be zero at a sufficient number of points. In all other cases at the door side in the 1st layer the displacement to be considered is 0,4 cm; the same applies to the 2nd layer. For the front walls, in general, no displacement is to be considered in the computations.

1.3 Normally, containers shall be stowed in fore to-aft direction. Stowing containers athwartships shall be agreed upon from case to case with the owner and BKI.

1.4 Lashings shall in general be arranged at the front and rear end of any 1(one) block of containers (containers placed side by side and atop 1(one) another).

1.5 Forces acting transversely on the container (transverse forces)

Owing to the ship's motions and the wind, the container, including its cargo, is exposed to a transverse force Fq (see 2.) which may be assumed to act evenly on its side wall. 1 (One) half each of this force is transmitted by the lower and upper container longitudinals to the transverse end frames.

The share 1/4 Fq transmitted through the upper longitudinal takes effect as transverse force in the end frame of the respective container. In case of several containers stacked upon each other, this transverse force is increased by the sum of the transverse forces taking effect in the frames placed atop the transverse frame under consideration. In lashed containers, the forces occurring in the transverse frames (racking loads) are reduced by the horizontal components of the lashing forces.

Resultant transverse force T: See 5.2.

The racking loads shall not exceed the values permitted for the types of containers in question. Since 1971, the permissible racking load as to the respective ISO standard amounts to 150 kN.

1.6 Forces in longitudinal direction

The assumptions indicated in 1.5 apply by analogy to the stressing of the container in longitudinal direction. The corresponding permissible load is 125 kN ISO test load is 75 kN.

2. Determination of the transverse components Fq

2.1 The determination of the transverse acceleration factor "k ·bq" by formulae below is only permitted for load cases, where a metacentric height (GM_0) does not exceed the following value:

$$\overline{GM_0} = \frac{0{,}04 \cdot B^2}{Z}$$

B = ship's breadth at outer edge of frames [m]

$\overline{GM_0}$ =initial metacentric height [m]

Note

This is the maximum allowable $\overline{GM_0}$ *value for container stowage systems that are calculated* *according to "standard acceleration".*

Z = $h_{cont.}$ + H [m]

$h_{cont.}$ = maximum in stowage and lashing plan assigned number of container tiers (n_{tiers}) on hatch covers or on weatherdeck, if no hatch covers are provided - multiplied by 1,05

$h_{cont.}$ = n_{tiers} · 1,05 [m]

H = vertical distance between designed waterline container fore-to-aft location and shall be calculated as and lower edge of container stack considered. follows:

$$\overline{GM_0} = \frac{0,018 \cdot B^2}{Z}$$

2.2 Reductions of the transverse acceleration are possible for ship lengths greater than L = 120 metres if the following, in comparison with 2.1 decreased initial metacentric heights are not exceeded at the load cases intended. The decreased maximum initial metacentric height shall be calculated as follows:

This $\overline{GM_0}$ − value shall be entered into the stowage plan to be approved BKI.

Note

This is the maximum allowable $\overline{GM_0}$ value for container stowage systems that are calculated accordance with "reduced acceleration".

2.3 The factor k allows for the influence of the container fore-to-aft location and shall be calculated as follows:

$$\text{AP to } 0,2\,\mathbf{L} \gg k = 1,15 - \frac{0,75 \cdot x}{\mathbf{L}}$$

$$0,2\,\mathbf{L} \text{ to } 0,6\,\mathbf{L} \gg k = 1,0$$

$$0,6\,\mathbf{L} \text{ to FP} \gg k = 0,55 + \frac{0,75 \cdot x}{\mathbf{L}}$$

X = distance of the container's center of gravity from A.P., in [m]

L = ship's length between perp. in [m]

Table 3.1 Transverse acceleration factor "b_q" not reduced

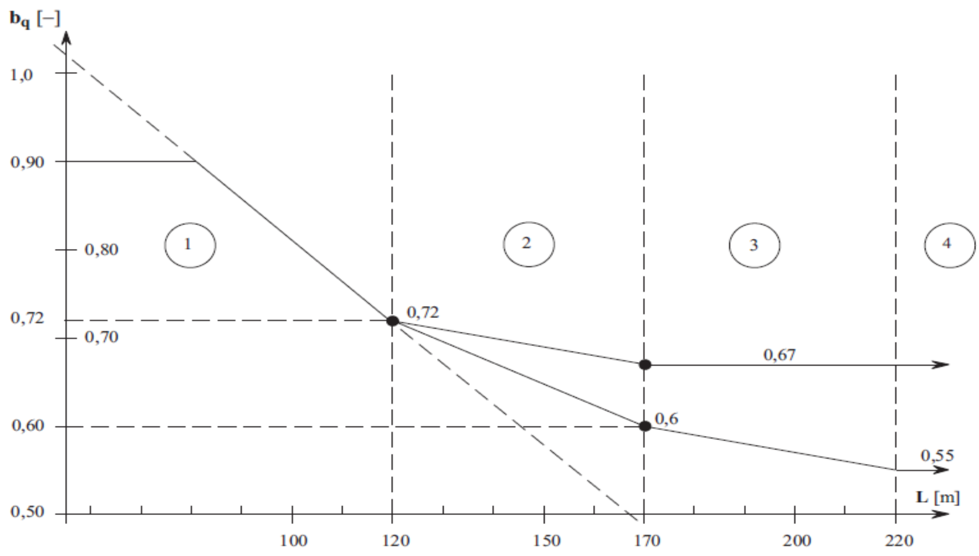
ship length range	on weather deck "b_q"	below weather deck "b_q"
range 1 **L** ≤ 120 m	1,32 – 0,005 · **L** [1]	1,2 – 0,005 · **L** [2]
range 2 120 m < **L** < 170 m	0,84 – 0,001 · **L**	0,648 – 0,0004 · **L**
range 3 and 4 **L** ≥ 170 m	0,67	0,58

1 not exceeding 0,9 and $k \cdot b_q$ not exceeding 1,0
2 not exceeding 0,8 and $k \cdot b_q$ not exceeding 0,9

See Fig. 3.1

Table 3.2 The reduced transverse acceleration factor "b_q" is to be determined according to table below:

ship length range	on the weather deck "b_q"	below weather deck "b_q"
range 2 120 m < **L** < 170 m	1,008 – 0,0024 · **L**	0,792 – 0,0016 · **L**
range 3 170 m ≤ **L** ≤ 220 m	0,77 – 0,001 · **L**	0,588 – 0,0004 · **L**
range 4 **L** ≥ 220 m	0,55	0,50



"b_q" values on weather deck for:

$$\overline{GM_0} \leq \frac{0{,}04 \cdot B^2}{Z} \text{ and } \overline{GM_0} \leq \frac{0{,}018 \cdot B^2}{Z}$$

Fig.3.1

As minimum value for the acceleration of deck containers 0,5 · g is to be taken unless individual calculations are on hand at BKI.

Reduced acceleration values shall not be used for constructions in hold.

Accelerations for GM-values higher than given in these Rules are to be agreed upon with BKI.

2.3.1 A side of the reduced and not reduced method for calculation of transverse acceleration a ship individual calculation is possible by BKI upon inquiry.

Note

The individual determination of the transverse accelerations is recommended for larger ships. Here the maximum GM-values are chosen generally in accordance with "standard" and "reduced" accelerations. However, other GM-values requested could be selected for the determination of the accelerations.

2.3.2 To be able to determine the accelerations for actually existing GM-values on board, it is allowed to interpolate the acceleration values between "standard", "reduced" and/or "individual".

If it is interpolated between "individual" and "standard", it is allowed to interpolate up to 10 % above the "standard" GM-value.

If it interpolated between accelerations of GM "reduced" and "standard", it is allowed to extrapolate by 20 % over the "standard" value.

It is not allowed to extrapolate below the GM "individual" value or "standard" value.

The calculated or given (with "individual" accelerations) $\overline{GM_0}$ values are the maximum allowable GM-value for these accelerations.

2.4 Wind loads

The transverse components Fq shall be increased by the values given in the following table for containers the side walls of which are exposed to wind pressure.

Table 3.3

Wind load F_w per container [kN]		
	container type	
	20'	40'
1st tier	30	60
2nd tier and higher	15	30
The stated values are valid for 8' 6" high containers. For other container heights and lengths the wind force has to be converted.		

The first tier contains a share for sea-sloshing. The windload is to be imposed on all outboard- or free-standing stacks. If inside positioned stacks from a gap, free standing stacks are to be imposed with windload only, if the gap is 3 (three) or more gaps wide.

Where container stacks placed side by side are coupled to 1(one) another athwartships by cone adapters, the value F_w/m shall be taken as wind load for each container in the calculation of the lashing forces.

n = number of container stacks in athwartships direction (n_{max} = 3)

The transverse component Fq for determination of lashing and racking forces in container frames, working parallel to the deck, are to be calculated by following formulae:

$$F_q = G \cdot k \cdot 9{,}81 \cdot b_q + F_w \quad [kN]$$

G = weight of a container including cargo in tons [t]

K = factor for container position

b_q = transverse acceleration factor

F_W = wind load for a container in outboard stacks, see 2.3

3. Determination of the longitudinal component F_ℓ

The longitudinal component F_ℓ for determining the fore- and aft stressing of the container buttress and cell guide structures as well as supports, and for determining the racking loads in the longitudinal walls of containers stowed in fore-to-aft direction, shall be calculated by means of the following formulae:

$$F_\ell = G \cdot b_\ell \quad [kN],$$

where b_ℓ -values for containers located between the lowermost layer in the cargo hold and the lowermost layer on deck shall be determined by interpolation, for containers above the first layer on deck by linear extrapolation.

4. Loads on container stanchions and sub-structures

4.1 Substructures for laterally supported containers

4.1.1 The stanchions and substructures are to be dimensioned, taking into account the forces arising vertically to the deck from the container (stack) stowed on the stanchions.

4.1.2 For systems with lateral support of the container blocks as well as for container blocks with longitudinal connections the vertical force P_v is calculated as follows:

$$P_v = V \cdot (1 + b_v) \cdot 9{,}81 \quad [kN]$$

P_v = vertical load on the container support [kN]

V = proportionate weight on the support by container or stack of containers [t]

bv = acceleration factor as follows:

$$b_v = \left(0{,}11 \cdot \frac{v_0}{\sqrt{\mathbf{L}}}\right) \cdot m$$

$$m = 1{,}0 \quad \text{for } 0{,}2 \le \frac{x}{\mathbf{L}} \le 0{,}7$$

$$m = m_o - 5\,(m_o - 1)\,\frac{x}{\mathbf{L}} \quad \text{for } 0 \le \frac{x}{\mathbf{L}} < 0{,}2$$

$$m = 1 + \frac{m_0 + 1}{0{,}3}\left(\frac{x}{\mathbf{L}} - 0{,}7\right) \quad \text{for } 0{,}7 < \frac{x}{\mathbf{L}} \le 1{,}0$$

$$m_o = \left(1{,}5 + 0{,}11 \cdot \frac{v_0}{\sqrt{\mathbf{L}}}\right)$$

L = ship's length between perpendiculars in [m]

x = distance from the aft perpendicular in [m]

v_0 = maximum speed in calm water in [kn], see Rules for Hull, Volume II, Section 1. v0 shall not be taken less than $\sqrt{L}$ [kn].

