Rules for the Classification of Inland Waterway Ships and for Conformity to Directive 2016/1629/EU

Effective from 1 March 2019

Part B

Hull and Stability

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GENERAL CONDITIONS

Definitions:

"*Administration*" means the Government of the State whose flag the Ship is entitled to fly or under whose authority the Ship is authorised to operate in the specific case.

"IACS" means the International Association of Classification Societies.

"*Interested Party*" means the party, other than the Society, having an interest in or responsibility for the Ship, product, plant or system subject to classification or certification (such as the owner of the Ship and his representatives, the ship builder, the engine builder or the supplier of parts to be tested) who requests the Services or on whose behalf the Services are requested.

"*Owner*" means the registered owner, the ship owner, the manager or any other party with the responsibility, legally or contractually, to keep the ship seaworthy or in service, having particular regard to the provisions relating to the maintenance of class laid down in Part A, Chapter 2 of the Rules for the Classification of Ships or in the corresponding rules indicated in the specific Rules.

"Rules" in these General Conditions means the documents below issued by the Society:

- (i) Rules for the Classification of Ships or other special units;
- (ii) Complementary Rules containing the requirements for product, plant, system and other certification or containing the requirements for the assignment of additional class notations;
- (iii) Rules for the application of statutory rules, containing the rules to perform the duties delegated by Administrations;
- (iv) Guides to carry out particular activities connected with Services;
- (v) Any other technical document, as for example rule variations or interpretations.

"*Services*" means the activities described in Article 1 below, rendered by the Society upon request made by or on behalf of the Interested Party.

"Ship" means ships, boats, craft and other special units, as for example offshore structures, floating units and underwater craft.

"*Society*" or *"TASNEEF"* means Tasneef and/or all the companies in the Tasneef Group which provide the Services.

"*Surveyor*" means technical staff acting on behalf of the Society in performing the Services.

Article 1

1.1. The purpose of the Society is, among others, the classification and certification of ships and the certification of their parts and components. In particular, the Society:
- (i) sets forth and develops Rules;
- (ii) publishes the Register of Ships;
- (iii) issues certificates, statements and reports based on its survey activities.

1.2. The Society also takes part in the implementation of national and international rules and standards as delegated by various G overnments.

1.3. The Society carries out technical assistance activities on request and provides special services outside the scope of classification, which are regulated by these general conditions, unless expressly excluded in the particular contract.

Article 2

2.1. The Rules developed by the Society reflect the level of its technical knowledge at the time they are published. Therefore, the Society, although committed also through its research and development services to continuous updating of the Rules, does not guarantee the Rules meet state-of-the-art science and technology at the time of publication or that they meet the Society's or others' subsequent technical developments.

2.2. The Interested Party is required to know the Rules on the basis of which the Services are provided. With particular reference to Classification Services, special attention is to be given to the Rules concerning class suspension, withdrawal and reinstatemen t. In case of doubt or inaccuracy, the Interested Party is to promptly contact the Society for clarification.
The Rules for Classification of Ships are published on the Society's website: www.tasneef.ae.

2.3. The Society exercises due care and skill:
- (i) in the selection of its Surveyors
- (ii) in the performance of its Services, taking into account the level of its technical knowledge at the time the Services are performed.

2.4. Surveys conducted by the Society include, but are not limited to, visual inspection and non-destructive testing. Unless otherwise required, surveys are conducted through sampling techniques and do not consist of comprehensive verification or monitoring of the Ship or of the items subject to certification. The surveys and checks made by the Society on board ship do not necessarily require the constant and continuous presence of the Surveyor. The Society may also commission laboratory testing, underwater inspection and other checks carried out by and under the responsibility of qualified service suppliers. Survey practices and procedures are selected by the Society based on its experience and knowledge and according to generally accepted technical standards in the sector.

Article 3

3.1. The class assigned to a Ship, like the reports, statements, certificates or any other document or information issued by the Society, reflects the opinion of the Society concerning compliance, at the time the Service is provided, of the Ship or product subject to certification, with the applicable Rules (given the intended use and within the relevant time frame).
The Society is under no obligation to make statements or provide information about elements or facts which are not part of th e specific scope of the Service requested by the Interested Party or on its behalf.

3.2. No report, statement, notation on a plan, review, Certificate of Classification, document or information issued or given as p art of the Services provided by the Society shall have any legal effect or implication other than a representation that, on the basis of the checks made by the Society, the Ship, structure, materials, equipment, machinery or any other item covered by such document or information meet the Rules. Any such document is issued solely for the use of the Society, its committees and clients or other duly authorised bodies and for no other purpose. Therefore, the Society cannot be held liable for any act made or document issued by other parties on the basis of the statements or information given by the Society. The validity, application, meaning and interpretation of a Certificate of Classification, or any other document or information issued by the Society in connection with its Services, is governed by the Rules of the Society, which is the sole subject entitled to make such interpretation. Any disagreement on technical matters between the Interested Party and the Surveyor in the carrying out of his functions shall be raised in writing as soon as possible with the Society, which will settle any divergence of opinion or dispute.

3.3. The classification of a Ship, or the issuance of a certificate or other document connected with classification or certificati on and in general with the performance of Services by the Society shall have the validity conferred upon it by the Rules of the Society at the time of the assignment of class or issuance of the certificate; in no case shall it amount to a statement or warranty of seaw orthiness, structural integrity, quality or fitness for a particular purpose or service of any Ship, structur e, material, equipment or machinery inspected or tested by the Society.

3.4. Any document issued by the Society in relation to its activities reflects the condition of the Ship or the subject of certifi cation or other activity at the time of the check.

3.5. The Rules, surveys and activities performed by the Society, reports, certificates and other documents issued by the Society are in no way intended to replace the duties and responsibilities of other parties such as Governments, designers, ship builders, manufacturers, repairers, suppliers, contractors or sub-contractors, Owners, operators, charterers, underwriters, sellers or intended buyers of a Ship or other product or system surveyed.
These documents and activities do not relieve such parties from any fulfilment, warranty, responsibility, duty or obligation (also of a contractual nature) expressed or implied or in any case incumbent on them, nor do they confer on such parties any right, claim or cause of action against the Society. With particular regard to the duties of the ship Owner, the Services undertaken by the Society do not relieve the Owner of his duty to ensure proper maintenance of the Ship and ensure seaworthiness at all times. Likewise, t he Rules, surveys performed, reports, certificates and other documents issued by the Society are intended neither to guarantee the buyers of the Ship, its components or any other surveyed or certified item, nor to relieve the seller of the duties arising out of the law or the contract, regarding the quality, commercial value or characteristics of the item which is the subject of transaction.
In no case, therefore, shall the Society assume the obligations incumbent upon the above-mentioned parties, even when it is consulted in connection with matters not covered by its Rules or other documents.
In consideration of the above, the Interested Party undertakes to relieve and hold harmless the Society from any third party claim, as well as from any liability in relation to the latter concerning the Services rendered.
Insofar as they are not expressly provided for in these General Conditions, the duties and responsibilities of the Owner and Interested Parties with respect to the services rendered by the Society are described in the Rules applicable to the specific Service rendered.

Article 4

4.1. Any request for the Society's Services shall be submitted in writing and signed by or on behalf of the Interested Party. Such a request will be considered irrevocable as soon as received by the Society and shall entail acceptance by the applicant of all relevant requirements of the Rules, including these General Conditions. Upon acceptance of the written request by the Society, a contract between the Society and the Interested Party is entered into, which is regulated by the present General Conditions.

4.2. In consideration of the Services rendered by the Society, the Interested Party and the person requesting the service shall be jointly liable for the payment of the relevant fees, even if the service is not concluded for any cause not pertaining to the Society. In the latter case, the Society shall not be held liable for non-fulfilment or partial fulfilment of the Services requested. In the event of late payment, interest at the legal current rate increased by 1.5% may be demanded.