Table 3.4 Longitudinal acceleration factor b_ℓ

for lowermost container in cargo hold	for lowermost container on deck
$\mathbf{L} \le 120\,\text{m} : b_\ell = \left(0{,}22 - \frac{\mathbf{L}}{1710}\right) \cdot 9{,}81$ $\mathbf{L} > 120\,\text{m} : b_\ell = 0{,}15 \cdot 9{,}81$	For any length of the ship: $b_\ell = \left(0{,}35 - \frac{\mathbf{L}}{1000}\right) \cdot 9{,}81$
As for **L** and **G**, see 2.1 b_ℓ in $[\text{m/s}^2]$	min $b_\ell = 0{,}15 \cdot 9{,}81$ b_ℓ in $[\text{m/s}^2]$

4.2 Foundations / container stanchions stowage bridges for container stacks with lashing and/or twistlocks (without lateral support)

4.2.1 The stanchions and substructures are to be dimensioned, taking into account the simultaneously acting forces arising horizontally and vertically to the deck from the container (stack) stowed on the stanchions.

The vertical forces P1' and P1" are to be calculated as follows:

$$P_1' = F_H + F_V \quad [\text{kN}]$$

$$P_1'' = F_H - F_V \quad [\text{kN}]$$

$$F_H = \frac{F_{q1} \cdot h_1 + F_{q2} \cdot h_2 + ... + F_{qn} \cdot h_n}{2 \cdot B_C} \quad [\text{kN}]$$

$$F_V = \frac{(G_1 + G_2 + ... + G_n) \cdot b_t \cdot 9{,}81 \cdot \cos 30°}{4} \quad [\text{kN}]$$

P2', P3' and P4' or P2", P3" and P4" can be calculated corresponding to this formula

P1' = vertical load on the container support

P1" = lifting force

BC = 2,260 [m] for ISO-containers (8' width)

G = weight of a container including cargo

Fq = See 2.4 (for outside stacks the wind loads have to be considered)

h = height to the centre of gravity of the container [m].

The centre of gravity is to be set to 0,45 × container height.

k = see 2.3

$$b_t = k \cdot \left(1 + \frac{70}{\mathbf{L} + 70}\right)$$

= container position correction factor

If the container stacks are lashed, this will have to be taken into account, when calculating the vertical forces P" and P'.

The most unfavourable dislocation on the stanchion of the vertical force P1' is to be assumed.

P1' has to be taken into account simultaneously with the horizontal force.

$$\left(T_1 + \frac{1}{4} F_{q1}\right)$$

If the transverse component Fq at the lower edge of the 1st container layer is not intended to be determined separately, a maximum value of 210 kN is to be assumed.

In cases where the bending strength of the stanchions is smaller in longitudinal than in transverse direction, also the action of the maximal longitudinal force according to 3. (the container stack weight has to be taken) is to be considered. The vertical force acting simultaneously in this case is to be taken as P1'.

4.2.2 Container stanchions provided only with a sliding plate, respectively an athwartships arranged "dove tail base" at their upper end are to be dimensioned according to vertical loads as to 4.2.1 and to horizontal friction forces resulting from these vertical loads. The horizontal force, however, need not be taken greater than the one producing a deflection equal to the maximum possible dislocation of the container (usually, abt. 7 mm). In case of major deformations of hatches - e.g. with long hatches - they are to be taken into account in connection with horizontal shifting (friction coefficient μ = 0,25 for cast/steel, μ = 0,50 for steel to steel, other combinations upon agreement).

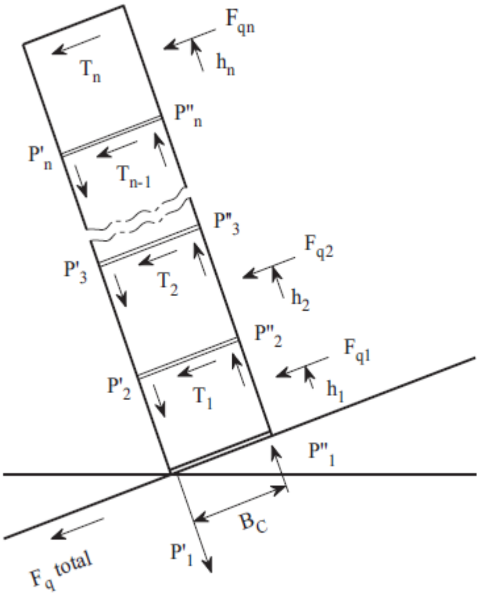


Fig. 3.2

4.2.3 Where lashings are arranged at the stanchions, the stanchions are to be dimensioned also according to the vertical and horizontal loads resulting from the lashing forces.

4.2.4 Detached stanchions are to be designed so that shocks occurring during normal loading operations can be safely absorbed.

4.2.5 In the event of major hatch deformations it will also have to be taken into account that the containers arranged on the stanchion and the cover and/or between 2(two) covers do not resist the shifting forces.

4.3 Container foundations

Container foundations welded on and/or welded in have to be dimensioned analogously to 4.2.

It will have to be ensured that the vertical force is properly introduced into the foundation through the twistlock casing and/or the stacking cone. Thus, in the event of loads exceeding 600 kN (700 kN max. pressure for twistlock at 1st tier top and higher) the minimum surface of direct pressure transmission of the twistlock (i.e., the web surface of the corner fitting covered by the twistlock foundation plate) is to be 25 cm².

Note

At twistlock foundations with elongated ISO holes an even larger base is recommended in the sense of a longer life time.

Depending on the container weights, the stacking heights and the accelerations, lifting forces occur at the foundations. In view of this, the foundation structure, including its substructure, will have to be dimensioned satisfactorily. (For calculation and maximum admissible lifting forces at the container corner fitting, see 4.4).

Foundations welded in to the ship's longitudinal main structures (strength deck, inner bottom, etc.) the strength of the structural stress has to be considered for the sizing of the foundations.

4.4 Lifting forces at container castings and container foundations

4.4.1 Where the arrangement of the container stacks is such that tilting may occur, the forces induced in the lashing elements thereby are to be specially considered.

Also it will have to be checked, whether in case of securing of the containers by twistlocks only (racking force T1≤ 150 kN) the admissible SWLs (tension) of the twistlocks and of the container foundations are not exceeded.

The maximum admissible tensile load at the container corner fitting is 250 kN, so that twistlocks and foundations can be designed for this value.

The lifting forces P" are to be determined according to 4.2.1 (see Fig. 3.2).

If the admissible value for the container corner fittings of 250 kN is exceeded, relevant measures (additional lashings, reduction in container weights, etc.) will have to be taken to ensure observance of the admissible load.

Up to a calculated remaining lifting force of 375 kN a vertical lashing can be applied for balance of the forces. This lashing shall be "loose" to equalize the clearance of 10 mm in the twistlock. This equalization could also be done by spring-elements.

4.4.2 Substructures for container foundations are to be determined according to the Rules for Hull, Volume II.

4.5 Permissible stresses

The following permissible stresses are observed for supports, foundations, etc.:

$$\sigma_N = \frac{R_{eH}}{1,25}$$

$$\tau = \frac{R_{eH}}{2,5}$$

$$\sigma_v = \sqrt{\sigma_N^2 + 3\tau^2} = \frac{R_{eH}}{1,13}$$

σ_N = perm. normal stress [N/mm2] (tension, compression, bending)

τ = perm. shear stress [N/mm2]

σ_v = perm. equivalent stress [N/mm2]

ReH = reference yield point of the material used (see B.2.2) [N/mm²]

It has to be observed that transitions into the deck, into longitudinal coamings etc. shall be built sufficiently smooth in order to avoid peaks of tension.

5. Determination of the forces in the lashing system

5.1 The lashing forces as well as the forces taking effect in the container transverse framework follow from the elastic deformation of the lashings and the transverse frames, from the shifting, if any, of the containers and from the pre-stressing, if any, of the lashings.

5.2 Forces and deformations

The determination of the racking loads T and the lashing forces Z is shown by means of a simple example (see Fig. 3.3). In this connection, the deformations of the container and the lashing elements at the various lashing points are on principle equated to one another with any possible shiftings being taken into account. There from results a set of equations for the unknown lashing forces and racking loads.

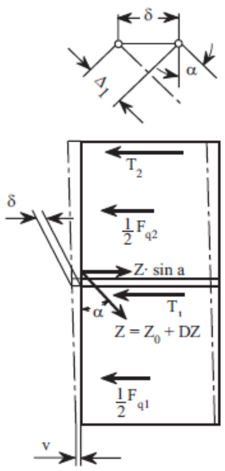


Fig. 3.3

$$T_1 = \frac{1}{2} F_{q2} + 0{,}225 F_{q1} - \sin\alpha \left(Z_0 + \Delta Z\right) \quad [\text{kN}]$$

(Fq1 and Fq2 = transverse forces, see 2.)

Z_0 = pre-stressing (see 1.1)

$$\Delta Z = \delta \cdot E_z \cdot \frac{A}{\ell} \cdot \sin\alpha \quad [\text{kN}]$$

(lashing force alteration due to external forces Fq)

A = effective cross-section of lashing [cm²]

Ez = overall modulus of elasticity of lashing

For lashing steel bars (including tensioning device and eye) depending on composition the following values can be used:

$$E_z = 1{,}4 \cdot 10^4 \div 1{,}9 \cdot 10^4 \quad \left[\text{kN/cm}^2\right]$$

Unless the documentation submitted contains any data to the contrary, BKI will base their lashing computations on the following values:

ℓ_1	1st layer top	354 cm	α = 43°
ℓ_2	2nd layer bottom	365 cm	α = 41°
E-module lashing rod		$1{,}4 \cdot 10^4$ [kN/cm²]	

ℓ_3	2nd layer top	560 cm	α = 24°
ℓ_4	3rd layer bottom	575 cm	α = 22°
E-module lashing rod		$1{,}75 \cdot 10^4$ [kN/cm²]	

ℓ_5	3rd layer top	710 cm	α = 19°
ℓ_6	4th layer bottom	725 cm	α = 18°
E-module lashing rod		$1{,}9 \cdot 10^4$ [kN/cm²]	

c_z = spring constant of lashing

$$c_z = \frac{E_z \cdot A}{\ell} \quad [\text{kN/cm}]$$

Hence

$\Delta Z = \delta \cdot c_z \cdot \sin\alpha$ [kN]

ℓ = length of lashing [cm]

Z = $Z_0 + \Delta Z$ = total lashing force [kN]

$\delta = c_c \cdot T1 + v$ = transverse dislocation at upper edge of container

c_c = resilience of the container transverse frame; where the resilience values of the containers to be stowed are unknown, the following mean values may be used for steel frame containers:

Door frame [cm/kN]	Front wall frame [cm/kN]
$2{,}7 \cdot 10^{-2}$	$0{,}60 \cdot 10^{-2}$

In case of aluminium containers, the values of cc are to be specially agreed.

5.3 Load attacking angles between 40° and 45° the max. SWL is 230 kN, at angles between 20° and 25° 270 kN. In vertical direction the corner casting may be loaded with 300 kN. If corresponding technical proof is given. The max. SWL can be risen up to 300 kN for other load angles.

6. Shoring of containers in the cargo hold - determination of the forces

6.1 Permissible loads on the corner fittings

6.1.1 In cases where the shoring forces are determined according to 6.3, the admissible forces are as follows:

at the upper corner fittings:

– 250 kN tension/compression

at the lower corner fittings:

– 400 kN tension/compression

Where containers are stowed that may not be stressed by the loads mentioned above on account of their type of construction, the maximum lateral shoring loads shall be adequately reduced (see also ISO 1496/I).

6.1.2 In general, in the longitudinal direction of the containers, the supporting forces as listed below shall not be exceeded:

At the upper corner fittings:

– 125 kN tension/compression

(only for closed type containers, so-called box containers).