4.3. The contract for the classification of a Ship or for other Services may be terminated and any certificates revoked at the request of one of the parties, subject to at least 30 days' notice to be given in writing. Failure to pay, even in part, the fees due for Services carried out by the Society will entitle the Society to immediately terminate the contract and suspend the Services.
For every termination of the contract, the fees for the activities performed until the time of the termination shall be owed to the Society as well as the expenses incurred in view of activities already programmed; this is without prejudice to the right to compensation due to the Society as a consequence of the termination.
With particular reference to Ship classification and certification, unless decided otherwise by the Society, termination of the contract implies that the assignment of class to a Ship is withheld or, if already assigned, that it is suspended or withdrawn; any st atutory certificates issued by the Society will be withdrawn in those cases where provided for by agreements between the Society and the flag State.

Article 5

5.1. In providing the Services, as well as other correlated information or advice, the Society, its Surveyors, servants or agents operate with due diligence for the proper execution of the activity. However, considering the nature of the activities performed (see art. 2.4), it is not possible to guarantee absolute accuracy, correctness and completeness of any information or advice supplied. Express and implied warranties are specifically disclaimed.
Therefore, except as provided for in paragraph 5.2 below, and also in the case of activities carried out by delegation of Governments, neither the Society nor any of its Surveyors will be liable for any loss, damage or expense of whatever nature sustained by any person, in tort or in contract, derived from carrying out the Services.

5.2. Notwithstanding the provisions in paragraph 5.1 above, should any user of the Society's Services prove that he has suffered a loss or damage due to any negligent act or omission of the Society, its Surveyors, servants or agents, then the Society will pay compensation to such person for his proved loss, up to, but not exceeding, five times the amount of the fees charged for the specific services, information or opinions from which the loss or damage derives or, if no fee has been charged, a maximum of AED5,000 (Arab Emirates Dirhams Five Thousand only). Where the fees charged are related to a number of Services, the amount of the fees will be apportioned for the purpose of the calculation of the maximum compensation, by reference to the estimated time involved in the performance of the Service from which the damage or loss derives. Any liability for indirect or consequential loss, damage or expense is specifically excluded. In any case, irrespective of the amount of the fees charged, the maximum damages payable by the Society will not be more than AED5,000,000 (Arab Emirates Dirhams Five Millions only). Payment of compensation under this paragraph will not entail any admission of responsibility and/or liability by the Society and will be made without prejudice to the disclaimer clause contained in paragraph 5.1 above.

5.3. Any claim for loss or damage of whatever nature by virtue of the provisions set forth herein shall be made to the Society in writing, within the shorter of the following periods: (i) THREE (3) MONTHS from the date on which the Services were performed, or (ii) THREE (3) MONTHS from the date on which the damage was discovered. Failure to comply with the above deadline will constitute an absolute bar to the pursuit of such a claim against the Society.

Article 6

6.1. These General Conditions shall be governed by and construed in accordance with United Arab Emirates (UAE) law, and any dispute arising from or in connection with the Rules or with the Services of the Society, including any issues concerning responsibility, liability or limitations of liability of the Society, shall be determined in accordance with UAE law. The courts of the Dubai International Financial Centre (DIFC) shall have exclusive jurisdiction in relation to any claim or dispute which may arise out of or in connection with the Rules or with the Services of the Society.

6.2. However,

(i) In cases where neither the claim nor any counterclaim exceeds the sum of AED300,000 (Arab Emirates Dirhams Three Hundred Thousand) the dispute shall be referred to the jurisdiction of the DIFC Small Claims Tribunal; and

(ii) for disputes concerning non-payment of the fees and/or expenses due to the Society for services, the Society shall have the right to submit any claim to the jurisdiction of the Courts of the place where the registered or operating office of the Interested Party or of the applicant who requested the Service is located.

In the case of actions taken against the Society by a third party before a public Court, the Society shall also have the righ t to summon the Interested Party or the subject who requested the Service before that Court, in order to be relieved and held harmless according to art. 3.5 above.