For tank containers, open-top containers, open-side containers and platform-based containers:

– 75 kN tension/compression

At the lower corner fittings:

– container weight

6.2 Calculation in case of containers forming a block

Where several rows of containers, connected with double cones horizontally are to be supported, the shoring force F_q is to be determined according to 6.3.

Where the number of rows is greater than 4, the forces H may be reduced by the following factor f_r:

$$\text{if } (n - m) \le 4, \text{ the factor } f_r = 1 - \frac{(n - 4)^2}{2 \cdot n \cdot m}$$

$$(n - m) > 4, \text{ the factor } f_r = \frac{8 + m}{2 \cdot n}$$

If the container block is not complete i.e. tanks in fore ship region, the container layers m, respectively the container stacks n are to be determined as follows:

number of layers m:

1. biggest number of layers of the Section considered / 3 = result A
   (complete numbers without decimals only)

2. Original total number of layers to be reduced by result A.

   The layers that have less rows than A are deleted.

   This gives the new number of layers.

number of stacks n:

1. new number of layers (see above) / 2 = result B
   (complete numbers without decimals only)

2. Stacks are to be neglected, which layers are smaller or equal to result B.

Tank steps still existing are not considered.

The newly determined number of layers and stacks are to be inserted into the formula for the reduction factors.

m = number of container layers

n = number of container stacks to be supported at the respective shoring point.

Where 2 (two) opposite shoring points are designed to act simultaneously in tension and compression, n shall only be taken as half the number of piles.

Reduction is admissible only if the requirement

$$0{,}3 \cdot m \cdot G \cdot 9{,}81 \cdot (1 - fr) \leq 150 \text{ kN}$$

is met.

6.3 Rigid shoring

Where a largely rigid shoring of the containers may be assumed on account of the ship's construction under consideration, the shoring loads may be determined to a sufficient degree of accuracy as follows (example):

$$E = F_q = \frac{e}{2} \cdot 9{,}81 \cdot G \cdot b_q \cdot k \cdot f_r$$

number of containers to be supported

G = Container gross weight in tons [t]

Bq = transverse acceleration factor in hold according to 2.1 respect. 2.2

k = factor for container position acc. to 2.3

f_r = Reduction factor to 6.2

In the following the number of containers to be supported is demonstrated basing on a block with 2(two) supports, 5 (five) layers and x stacks.

The load from the container layers is to be distributed ideally to the supports.

Hence the load from both uppermost container layers (see Fig. 3.4) can be distributed in equal shores to both supports. Both supports are loaded with

$$F_q = \frac{2 \cdot \text{number of stacks}}{4} \cdot 9{,}81 \cdot G \cdot b_q \cdot k \cdot f_r$$

Additionally the lower support is loaded with the proportional share from the 3 (three) lower container layers. These loads go equally into the lower support and into tank top with:

$$F_q = \frac{5 \cdot \text{number of stacks}}{4} \cdot 9{,}81 \cdot G \cdot b_q \cdot k \cdot f_r$$

Remaining shear forces are transmitted into the double bottom.

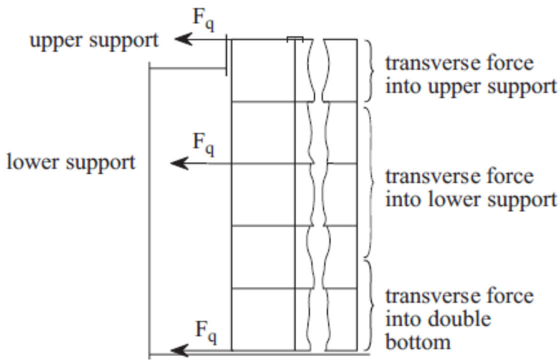


Fig. 3.4

7. Safety factors for container lashing elements

safety factor in general : $\upsilon_{Br} = 2{,}0$

for lashing ropes applies factor : $\upsilon_{Br} = 2{,}25$

for lashing chains applies factor : $\upsilon_{Br} = 2{,}50$

7.1 Above factors apply for rigid fittings that are imposed by tension, pressure and bending.

See also Annex D.

B. Design of the Cell Guide Structures

1. General

1.1 Shoring structures may be constructed in accordance with the following guide lines.

Necessary calculations may be carried out with suitable computer programs. In this case the computer model, the boundary conditions and load cases are to be agree upon with BKI. The calculation documents are to be submitted including input and output.

1.2 Where parts of the cell guide structures are also components of the ship's hull, the Rules for Hull, Volume II shall be taken into consideration as well.

2. Permissible stresses

2.1 The resultant stresses calculated shall not exceed 88 %, the shear stresses alone, 44 % of the reference yield point of the material used.

2.2 Reference yield point

The reference yield point is the value which shall be taken as a basis for the calculation. A distinction is to be made:

– If the yield point of the material of a structural member has not been determined by test, there shall not be used a value exceeding 0,6 of the tensile strength of the material.

– If the proven yield point and the nominal yield point of the material of a structural member exceeds 0,7 of the tensile strength, only 0,7 of this strength may be taken into account.

2.3 In this connection the lower limit of the nominal tensile strength of the material is considered as tensile strength.

2.4 Safety against buckling

The safety against buckling of cross tie sections in cell guide structures with compressive loads shall be proofed as follows:

The sectional area of tie bars is not to be less than:

$$A_{s\,req} = 10 \cdot \frac{P_s}{\sigma_p} \quad \left[cm^2\right]$$

σp = permissible compressive stress [N/mm^2]

As = sectional area of tie bar [cm^2]

Ps = tie bar load [kN]

κ = reduction factor

$$= \frac{1}{\phi + \sqrt{\phi^2 - \lambda_s^2}}$$

$$\phi = 0{,}5\left[1 + n_p\left(\lambda_s - 0{,}2\right) + \lambda_s^{\,2}\right]$$

= 0,34 for tubular and rectangular profiles

= 0,49 for open sections

λ = degree of slenderness of the tie bar

$$= \frac{\ell_s}{i_s \cdot \pi} \cdot \sqrt{\frac{R_{eH}}{E}} \geq 0{,}2$$

ℓs = length of the tie bar [cm]

E = modulus of elasticity [N/mm^2]

i_s = radius of gyration of the tie bar

$$= \sqrt{\frac{I_s}{A_s}} \quad [cm]$$

I_s = smallest moment of inertia of tie bar cross section [cm^4]

S = safety factor

= 1,4 for $\lambda_s \leq 1$

= 1,65 for $\lambda_s > 1$

3. Load athwartships

3.1 Amount of load

The force Fq as to A.2. shall be taken to be the load of each container to act upon the cell guide structure.

It may be assumed that 1/4 Fq is transmitted to the cell guide structure through each of the four corner fittings of one longitudinal side wall of the container.

3.2 Cross ties

3.2.1 Cross ties rigidly connected at their ends to the hull

The outer cross tie sections shall be designed for absorbing such compressive and tensile loads as result from half of all stacks of containers placed side by side. Where necessary, a check shall be made to determine whether additional compressive and/or tensile loads due to transverse deformations of the ship's hull shall be absorbed by the cross ties.

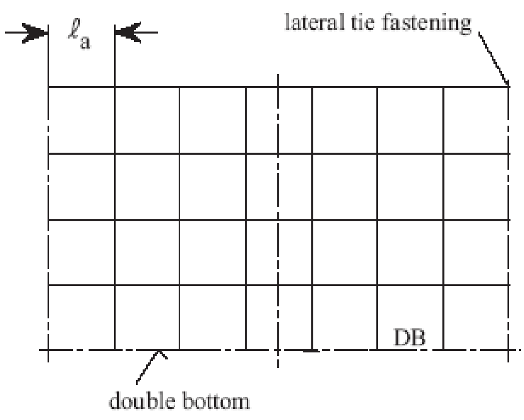


Fig. 3.5

The clear effective (buckling) length s_K results from:

– For welded connections : $s_K = 0{,}7 \cdot \ell a$

– For screw connections and suspended structures : $s_K = \ell a$

The inner cross tie rods may be designed to be weaker according to the loads occurring. Slenderness ratio $\lambda \leq 250$.

3.2.2 Cross ties not connected with the hull

The loads acting upon the members of the structure shall be determined by a frame computation (see 1.). The computation for buckling shall be done as indicated in 3.2.1.

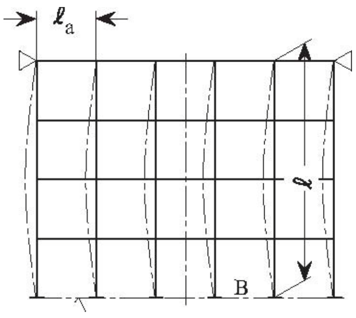


Fig. 3.6

3.3 Vertical guide rails

In case of non-displaceable end and intermediate shoring points (see Fig. 3.6), the rails shall be considered, for the calculations, as continuous girders simply supported at both ends. In case of a shoring system as to Fig. 3.6, the total horizontal load acting upon each cross tie is distributed among the vertical guide rails according to their rigidity values

$$k_i = \frac{I_i}{\ell_1^3}$$

(In the example, Fig. 3.6, all the lengths ℓ_i would be the same.)

Load on each rail at the cross tie level:

$$P_i = \sum P_q \cdot \frac{k_i}{\sum k} \quad [\text{kN}]$$

P_q = total transverse force per cross tie

Σk = sum of the rigidity values of all vertical guide rails

3.4 Lateral supporting rails

The forces as to A.6. shall be used in the design of these rails.

4. Load fore and aft

4.1 Amount of load

The force F_ℓ as to A.3. shall be taken to be the load of each container to act upon the cell guide structures.

It may be assumed that 1/4 F_q is transmitted to the cell guide structure through each of the 4 (four) corner fittings of the front or door wall of the container. Reductions due to friction between container layers are not permissible.

4.2 Longitudinal ties

The effective compressive and tensile loads follow from the load assumption as to 4.1 and the number and arrangement of the longitudinal ties. For compression members the slenderness ratio shall not exceed 250. The true tie length shall be taken for the effective length subject to buckling.

The longitudinal ties shall be so connected to the ship's hull that they will not absorb any considerable compressive and tensile stresses resulting from longitudinal bending stresses the ship is exposed to.

4.3 Cross ties

Where the longitudinal forces are to be absorbed by the cross ties only, the same shall be designed to withstand the bending and shearing stresses occurring. The distribution of the loads acting upon the transverse girder follows from the arrangement of the vertical guide rails.

A load distribution as to Fig. 3.7 throughout the length of the cross tie may be assumed as well.

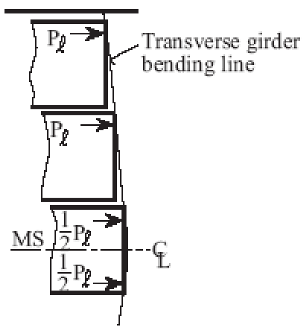


Fig. 3.7 Load distribution throughout cross tie

5. Vertical load

For the purpose of designing vertical guide rails which also are to support hatch covers or deck parts or similar parts loaded with containers, the loads shall be determined including the acceleration factor "b_v" according to A.4.1.3. The scantlings resulting for the structural members shall not be taken less than those following from Rules for Hull, Volume II, Section 10, C.

Section 4

Materials, Welding and Tests

A. Materials and Constructional Parts

1. Manufacture and testing

1.1 Works approval

Materials and constructional parts for cell guides and lashing elements may only be supplied by manufacturers approved by BKI in this respect. Approval shall be applied for in writing to BKI and will be granted, as a rule, on basis of an inspection of the works and approval tests of the products. The scope of testing will be laid down in this respect from case to case.

1.2 Requirements for the materials, quality evidence

All materials and constructional parts decisive for the strength of the buttress and cell guide structures as well as lashing elements shall satisfy, in respect of their quality characteristics, the Rules for Materials, Volume V, be tested in the presence of the Surveyor and be certified by BKI according to the Rules for Materials, Volume V, Section 1, H.1.2 and 3.1 respectively.

Where parts not welded to the ship's hull or not relevant for the ship's strength are concerned, testing by the manufacturer with a Certificate according to the Rules for Materials, Volume V, Section 1, H.1.2, e.g. an acceptance test Certificate 3.1 as to EN 10204, may be consented[1].

The material records shall contain specific details on the manufacturing procedure, composition, heat treatment, mechanical properties and marking.

Relevant equivalent Certificates can be recognized. Inspection of constructional parts:

All parts shall be made available to the Surveyor for an inspection of their surface condition and a dimensional check. The dimensional checks and - in case of piece numbers above 100 - also the visual inspection will be carried out at random. On request of the Surveyor non-destructive tests are to be carried out, e.g.ultrasonic, x-ray or surface crack indication tests.

1.3 Retests

Where no or insufficient material records are furnished for the materials and/or individual parts or if the association with the test Certificates is insufficient, BKI may call for retests to be carried out under their supervision. The kind and scope of the tests will be laid down from case to case in conformity with the Rules for Materials, Volume V.

1.4 Selection and materials

The selection of materials shall be done taking all qualities into account, a confirmation of BKI is done normally by the drawings approval.

1.5 Marking

Materials and fittings shall be marked by the manufacturer in such a way that an unobjectionable identification can be done by the material Certificates. Materials tested by BKI are stamped additionally according to the Rules for Materials, Volume V, Section 1, F.

Cast steel and forged pieces are to be marked with the manufacturer's identification, short identi-fication of the kind of cast and a marking respect. Identification number for the charge (i.e. last 3 (three) numbers of the charge number). Additional markings can be agreed between manufacturer and customer.

2. Approved materials

2.1 Materials for cell guides, blind frames and similar structures

Plates, sections, bars and pipes for cell guides and blind frames, container stanchions and similar structures shall be in accordance with the Rules for Materials, Volume V, Section 4.

The materials shall fulfill the requirements of the minimum impact strength of the Rules mentioned before.

Table 4.1 furnishes a summary of permissible BKI-shipbuilding steels and comparable steels acc. to EN 10025-2. Steels from other norms may be used if equivalent to those listed in the Table, if it can be proved that they are suitable for welding and if they

[1] Lashing elements welded on hull are in general of minor importance to ship's strength and are normally sufficiently certified by a material certificate 3.1 according to EN 10204 .

meet the requirements of the Rules for Materials, Volume V, Section 4, C.2.3.

Table 4.1 Materials for cell guides, container stanchions and similar structures (excerpt of properties required)

Hull structural steels [1]			Comparable structural steels [2]			
Grade	Min. yield point [N/mm²]	Tensile strength [N/mm²]	Steel quality acc. to EN 10025-2 and EN 10025-3	Min. yield point R_{eH} [3] [N/mm²] t ≤ 16 mm	Min. yield point R_{eH} [3] [N/mm²] 16 < t ≤ 40 mm	Tensile [3] strength Rm [N/mm²]
KI-A	235	400 - 520	S 235 JR	235	225	360 - 510
			S 275 JR	275	265	410 - 560
KI-B			S 235 J0	235	225	360 - 510
			S 275 J0	275	265	410 - 560
KI-D			S 235 J2	235	225	360 - 510
			S 275 J2	275	265	410 - 560
KI-E			S 275 NL	275	265	370 - 510
KI-A 36	355	490 - 630	S 355 J2	355	345	470 - 630
KI-D 36			S 355 K2			
			S 355 N			
KI-E 36			S 355 NL			

1 For more requirements, see Rules For Materials, Volume V.

2 Extract from the standards EN 10025-2 and EN 10025-3 respectively.

3 When dimensioning the components, possibly, the lower yield points or tensile strengths - depending on steel quality and/or thickness of products - have to be considered by increasing the cross sections accordingly.

2.2 Materials for stowage- and lashing fittings above or below weather deck

The steels shall fulfill following requirements:

- The steels shall be killed and fine grain treated.
- All products shall be heat treated, that means normalised or quenched and tempered.
- The steels shall fulfill the requirements for impact strength mentioned in the Standards and approved specifications respectively, at least fulfill the requirements mentioned in Table 4.2.
- Unalloyed steels intended for welding shall not have a higher carbon content than 0,22 % (ladle analysis)
- If the type of product requires it, additional non destructive test can be required.

Proof of impact energy is to be given for the temperatures at ISO-V specimen.

Table 4.3 gives an overview of the materials to be used for stowage- and lashing fittings.

Table 4.2 Minimum values of impact energy for stowage and lashing fittings above and below the weather deck

Product from	Impact energy KV[1] [J] min longitudinal	Impact energy KV[1] [J] min transverse	Test temperature for materials with usage above weather deck [°C]	Test temperature for materials with usage below weather deck [°C]
Rolled products[2] $R_{emin} \geq 235$ N/mm²	27 (19)	20 (14)	– 20	± 0
Rolled products[2] $R_{emin} \geq 355$ N/mm²	34 (24)	24 (17)		
Forged steels	27 (19)			
Cast steels	27 (19)			
Nodular cast iron	14 (11)			

[1] Obtained from ISO-V-specimens as an average value from three tests. One of these values may occur as the lowest individual value; see data indicated in brackets.

[2] Plate, section, bar

Table 4.3 Materials for stowage and lashing fittings

Type of product, standard	Steel- or casting grade
Structural steels acc. to Rules for Material, Volume V	KI-D, KI-D 32 KI-D 36, KI-E KI-E 32, KI-E 36
General steels EN 10025-2	S 235 J2 +N S 275 J2 +N S 355 J2 +N
Fine grain steels suitable for welding acc. to EN 10025-3	basic qualities (N) tough at sub-zero temperatures (NL)
Cast steel DIN 1681 DIN 17182	GS-38 GS-45 GS-52 GS-16Mn5 GS-20Mn5
High temperature steel castings DIN 17245	GS-C 25
Low-temperature steel castings SEW 685	GS-21Mn5 GS-26CrMo4
Quenched temperature steel castings EN 10083	41Cr4 42CrMo4
Nodular cast iron EN 1563	EN-GJS-400-18-LT

Use of the grades KI-A, KI-B and S235JR, S235J0, S275JR, S275J0, S355JR respectively and S355J0 (EN10025-2) according to the Rules for Materials, Volume V, Section 4,B. and C. is not permitted.

If stowage and lashing fittings are fabricated from materials according to EN 10025-2 and EN 10025-3 by hot forming, the requirements as regards chemical composition of the Rules for Materials, Volume V, Section 4, C.2.3.1 are to be observed.

If an impact strength of 14 (11) Joule at – 20 °C is proofed for nodular cast iron of grade EN-GJS-400-18-LT, it can be used for fittings for service above and below deck. Nodular cast iron shall not be used for dynamically high loaded fittings (bottom twistlocks, midlocks etc.).

The temperature at which the necessary impact strength values are proofed is to be chosen with – 20 °C for above-deck and with 0 °C for below-deck service.

2.3 Materials for lashing chains

For manufacture of lashing chains preferably fully killed steels (e.g. 21 Mn 5, 27 Mn Si 5) according to DIN 17115 or equivalent steels shall be used. The grade RSt 35-2 may be used after special approval. Where the material grade and the welding procedure so require, the chains are to be properly heat treated.

B. Welding

The following summarises the most important quality assurance measures to be observed and/or to be taken during welding. The scope of quality assurance measures is to be brought into conformity with the production. For any additional requirements having to be imposed the Rules for Welding, Volume VI and Rules for Hull, Volume II, Section 19 apply analogously.

1. Conditions in respect of workshops

1.1 Works' approval

Works and shops, subsidiaries and also sub-contractors intending to carry out welding work on container lashing elements shall be approved by BKI in this respect. The approval is to be applied for at BKI head office with the following statements and particulars:

– description of the workshop

– materials used

– welding procedure and consumables

– welding personnel

– test equipment as far as available

1.2 Facilities

The works and shops shall avail themselves of the necessary facilities permitting expert and perfect welding. Such facilities are, inter alia, working places protected against atmospheric influences, machinery and equipment for an expert preparation of the welding joints, reliable welding machinery and equipment, stationary or portable drying spaces or cabinets for storing the welding filler metals and consumables.

1.3 Welding jigs

For assembly and welding, it is recommendable to use jigs in order to ensure correct dimensions of the structural parts. The jigs shall be of such a configuration that the weld seams are easily accessible and can be welded in the most favourable position possible (see also 5.1 and 6.5). Tack or temporary welding shall be avoided wherever possible.

2. Welders, welding supervision

2.1 Welder's qualification test

All welding work on container lashing elements may only be carried out by BKI-recognized welders examined in connection with the welding process in question. For manual arc welding and semi-mechanized gas-shielded welding on stowage or lashing fittings as well as on the hull only welders are permitted, who have qualified according to EN 287 respect. ISO 9606 and, additionally, fulfil the Rules for Welding, Volume VI, Section 3.

Welders to be employed for special grade structural steels shall have qualified by analogy with the Rules for Welding, Volume VI, Sect. 3. or in a corresponding qualification group as to EN 287 and ISO 9606 respectively. Equivalent welder's qualification tests on the basis of other Rules or Standards may be recognized.

2.2 Welding supervisors

Each workshop carrying out welding work shall have in its employ a welding supervisor whose professional qualification shall be evidenced. Depending on the type and scope of the welding work to be carried out, welding supervision may be effected by, e.g., a welding specialist or a graduate welding engineer. Changes in respect of the welding supervisors shall be communicated to BKI without any prior request to do so. The welding supervisor(s) shall responsibly supervise the preparation for, and execution of, the welding work.

3. Welding processes, procedure tests

3.1 Evidence of suitability

Only welding processes shall be used the suitability of which has been proved in a procedure test.

As to welding procedure tests for the flash butt welding and friction welding see Appendix C.

3.2 Application, execution

The execution of a procedure test in order to extend the approval according to 1.1 is to be applied or at BKI Head Office with the following statements and particulars:

– description of the procedure and the equipment (if possible also pictures, leaflets or similar)

– particulars of the procedure (preparation of seams, welding data, etc.)

– materials to be welded and dimensions of the parts to be connected

– welding consumables to be used and auxiliaries

– subsequent works, if applicable

– subsequent heat treatment data, if applicable

– intended testing during manufacture

– place and time of procedure testing

Welding of samples and testing is to be done under supervision of BKI.

3.3 Scope of testing, requirements, welders

The scope of testing, test pieces and specimens, and requirements will be laid down, by analogy with the Rules for Welding, Volume VI, Section 12 from case to case in accordance with the application range applied for. Welders employed in procedure tests are considered qualified in the welding technique concerned and/or for the respective materials, provided that the procedure tests have been successfully completed. Where further welders or operator groups are to be employed with the procedure application range enlarged later on, the welders or operator groups shall be adequately trained and tested.

4. Welding filler metals and consumables

4.1 Approval and range of application

All welding filler metals and consumables (such as rod electrodes, shielded-gas welding wires etc.) shall have been approved by BKI in accordance with the Rules for Welding, Volume VI, Section 5. The required quality grade depends on the base materials to be welded.