Article 7

7.1. All plans, specifications, documents and information provided by, issued by, or made known to the Society, in connection with the performance of its Services, will be treated as confidential and will not be made available to any other party other than the Owner without authorisation of the Interested Party, except as provided for or required by any applicable international, European or domestic legislation, Charter or other IACS resolutions, or order from a competent authority. Information about the status and validity of class and statutory certificates, including transfers, changes, suspensions, withdrawals of class, recommendations/conditions of cl ass, operating conditions or restrictions issued against classed ships and other related information, as may be required, may be published on the website or released by other means, without the prior consent of the Interested Party.

Information about the status and validity of other certificates and statements may also be published on the website or released by other means, without the prior consent of the Interested Party.

7.2. Notwithstanding the general duty of confidentiality owed by the Society to its clients in clause 7.1 above, the Society's c lients hereby accept that the Society may participate in the IACS Early Warning System which requires each Classification Society to provide other involved Classification Societies with relevant technical information on serious hull structural and engineering systems failures, as defined in the IACS Early Warning System (but not including any drawings relating to the ship which may be the specific propert y of another party), to enable such useful information to be shared and used to facilitate the proper working of the IACS Early Warning System. The Society will provide its clients with written details of such information sent to the involved Classification Societies.

7.3. In the event of transfer of class, addition of a second class or withdrawal from a double/dual class, the Interested Party undertakes to provide or to permit the Society to provide the other Classification Society with all building plans and drawings, certificat es, documents and information relevant to the classed unit, including its history file, as the other Classification Society may require for the purpose of classification in compliance with the applicable legislation and relative IACS Procedure. It is the Owner's duty t o ensure that, whenever required, the consent of the builder is obtained with regard to the provision of plans and drawings to the new Society, either by way of appropriate stipulation in the building contract or by other agreement.

In the event that the ownership of the ship, product or system subject to certification is transferred to a new subject, the latter shall have the right to access all pertinent drawings, specifications, documents or information issued by the Society or which has come to the knowledge of the Society while carrying out its Services, even if related to a period prior to transfer of ownership.

Article 8

8.1. Should any part of these General Conditions be declared invalid, this will not affect the validity of the remaining provisions.

RULES FOR THE CLASSIFICATION OF INLAND WATERWAY SHIPS AND FOR CONFORMITY TO DIRECTIVE 2016/1629/EU

Part B
Hull and Stability

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Part B
Hull and Stability

Chapter 1
GENERAL REQUIREMENTS

SECTION 1 GENERAL REQUIREMENTS

1 Rule application

1.1

1.1.1 Part B applies in general to all types of ships which are to be classed by Tasneef, intended for the carriage of solid or liquid cargoes in holds or on deck, and engaged in inland waterway service.

These Rules specify the minimum scantlings applicable to steel or light alloy ships of normal type of all welded construction.

For ships built with hulls in GRP or wood, the requirements of Tasneef Rules for the Classification of ships with reinforced plastic, aluminium alloy or wooden hulls are to be applied.

Specific requirements, alternative or additional to those contained in this Part, applicable to special ship types are contained in Part E.

1.2 Stability

1.2.1 For the classification purposes the ship design is to take into account the intact stability given in Ch 6, Sec 2.

1.3 Subdivision and internal arrangement

1.3.1 Watertight bulkheads *(1/1/2017)*

For ships not required to comply with subdivision regulations, and when particular transverse connections for structural purposes are not required, unless equivalent safety is otherwise ensured, at least the following transverse bulk-heads are to be provided and carried up to the deck or, where the deck is not provided, to the uppermost edge of the plating:

- a collision bulkhead fitted between 0,04 L and 0,04 L+2 m aft of the forward perpendicular, where L is the length defined in Ch1, Sec 2, [3.2.1]. Tasneef may, on a case-by-case basis, accept a distance from the collision bulkhead to the forward perpendicular greater than the maximum specified above, providing that in case of flooding of the space forward of the collision bulkhead, subdivision and stability calculations in both the full load departure condition and the arrival condition show compliance with Tasneef Rules.
The collision bulkhead is to be located at a suitable distance from the bow in such a way that the buoyancy of the laden vessel is ensured, with a residual safety clear-ance of 100 mm if water enters the watertight compart-ment ahead of the collision bulkhead.
- a bulkhead fitted in the after part of the ship at an appropriate distance from the stern having regard to the configuration of the ship's after extremity. For ships more than 25 m in overall length, the machinery space, including the working spaces which form part of it, is to be contained within two transverse bulkheads.