5. Design of weld joints

5.1 General principles

The weld joints shall be designed from the beginning in such a way that they be easily accessible during manufacture and can be made in the most favourable welding sequence and welding position possible (see also 6.5), care being taken that only the least possible residual welding stresses and distortions will remain in the constructional components after manufacture. Small distances of the welded joints from 1 (one) another and local accumulations of welds shall be avoided.

5.2 Weld shapes

Butt weld joints (such as I, V or X seams) and corner or cross joints (such as single-bevel butt joints) shall be designed in such a way that the full plate or shape cross section is fused. In order to achieve this, the constructional components shall be prepared with adequately chosen weld shapes as to the standards being given a sufficient angle between the planes of the fusion faces, a sufficient air gap, and the smallest possible depth of the root faces in accordance with the plate thickness. Special weld shapes require BKI approval; where necessary, the weld shapes are laid down in connection with a procedure test.

5.3 Fillet welds

Fillet welds shall, in zones of high local stress (i.e. load introductory zones), whenever possible, be so designed as to be continuous on both sides. Only fillets continuous on both sides or intermittent fillets shall be provided at especially corrosion endangered parts (i.e. exposed to sea water) where the fillets being led around the stiffener or scallop ends to seal them. The fillet throat depends on the stressing in each case, and proof calculations of its sufficiency shall be furnished in cases of doubt. The "a" dimension (throat thickness) shall not exceed 0,7 t (t = thickness of the thinner part) nor be less than 3,0 mm.

5.4 Overlapped welds

Overlapped weld joints (instead of butt-seam connections) shall only be used in connection with structural parts subject to small loads and only be arranged, wherever possible, in parallel to the direction of the main stress. The overlap width shall be at least 1,5 t + 15 mm, as t being the thickness of the thinner plate. The fillets shall be made in accordance with 5.3.

6. Manufacture and testing

6.1 Welding preparation

The constructional components shall be dry and clean in way of the weld. Any scale, rust, flame cutting slag, grease, paint (with the exception of permitted over-weldable production coatings), and dirt shall be thoroughly removed prior to welding.
Where plates, shapes or constructional components are provided with a corrosion-reducing production coating (shop-primer) prior to welding, this coating shall not affect the quality of the welded joints.

6.2 Assembly

When preparing and fitting together the constructional parts, care shall be taken to meet the specified weld shapes and gap widths (air gaps). Where the permissible gap width is slightly exceeded, the same maybe reduced by deposit welding on the fusion faces of the joint. Filling pieces or wires shall not be welded in.

6.3 Alignment of constructional components
Plates and shapes shall be accurately aligned, in particular in structures interrupted by crossing members. A displacement of the edges relative to 1(one) another of more than 15 % of the plate or shape thickness, but maximum 3 mm, the lesser figure being applicable, is not acceptable.

6.4 Protection against atmospheric influences
During welding operations, the area where work is carried out shall be protected against atmospheric influences. In cold air (below 0°C), suitable measures shall be taken (covering, heating the constructional components) to ensure satisfactory

execution of the weld joints. Welding shall cease at temperatures below -10° C. Any rapid cooling - in particular in the welding of thickwalled parts or steels susceptible to hardening - shall be avoided.

6.5 Welding position and sequence

Welding work shall be carried out in the most favourable welding position possible. Welding in vertical downward position shall be avoided wherever possible and shall not be applied to connecting load-bearing components, not even after a procedure test for vertical downward welding in general and irrespective of the approval of welding consumables. A suitable welding sequence shall be chosen to ensure the least possible restriction of the weld seam shrinkage.

6.6 Workmanship

In welding operations, care shall be taken to achieve uniform penetration, perfect fusion down to the root, and uniform, not excessively convex weld surfaces. In multi-pass welding, slag having originated from the preceding runs shall be thoroughly removed. Cracks (including broken tack welds),larger pores or slag inclusions etc. are not to be welded over but shall be gouged out.

6.7 Repair of defects

The repair of major workmanship defects may only be carried out after consent of BKI has been obtained.

6.8 In-shop control

Workmanlike, perfect and complete execution of the welding work shall be ensured by a close control by the works or shop concerned. BKI will check the welds at random during fabrication and, where necessary, during the final inspection after completion. BKI is entitled to reject insufficiently checked constructional components and require their being tendered a new for inspection after successful in-shop control and completion of any repairs necessary.

6.9 Weld seam testing

BKI is entitled to demand additional non-destructive tests to furnish evidence of a satisfactory weld quality, to be carried out on important structural parts. The type and scope of the tests will be laid down by BKI from case to case.

Appendix A

Instruction for The Performance of Inspections and Surveys of Containers Lashing Element

A. Performance of Inspections

1. General

1.1 All components for container stowage and lashing elements are in principle subject to testing in accordance with the following requirements. The testing and inspections required are to be carried out at manufacturers', prior to delivery.

1.2 The scope and type of testing shall comply with the requirements of items 1., 2. and 3. below. Where deemed necessary, deviations there from may be admitted upon agreement with BKI.

1.3 In general, proofs of materials as defined in item 2. below are to be furnished for the components presented for testing. Where such proof cannot be presented, in agreement with BKI Head Office, a subsequent material test is to be carried out. To this effect, the relevant components are to be marked unmistakably.

1.4 Generally with the test, the drawings approved by BKI have to be presented to the Surveyor.

1.5 All components exposed to tension/ compression are to be subjected to load tests, see 3. For this purpose, at least 2 % of the items delivered are to be selected and subjected to the test load prescribed to which the component shall be able to resist without cracks or permanent deformations occurring. If the test reveals any deficiencies, the Surveyor may extend the scope of testing at his own discretion. Any deficient parts are to be eliminated.

Where a series consists of less than 50 parts, at least 1 (one) of them is to be load tested. Where a manufacturer repeatedly produces minor series of equal parts at certain intervals, proof of quality is to be furnished by load testing of each individual series.

1.6 The parts to be subjected to the test load to be arranged on/clamped into the test bench in a manner corresponding to onboard conditions.

For fittings which have to be welded-in for the purpose of testing and which therefore cannot be used anymore after testing, the scope of testing may be reduced. For this an acceptance test is to be presented, not older than 12 month. Furthermore a type Certificate of BKI shall be presented for these fittings.

1.7 Where a lashing element is composed of several components (e.g. turnbuckles, twistlocks) supplied by different manufacturers, testing has to be carried out upon final assembly. For components not subject to load testing, only proofs of materials as defined in item 2. below are to be furnished by the subcontractors.

1.8 In case of doubt, the Surveyor is entitled to have testing carried out beyond the prescribed scope, e.g., additional materials tests.

1.9 Break-load-tests are carried out in conjunction with the type test (see 3.). Break-load-test are to be repeated depending on production numbers upon agreement with the Surveyor, however, latest after 5 years.

1.10 Kinds of testing

1.10.1 Testing on a lot basis

In general, testing is carried out by lots, combining into 1 (one) testing unit elements manufactured by the same process, from the same material and in the same form. The Surveyor will select not less than 2 % of the parts of each lot and check these for their surface finish and accuracy to size and tolerances.

1.10.2 Testing on a piece basis

Where testing on a piece basis is required, e.g. on account of the kind of element, special agreements will have to be reached between manufacturers and BKI.

2. Special test

2.1 Cell guides are to be controlled for measurements after installation. A function test has to be done as a random check with containers or a corresponding pattern.

2.2 Generally a material-test Certificate of a neutral institution of the maker has to be presented with the test. Welded-in lashing elements, that are welded into ship structures which are important for ships strength, require a BKI Certificate. The welded-in plates shall reach at least the characteristic values of the plates where they are welded into. Exceptions have to be agreed upon with BKI Head Office.

2.3 Welded fittings have to be randomly checked for welding thicknesses aside of the normal welding seam examination (especially with container foundations).

2.4 Welding-in foundations (pots)

All welding-in pots have to be checked for tightness (proof by makers Certificate). BKI reserves the right to be present at this test. Exceptions shall be arranged with BKI Head Office.

3. Load tests (type test)

The table in Appendix D shows working load, test load and breaking load for the most frequent fittings, as well as the test arrangement for the load tests. The stated values are applicable in case the materials which are usual for the specific fitting are used. The test loads are calculated in accordance with the values of the table below and are to be transmitted correspondingly onto other fittings.

Container lashing fittings are also approved and tested for lower safe working loads as long as it fits into the system.

The number of necessary test- and breaking load tests for the type-test (-approval) will be stated for each fitting with the drawings approval by the BKI. For standard elements, however, at least 3(three) pieces are to be tested with break load.

On completion of the load test, an operational test shall be carried out.

Under the test load no permanent deformations or incipient cracks may occur.

The successfully carried out type test will be certified with a type-Certificate by BKI (sample see Appendix D).

A load test plus an operational test may be required for lashing appliances consisting of several individual parts the joint performance of which has not yet been proven.

4. Marking of components

4.1 General

The marking of the fittings is to be done in such a way that an identification on account of the material Certificates to be presented is possible. The stamping by the Surveyor is done after examination of the material Certificates, after visual inspection of the finished product and, if need be, the successful practical testing. In order to avoid damages to the component, the method of fixing the marking may have to be agreed upon with the Surveyor (see 4.3.5 below).

4.2 Marking by BKI stamp

4.2.1 Testing on a lot basis

Materials and components tested on a lot basis, which met the test conditions are provided with the BKI stamp.

4.2.2 Testing on a piece basis

Materials and components tested or inspected individually in accordance with the Rules and meeting their requirements will be provided with the

4.2.3 Extent of stamping

At random checks all examined fittings are stamped (2 % of the delivery). With individual inspection all parts are stamped.

4.3 Examples for marking of individual part

4.3.1 Castings are to be provided by manufacturers at least with their symbol and with a marking showing the charge or heat treatment batch. In addition, parts are to be marked as defined in 4.2.

4.3.2 Forgings are to be provided with the manufacturer's symbol and a marking showing the charge, production or heat treatment batch. In addition, parts are to be marked as defined in 4.2.

4.3.3 Parts made of rolled steels

Stamping is to be done in accordance with 4.2.

4.3.4 Lashing bars

Following the tensile test according to 4.2 each test a lashing bar is to be stamped.

4.3.5 Lashing chains

Following the tensile test each chain is to be stamped at 1 (one) end according to 4.2. In addition, following testing in accordance with the standards applicable to chains, each chain is to be stamped by manufacturers with their symbol (or identification character) as well as with the grade characteristic of the chain material employed (see DIN 685). In principle, stamping is to be effected on the un-welded side of the chain link and shall not create any deterioration of the link.

4.3.6 Lashing ropes

For marking the nominal strength of the wires, lashing ropes are to be provided with colored spun in identification threads, as follows:

– nominal strength 1570 N/mm²: red

– nominal strength 1770 N/mm²: green

Ropes tested by approved manufacturers or dealers independently and supplied with BKI approved Works Test Certificates shall additionally be provided with a spun in identification thread carrying the manufacturer's symbol or the identification No. designated by BKI.

Ropes tested in the Surveyor's presence are marked by a lead seal carrying the stamp.

5. Survey of Container Stowage and Lashing Components

5.1 This survey is required only for ships with the notation “container ship” or “equipped for carriage of containers” appended to their Character of Class.

5.2 A random survey is to be carried out on the basis of the relevant BKI Certificates carried on board to verify that only such container stowage and lashing components are used as have been approved and, where applicable, tested by BKI. Defective parts are to be replaced or repaired, as necessary. Should the result of the survey be unsatisfactory, its scope is to be increased.

Note

Loose container stowage and lashing components are generally inspected only in batches, i.e. about 2-5 % of a consignment. This means that not every unit bears a stamp mark.

5.2.1 Approved documents relating to the container equipment (container stowage and lashing plan with documentation of the various components) are to carried on board[1] and are to be presented, on request, to the Surveyor.

---

[1] Ships built before 1980 were not subject to any equipment Regulations involving the approval by BKI of individual components, so that exceptions may occur in the case of these ships.

The procedure then followed shall be analogical to the aforementioned instruction.

Where no approved stowage and lashing plans are available, it is recommended that these be prepared, approved by BKI and placed on board.

When replacement part are procured, only such stowage and lashing components as have been approved and, where applicable tested by BKI may be placed on board together with the relevant Certificates

Appendix B

Certificates of The Testand Examination of Container Stowage- and Lashing Parts

BIRO KLASIFIKASI INDONESIA

Sertifikat Uji dan Pemeriksaan
Alat Pengikat dan Pengaman Peti Kemas

Certificate of Test and Examination of Container Stowage- and Lashing Parts

No : ____________________________ Tanggal : ________________________
Date

Jumlah bagian-bagian yang dikirim *Number of Parts Delivered*	Uraian/Jenis *Designation of parts/type*	Jumlah Bagian yang diuji *Number of parts tested*	Tanggal uji *Date of Test*	Beban uji yang digunakan *) *Test Load applied* [kN]	Beban yang diijinkan *Perm. Load* [kN]
1	2	3	4	5	6

*) Beban Putus/*Breaking Load*

Material uji telah diverifikasi sesuai dengan peraturan BKI : ____________________________
Proof of materials has been noted according to BKI Rules

Nama dan alamat pembuatan atau penyalur : ____________________________
Name and address of manufacturer or suppliers

Bagian-bagian ini digunakan untuk :____________________________
The parts are intended for

No. Surat Permohonan :____________________________
Customer Order no.

No. Kontrak : ____________________________
(BKI) Contract no.

Nama dan alamat Badan atau Perusahaan atau Petugas yang melaksanakan pengujian dan pemeriksaan : ____________________________
Name and address of Society, Firm or Person having carried out the test and examination

Dengan ini menerangkan bahwa, pada ..……………………………………………………………………………………………….....
I certified that on the

Bagian tersebut diatas telah diperiksa oleh Surveyor. Beban yang diijinkan seperti ditunjukkan pada kolom (6) dengan ini disetujui
the parts listed above have been examined by Surveyor. The permited Load indicated in Column (6) is hereby approved.

Catatan :
Remarks

BIRO KLASIFIKASI INDONESIA

____

No. Form :
Form No.

Appendix C

Welding Procedure Qualification Test Flash Butt Welding or Friction Welding of Container Lashing

A. Procedure Qualification Flash Butt Welding

1. Scope and purpose

The present working sheet applies to welding procedure qualification tests for flash butt welding or friction welding of Container lashing elements. It supplements the Rules for Welding, Volume VI, as well as the "Rules for Stowage and Lashing of Containers aboard Ships" and describes the special test pieces, test specimens and requirements for proof of unobjectionable workmanship and adequate mechanical properties of the welding joints.

2. Types of joints, materials, requirements

In accordance with the state of technology and application the above procedures are mainly employed for joining lashing bars, including their end fittings, such as hooks, eyes etc., made from quenched and tempered steels 41 Cr 4 (Mat.-No. 1.7035), 25 Cr Mo 4 (Mat.-No. 1.7218) and 42 Cr Mo 4 (Mat.-No. 1.7225). As a rule their diameters are approx. 25 mm.

In most cases these steels are used in quenched and tempered condition and owing to their chemical composition are relatively susceptible to hardening. Particularly in the case of flash butt welding embattlement of the weld area is to be reckoned with, which can only be compensated by subsequent systematical heat treatment. Therefore, apart from furnishing proof of strength, the main purpose of the procedure test is to furnish proof of adequate toughness (ductility). The welding and, where applicable, annealing data shall be capable of being reproduced.

3. Test pieces and specimens

The test pieces are to be welded from known steels, for which proofs are available. If different materials are employed, the different steels are to be welded to each other and/or welded to each other in the envisaged combination. All welding and annealing data, if any, including the pertinent machine adjustment characteristics, are to be recorded. The length of the test pieces is to be taken such as to enable them to be perfectly clamped, to exclude heat accumulation and to enable sampling as required. The minimum length of test specimens is 300 mm.
For each kind and/or combination of material(s) in the presence of the Surveyor at least 6 (six) equal test pieces are to be welded, from which following a magnetic particle or dye penetration test for surfaces flaws the following specimens are to be taken:

– 1(one) round tensile test specimen according to DIN 50120 Part 2 (diameter of test specimen do =20 mm)

– 3(three) transverse bending test specimens according to DIN 50121 Part 2 (cross-section of test specimen≈ cross section of component)

– 1(one) notched transverse bending test specimen analogously to DIN 50121 Part 2 (cross-section of test specimen ≈ cross-section of component)

– 1(one) macro-etching (longitudinally) with hardness measurements (1 × at specimen centre, 1 × near surface of specimen)

In particular cases BKI may stipulate other supplementary examinations (e.g. ultrasonic test) or testing (e.g. of notch impact bending test specimens); in that case the number of test specimens will have to be increased accordingly.

4. Testing and requirements

Testing is to be effected in the presence of the Surveyor subject to the standards mentioned. The tensile strength is to be at least equal to the values fixed for the quenched and tempered condition in the materials standards for the material concerned. In the transverse bending tests using a mandrel diameter of 4 × specimen thickness, a minimum bending angle of 60° shall be reached. The bending elongation (measuring length lo = 2 × specimen thickness) is to be reported.

The notched transverse bending test specimen shall not show any welding flaws, such as pores, inclusions, cracks and the like in the broken section. The same supplies to macro-etchings. The hardness survey shall be as even as possible and shall not show any preeminent hardness peaks. The requirements for possible additional testing will be fixed from case to case.

5. Recording of results

During the test weldings all parameters essential for the constancy and quality of the weld connections are to be recorded.

In the case of flash butt welding these include:

– Welding machine (kind, manufacturer, type, output, steering mechanism, control devices, etc.)

– Basic material (kind, shape and dimensions)

– Workpiece preparation (clamping and abutting surfaces)

– Length tolerance (overlength) and clamping length

– Clamping jaws (shape and material)

– Clamping force

– Upsetting force and upsetting pressure

– Welding current and platen speed

– Welding time

– Axial reduction of parts length

– Post-heating current and time

– Removal of welding burrs

It is advisable to this effect to equip the welding machine with a device for recording the time curve of current, distance and force.

In the case of friction welding these include:

– Welding machine (kind, manufacture, type, output, steering mechanism, control devices, etc.)

– Basic material (kind, shape and dimensions)

– Workpiece preparation (clamping and abutting surfaces)

– Length tolerance (overlength) and clamping length

– Speed (number of revolutions)

– Contact pressure

– Welding time

– Axial reduction of parts length

– Removal of welding burrs

Here, too, it is advisable to record the time curve of relative speed and contact pressure and under all circumstances to equip the machine with relevant control devices.

During the tests the shapes of test specimens and their dimensions, mechanical properties achieved, findings of tests (flaws) are to be recorded and the hardness curves are to be represented graphically. The protocols are to be countersigned by the Surveyor.

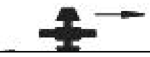
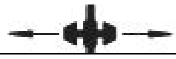
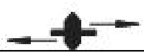
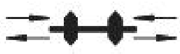
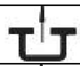
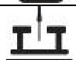
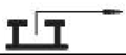
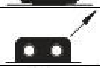
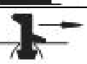
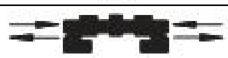
6. Literature

The literature will refer to recognized welding standards.

Appendix D

Container Lashing Fittings

A. Loads for Containers Stowage- and Lashing Fittings

Type	Test Arrangement		WL Usual Working Load [kN]	TL Test Load [kN]	min BL Breaking Load [kN]
Lashing rod			230	288	460
Lashing Chain			80	100	200
Lashing Steel wire rope			200	250	450
Turnbuckle			230	288	460
Twistlock (single)/ Midlock[1]			210	263	420
Twistlock (single)/ Midlock[1]			250	313	500
Stacker			210	263	420
Doublestacker		Deck	200	250	400
		Hold	560	620	730
Flush socket			250	313	500
Pedestal socket[2]			250	313	500
Pedestal socket[2]			210	263	420
"D"-Ring			230	288	460
Lashing Plate			230	288	460
Penguin Book			230	288	460
TP Bridge fitting			210	263	420
Buttress		Betw.	650	715	850
		Top tier	250	275	325
Dove Tail Twistlock		Zug	200	250	400
		Schub	210	263	420
Linkage Plate			150	188	300
General note		Deck	WL	1,25 WL	2,0 WL
		Hold	WL	1,1 WL	1,33 WL

The loads above are valid for Ro-Ro lashing elements also. Lashing belts are also tested with factor 2,0 BL/SWL.

[1] Load requirement for fully automatic locks are the same as for twistlocks. Additionally required is testing in a test jig, where pressure, shear and lifting forces
can be applied simultaneously.

B. Type Certificate for Container Lashing Fittings

BIRO KLASIFIKASI INDONESIA

SERTIFIKAT JENIS
Type Certificate

No. Sertifikat :
Certificate No.

Untuk
For

Pabrik Pembuat Peralatan pengaman
The lashing fitting of the manufacturer

Telah diuji dengan dihadiri oleh Surveyor
was type tested in presence of the undersigned Surveyor

Persetujuan gambar No: Tanggal:
Drawings approval under *dated*

Beban kerja yang dibolehkan: KN.
Allowable working load:

Elemen Utama peralatan dispesifikasikan sebagai berikut:
The main elements of the fitting are specified as follows

Bagian *Part*	No. Gambar *Drawing No*	Bahan *Material*	Pabrik pembuat *Manufacturer:*

Pengujian beban putus:
Breakload test - results

Pada……..KN beban uji,tidak deformasi permanen dan tidak ada retak baru terdeteksi:
At …. KN test load no permanent deformation and no incipient cracks were detected

Masa berlaku Sertifikat sampai dengan :
The validity of this Certificate expires on

Tanggal dan tempat pengujian
Place and date of test

(………………………………………….)

No. Form :
Form No.

Appendix E

Survey of Container Stowage and Lashing Equipment

1. Survey of Container Stowage and Lashing Equipment

1.1 This survey is required only for ships with the Notation **CONTAINER SHIP** or **EQUIPPED FOR CARRIAGE OF CONTAINERS** appended to their Character of Class.

1.2 A random survey is to be carried out on the basis of the relevant BKI Certificates carried on board to verify that only such container stowage and lashing components are used as have been approved and, where applicable, tested by BKI. Defective parts are to be replaced or repaired, as necessary.

Should the result of the survey be unsatisfactory, its scope is to be increased.

Note

Loose container stowage and lashing components are generally inspected only in batches, i.e. about 2 - 5 % of a consignment. This means that not every unit bears a stamp mark.

1.2.1 Approved documents relating to the Container equipment (container stowage and lashing plan with documentation of the various components) are to be carried on board and are to be presented, on request, to the Surveyor.