Where damage stability is to be satisfied, additional transverse bulkheads are to be provided in order to have longitudinal compartments having dimensions such as to ensure the minimum stability requirements when flooded. Additional transverse bulkheads may be fitted according to the service of the ship and to satisfy strength require-ments.

1.3.2 Internal arrangements

Accommodation spaces are to be separated from the holds and the arrangements are to be watertight.

No accommodation spaces are to be fitted forward of the collision bulkhead. Accommodation spaces are to be separated from machinery spaces and boiler spaces by gas-tight bulkheads and are to have direct access from the deck. If such access is not possible, an emergency exit leading directly to the deck is to be fitted.

1.3.3 Openings in watertight bulkheads

- No door or manhole is permitted in the part of the collision bulkhead below the bulkhead deck.
- The number and dimensions of the openings, if any, in other watertight bulkheads are to be reduced to the minimum compatible with the operation of the vessel; satisfactory devices are to be provided for the water-tight closing of these openings, with indicators show-ing whether they are open or closed. Doors are to be capable of being operated on the spot from either side of the bulkhead. Doors may be of the hinged type.
- Where shafts, pipes, electrical cables etc are carried through watertight bulkheads, arrangements are to be made to avoid impairing the watertight integrity of the bulkheads or decks.
- In the collision bulkhead, no shut-off valves or cocks are to be fitted which open directly into the compart-ments lying abaft that bulkhead.
- Such devices are to be avoided so far as possible in the other watertight bulkheads. If, however, such de-vices are fitted, they are to at all times be capable of being opened and closed from an accessible point situated above the uppermost continuous deck. Indi-cators are to be fitted to show whether the devices are open or closed.
- If the drainage pipes of the forepeak tank pass through the collision bulkhead, each pipe is to be fitted with a valve which is controlled from a point situated above the freeboard deck and which is fitted to the col-lision bulkhead inside the forepeak.
- Doors fitted in the watertight bulkhead are to be of a type recognised appropriate by Tasneef

- Doors in watertight bulkheads are to be provided with a system for watertight closing, workable from either side of the bulkhead in proximity to the door and from a point above the maximum draught level.
- Each door is to be fitted with indicators showing at all operating stations whether it is open or closed.
- In the accommodation and working spaces, however, and in spaces in the 'tweendecks immediately below the freeboard deck, remote control is not required.

According to the size of the compartment Tasneef may accept on a case-by-case basis, that the after peak tank is connected with the compartment immediately forward of it by a draining device which is to be self-closing and ac-cessible in all circumstances.

1.3.4 Accommodation arrangements

a) Accommodation spaces are to be located abaft the collision bulkhead and, as far as is practical, above the bulkhead deck.

b) Forward, the floor is to be not more than 1,20 m below the maximum draught level.

   Requirements may be waived for spaces which are not permanently manned.

c) Access to accommodation spaces is to be easy and completely safe.

d) As a rule, living rooms and galleys are to be accessible from the deck through a passageway.

e) Transverse watertight bulkheads are not required if the front part is capable of withstanding a load at least equal to 2,5 times the load foreseen for the collision bulkhead of a ship for inland waterway service having the same draught.

1.3.5 Cofferdams and compartments forward of the collision bulkhead

Adjacent tanks or double bottoms, hereafter generi-cally referred to as "tanks", intended for the carriage of different liquids among the following:

a) fuel oil,

b) lubricating oil,

c) vegetable oil and other similar,

d) drinking water, washing and boiler feed water,

are to be separated by a cofferdam.

In general, a cofferdam is also required between tanks intended for the carriage of fuel oil or lubricating oil and adjacent tanks intended for the carriage of liquid foam for fire-extinguishing.