Appendix F

Approval of Computer Software for Determination of Forces in The Lashing Systems

A. Approval of Lashing Computer/Software

1. General remarks

A lashing program is computer-based software for calculation and control of container securing arrangements in compliance with the applicable strength requirements. BKI recommends the installation and the approval of a lashing program for each vessel carrying containers.

BKI examines and approves upon request calculation programs on test condition basis. This examinations and the corresponding approval are done in relation to a specific ship.

BKI recommends using the lashing program on a BKI type approved hardware only. If it is not the case, the program should be installed on 2 (two) nominated computers equipped with separate screen and printer.

2. General requirements

For each vessel the printouts of the test conditions, a copy of the program and a user's manual have to be sent to the BKI Head Office for examination. Test conditions of different bays shall include the following cases:

- twistlocks only
- complete lashing
- with exceeding of stack weight
- with exceeding of lashing load
- with exceeding of lifting force
- an example with outboard stacks missing
- one example, where 20' and 40' containers are arranged in mixed stowed
- typical stowage in hold

The software has to be user-friendly, with a graphic presentation of the container arrangement. It has to reject input errors from user. For example or negative weight input, container positioned outside or lashings, which are not possible on board are not to be accepted. The software and the stored characteristic data are to be protected against any erroneous use.

BKI has to be informed immediately about any modifications which may affect the approved lashing program installed on board of the ship. BKI will decide about a re-approval case by case. Failure to advice of any modifications will annul the issued Certificate.

The following details have to be given for each container arrangement in addition to the GM-Value of the ship:

- position of each stack
- container weight
- actual stack weights
- permissible stack weights
- lashing arrangement
- transverse acceleration of each stack
- racking forces
- lifting forces
- lashing forces
- corner post loads
- pressure loads at bottom
- percentage of exceeding
- a warning has to be given if any of the strength limit is exceed

The lashing program Certificate, the approved test conditions and the user's manual have to be kept on board.

Appendix G

Weights, Measurement and Tolerances

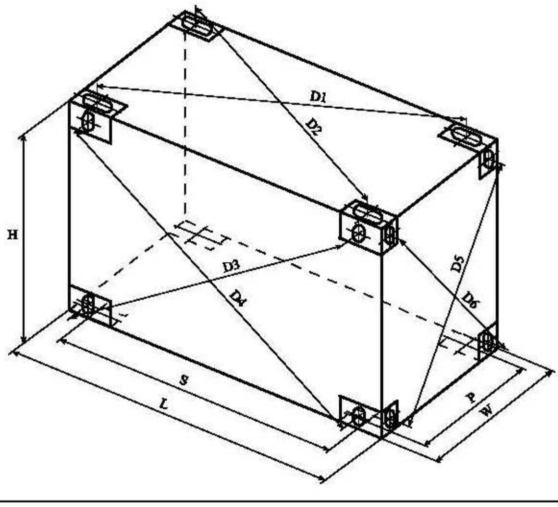
Table F.1 Weights, Measurements and tolerances

ISO designation of container	Max. permitted gross weight	External dimensions			Distance between centres of holes in corner fittings			
	[kg]	Length L [mm]	Height H [mm]	Width B [mm]	Lingitudinally S [mm]	crosswise P [mm]	Permitted difference d 1 of diagonals [mm]	Permitted difference d 2 of diagonals [mm]
1 AAA 1 AA 1 A 1 AX	30.480	12.192^{0}_{-10}	2.896^{0**}_{-5} 2.591^{0}_{-5} 2.438^{0}_{-5} <2.438	2.438^{0}_{-5}	11.990^{0}_{-10}	2.260^{0}_{-4}	19	10
1 BBB 1 BB 1 B 1 BX	25.400	9.125^{0}_{-10}	2.896^{0**}_{-5} 2.591^{0}_{-5} 2.438^{0}_{-5} <2.438	2.438^{0}_{-5}	8.923^{0}_{-10}	2.260^{0}_{-4}	16	10
1 CC 1 C 1 CX	24.000	6.058^{0}_{-6}	2.591^{0}_{-5} 2.438^{0}_{-5} <2.438	2.438^{0}_{-5}	5.854^{0}_{-6}	2.260^{0}_{-4}	13	10
1 DD 1 D 1 DX	10.160	2.991^{0}_{-5}	2.591^{0}_{-5} 2.438^{0}_{-5} <2.438	2.438^{0}_{-5}	2.788^{0}_{-5}	2.260^{0}_{-4}	10	10

1 Allowable difference of the diagonals of whole-center of the corner castings of bottom and roof areas and side walls.

2 Allowable difference of the diagonals of hole center of the corner castings of front walls, see following sketch.

** In certain countries there are legal limitations to the overall height of vehicle and load.

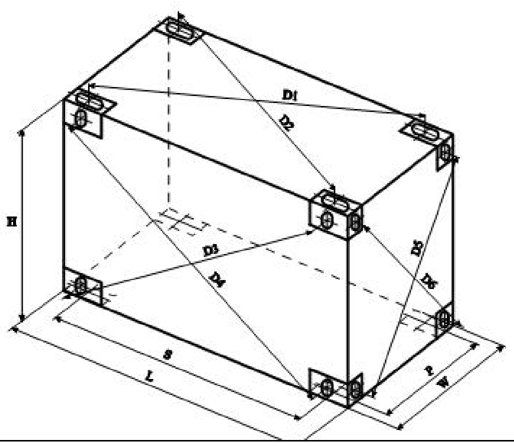


ISO designation of container	Max. permitted gross weight	External dimensions			Distances between centres of holes in corner fittings			
		Length L [mm]	Height H [mm]	Width B [mm]	Longitudinally S [mm]	Crosswise P	Permitted difference d [1] of	Permitted difference d [2] of
1 AAA 1 AA 1 A 1 AX	30480	12192	2.896 2.591 2.438 < 2.438	2438	11990	2260	19	10
1 BBB 1 BB 1 B 1 BX	25400	9125		2438	8923	2260	16	10
1 CC 1 C 1 CX	24000	6058		2438	5854	2260	13	10
1 DD 1 D 1 DX	10160	2991		2438	2788	2260	10	10

[1] Allowable difference of the diagonals of whole-center of the corner castings of bottom an roof areas

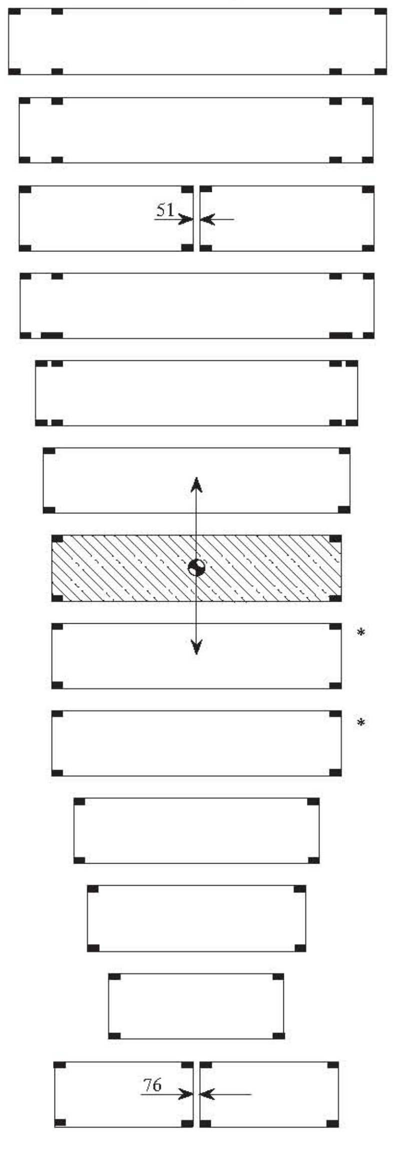
[2] Allowable difference of the diagonals of hole-center of the corner castings of front walls, see following sketch

** In certain countries there are legal limitations to the overall height of vehicle and load



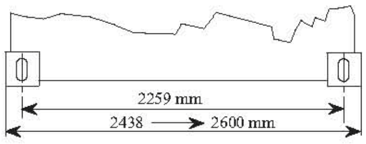
Appendix H

Container Dimensions

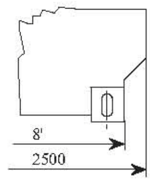


Größe	Länge (Seitenansicht)	Breite	Höhe
53' (16150 mm)		8' 6" (2591 mm)	9' 6 1/2"
49' (14935 mm)		2600 mm	9' 6" 2896 mm
2x24 1/2' (2x7442 mm)		2600 mm	9' 6" 2896 mm
48' (14630 mm)		8' 6" (2591 mm)	9' 6 1/2"
45' (13720 mm)		8' (2438 mm)	9' 6" 9' 6 1/2"
43' (13103 mm)		8' (2438 mm)	
40' ISO (12192 mm)		8' (2438 mm)	8' 9' 8' 6" 9' 6"
40' EURO (12192 mm)	*	2500 mm	8' 6" 9' 6"
40' Bell Lines (12192 mm)	*	2500 mm	
35' (10660 mm)		8' (2438 mm)	8' 6"
30' (9125 mm)		8' (2438 mm)	8' 8' 6"
24' (Matson) (7430 mm)		8' od. 8' 6" (2438 mm or 2591 mm)	8' 6" 9' 6"
2x20' (2x6058 mm)		8' (2438mm)	8' 9' 6" 8' 6"

Common for all containers in the transverse measure from center to center point of the holes of corner castings ≙ 2259 mm



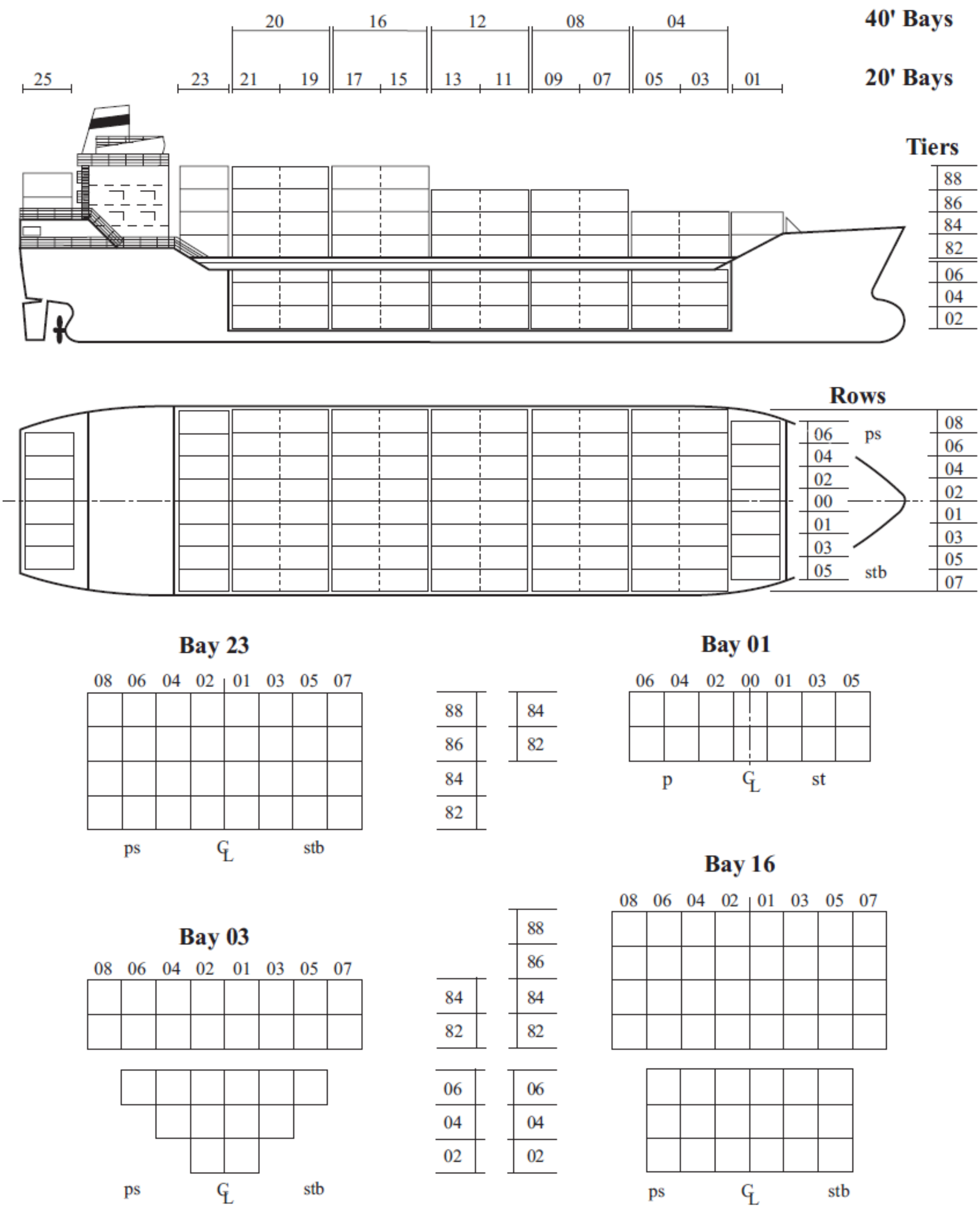
* to EURO-/ "Bell Lines"-Container view on top