Cofferdams separating fuel oil tanks from adjacent lu-bricating oil tanks and such tanks from adjacent tanks in-tended for the carriage of liquid foam for fire-extinguishing or fresh water or boiler feed water may not be required when deemed impracticable or unreasonable by Tasneef in relation to the characteristics and dimensions of the spaces containing said tanks, provided that:

- the thickness of common boundary plates of adjacent tanks is increased, with respect to the Rule thickness, by 2 mm in the case of tanks carrying fresh water or boiler feed water, and by 1 mm in all other cases;
- the sum of the throats of the weld fillets at the edges of said plates is not less than the thickness of the plates themselves;
- the hydrostatic test is carried out with a head in-creased by 1 m with respect to the Rule head.

Cofferdams between fuel oil double bottoms and tanks immediately above are only required when the inner bottom plating is subjected to the head of fuel oil contained therein, as in the case of a double bottom with its top raised at the sides.

Where a corner to corner situation occurs, tanks are not considered to be adjacent.

Adjacent tanks not separated by cofferdams are to have adequate dimensions to ensure easy inspection.

Spaces intended for the carriage of flammable liquids are to be separated from accommodation and service spaces by means of a cofferdam. Where accommodation and service spaces are arranged immediately above such spaces, the cofferdam may be omitted only where the deck is not provided with access openings and is coated with a layer of material recognised as suitable by Tasneef

The cofferdam may also be omitted where such spaces are adjacent to a passageway, subject to the con-ditions stated in this paragraph for fuel oil or lubricating oil tanks.

All cofferdams required in this paragraph are to be constructed so as to enable easy inspection and ade-quate ventilation.

For oil tankers. combination carriers, gas carriers and chemical tankers, the specific requirements of Part E are also to apply.

For tanks adjacent to refrigerated spaces, the re-quirements of Part C of the Rules are also to apply.

1.4 Ventilation

1.4.1 General requirements

Accommodation spaces, service spaces, machinery spaces, cofferdams and, in general, cargo spaces are to be provided with natural or mechanical ventilation.

Mechanical ventilation is to be provided, as a rule, in machinery spaces.

Machinery spaces are to be sufficiently ventilated so as to ensure that, when machinery or boilers are operat-ing at full power and in all weather conditions including heavy weather, a sufficient supply of air is maintained for the whole period of operation of the machinery.

The air supply is to be obtained, in general, through openings so located that weathertight closing devices are not required.

For oil tankers and combination carriers, the specific requirements of Part E are also to apply.

For gas carriers the requirements of Part E are also to apply.

For chemical tankers the requirements of Part E are also to apply.

1.5 Corrosion protection

1.5.1 Cementing or equivalent protective coating

The internal structures of compartments of double bot-toms located under the boiler room which are not used for fuel oil are to be adequately protected by a thick cement com-position or other protective material accepted by Tasneef

A similar procedure is to be applied to lateral bilges, double bottom and bottom in single bottom hulls, except for tank-ers, and it may be extended by thick cement, ce-ment wash-ing or equivalent coating to all double bottoms and tanks not intended for fuel oil.

It is recommended that narrow spaces are filled with a com-position of cement mixed with low density material, partic-ularly at the ends of the ships where maintenance would be impracticable due to their inaccessibility.

1.5.2 Painting

In general, all the metallic parts are to be protected against corrosion by means of a coating of recognised efficiency and adhesion, to be applied in at least two coats. Painting is not required for internal surfaces of spaces intended for fuel oil or mineral or vegetable oils.

Where internal tanks are intended for fresh water, painting may be replaced by the application of at least two coats of cement wash.

Tanks carrying drinking water are to be treated by ce-ment washing unless they are protected by special paints of rec-ognised efficiency.

Before the paint is applied, mill scale is to be removed from the external shell plating.

The use of aluminium paint is not permitted in cargo tanks, slop tanks, cargo pump rooms, cofferdams and any other space where cargo gases may accumulate.