The dimensions of the non-ISO-standardized containersizes are preliminary.

Appendix I

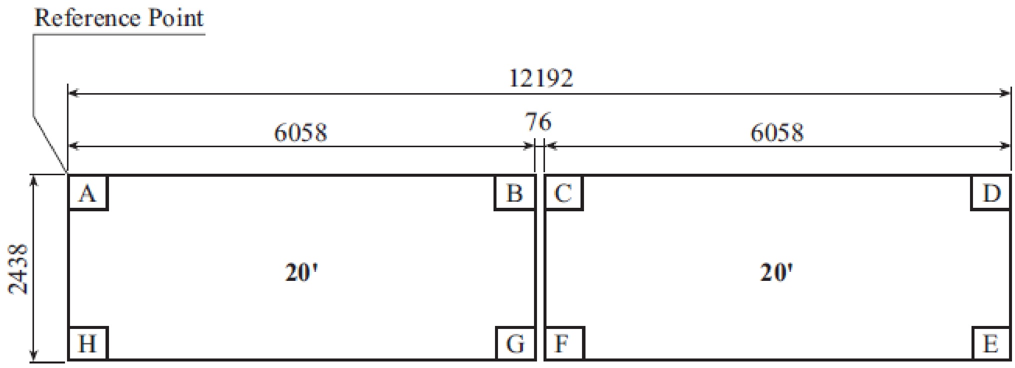
Code of Container Positions



It shall be started with tier 82 at each different deck level (Forecastle/poopdeck)

Appendix J

Height Tolerances of Container Foundations



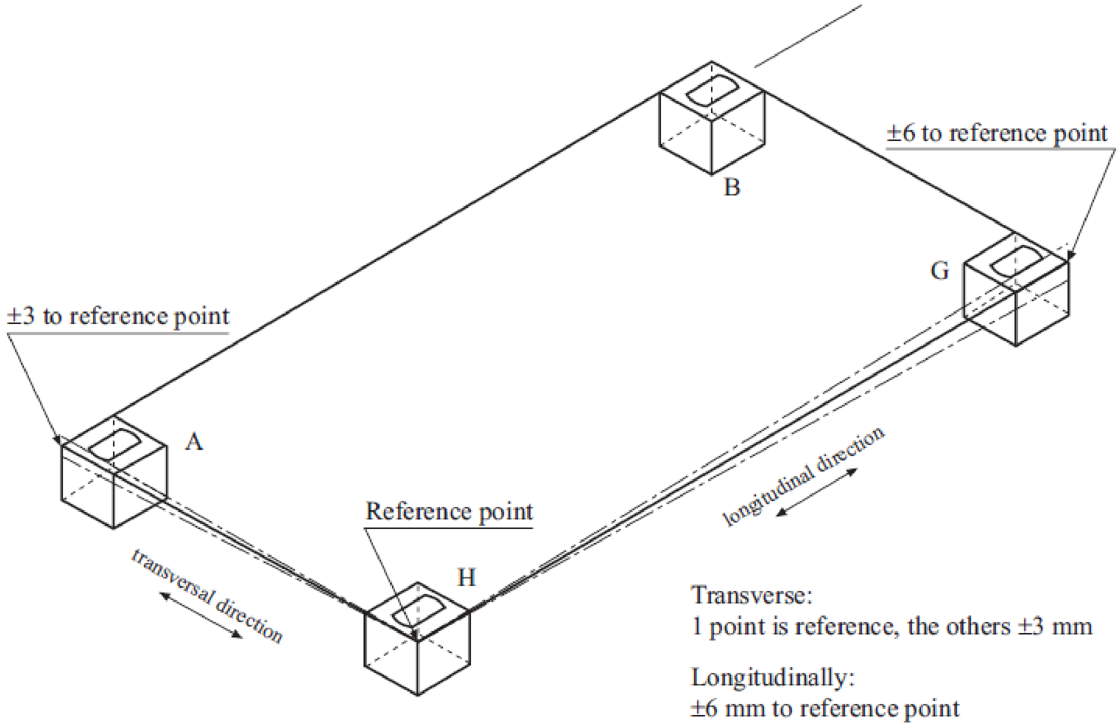
Example in mm

A	=	0
B + C	=	-3
D	=	-6
E	=	-9
F + G	=	-6
H	=	-3

in general the following tolerances have to be kept

in longitudinal not more than ± 6 mm	in transversal not more than ± 3 mm
A to B C to D A to D H to G F to E H to E	A to H B to G C to F D to E

This foundation to be levelled in relation to A with ±6 mm and in relation to G with ±3 mm

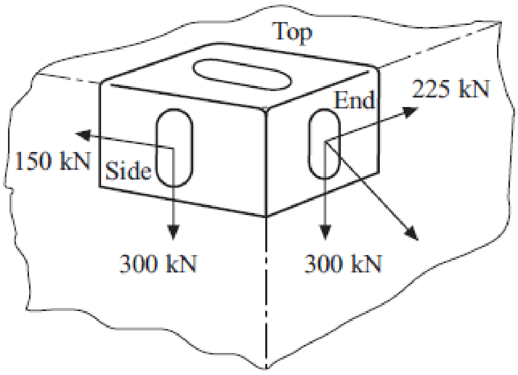


Transverse:
1 point is reference, the others ±3 mm

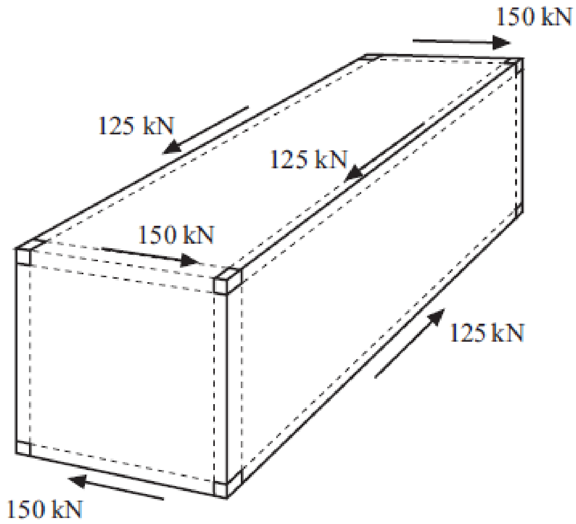
Longitudinally:
±6 mm to reference point

Appendix K

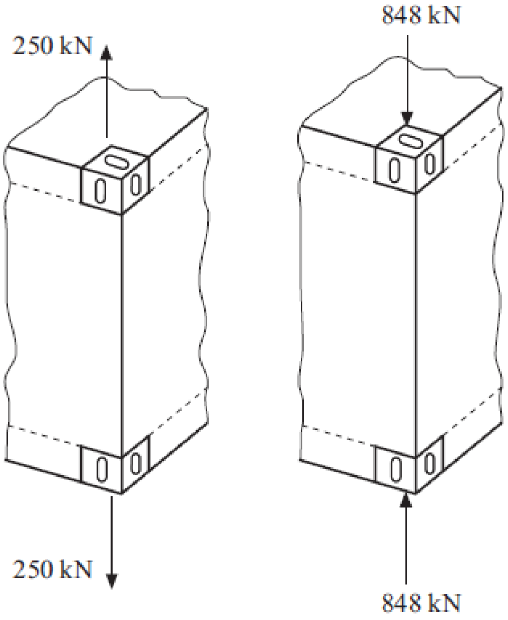
Maximum Allowable Forces on ISO-Container



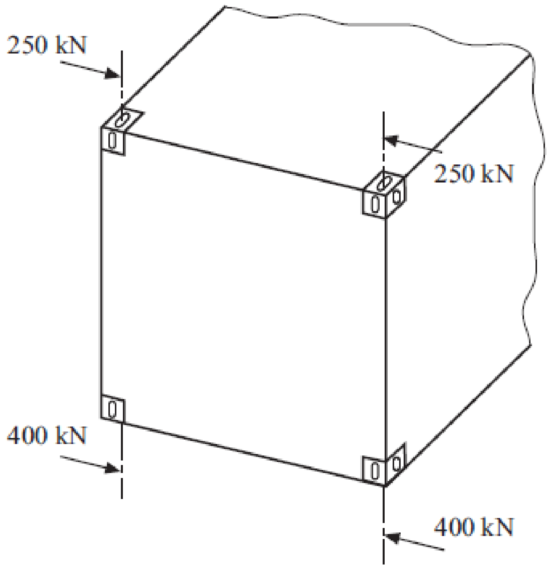
a) Corner casting lashing loads



b) Racking loads



c) Max. vertical corner lifting and compressive forces

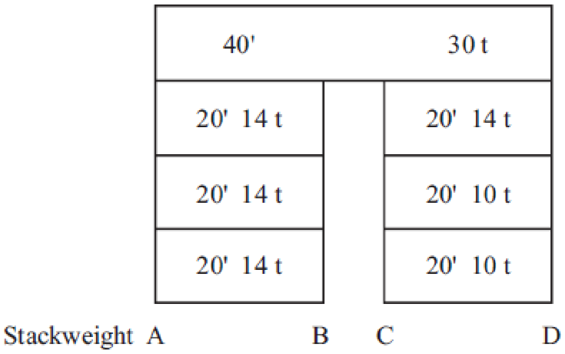


d) Transverse compressive forces

Appendix L

Determination of the Exixting Stack Weight for Mixed Stowage (20’ and 40’ Container) for the Individual Foundation Points

Example:



$$
\begin{aligned}
A &= 14 \cdot 3 + 30 = 72\,t \\
B &= 14 \cdot 3 = 42\,t \\
C &= 2 \cdot 10 + 14 = 34\,t \\
D &= 2 \cdot 10 + 14 + 30 = 64\,t
\end{aligned}
$$

At foundation A and D we get the existing stackweight for 40' Container, at foundation B and C the stackweight for 20' Container.