1.6 Other protection of steelwork

1.6.1 Ceiling

In single bottom ships other than tankers, ceiling is to be laid on the floors from side to side up to the upper bilge. In the case of a double bottom, ceiling is to be laid over the lateral bilges, if any. The arrangement of ceiling on the inner bottom is not compulsory where the latter complies with the requirements of Sec 9 [9.2].

Planks forming ceiling over the bilges and on the inner bot-tom are to be easily removable to permit access for mainte-nance.

Ceiling on the top plating of double bottoms intended for fuel oil is to be separated from the plating by means of bat-tens, in order to permit the drainage of any oil leakages to the bilges.

Ceiling located on the top plating of a double bottom intended for water may lie next to the plating, provided a suitable protective composition is applied beforehand.

In any case, the attachment of ceiling is not to affect the tightness of the double bottoms.

The thickness of ceiling boards, generally made of pine, is to be not less than 60 mm.

Tasneef may require greater thicknesses in ships where the floor spacing is greater than the Rule spacing. In bot-tom areas under cargo hatchways, the thickness of ceiling is to be increased by 15 mm.

In single bottom ships, ceiling boards are to be fas-tened to the reversed frames by galvanised steel bolts or any other equivalent detachable connection.

A similar connection is to be adopted for ceiling boards over the lateral bilges in double bottom ships.

1.6.2 Battens

In all cargo spaces where transverse framing is used, longi-tudinal battens formed by suitably spaced planks are to be secured to frames for the protection of the sides of the ship.

They are to extend from the bottom of the cargo space to at least the underside of the beam knees and are to be of not less than 50 mm thickness.

Cargo battens are to be not less than 150 mm in width and the space between them is not to exceed 300 mm.

Battens are to be secured to the frames by means of suitable clips which are generally fitted to every second frame. The clips may be permanently attached to the frames or remova-ble.

Where sides are longitudinally framed, battens are to be fit-ted vertically.

The arrangement is to be to the satisfaction of Tasneef

The arrangement of battens is not compulsory in ships intended exclusively for the carriage of bulk or timber car-goes, in car carriers or in container ships.

1.6.3 Wood sheathing of decks

The thickness of wood sheathing of decks is to be not less than:

- 65 mm, if made of pine
- 50 mm, if hardwood is used.

The width of the planks for the two types of wood is not to exceed 130 mm and 150 mm, respectively.

Before the fitting of wood sheathing, deck plates are to be painted with suitable protective varnishes.

1.6.4 Deck composition

The deck composition is to be of such a material as to pre-vent corrosion and is to be effectively secured to the steel underneath by means of suitable connections.

For compositions fitted within accommodation spaces, see the applicable requirements of Section F of the Rules.

1.7 Hoisting devices of wheelhouses

1.7.1 General requirements

A vertically movable wheelhouse is to permit efficient steering of the ship.

A vertically movable wheelhouse and its gear are to be designed in such a way as not to adversely affect the safety of persons on board. It is to be possible to fix the wheelhouse in different positions along the vertical axis. The possibility for immediate release of the fixing ar-rangements is to be ensured under all operational condi-tions inclusive of total electrical power failure.

1.7.2 Requirements relating to construction

The hoisting mechanism is to be designed to hoist at least 1,5 times the total weight of the wheelhouse fully equipped and fully manned.

The mechanism for hoisting the wheelhouse is to func-tion reliably under all possible conditions of asymmetrical load as well as at all angles of ship's list and trim which could occur during its normal operation.

The wheelhouse is to be earthed so that it is in effec-tive metallic contact with the ship's hull.

The protective earthing device may at the same time form an integral part of the lightning conductor system if the lightning conductor receiver is located on the wheel-house.

The feed cables for systems inside the wheelhouse are to be laid and fastened in such a way as to exclude the possibility of mechanical damage to them.

The devices for fastening the cables may also be used for laying hoses or pipes leading into the wheelhouse, provided that the distance between such hoses or pipes and the cables is not less than 100 mm.

Optical signalling of the following positions is to be provided:

- electric drive switchboard live;
- wheelhouse in lower terminal position;
- wheelhouse in upper terminal position.

Optical and acoustic signalling of the wheelhouse movements is to be provided; the signals are to be visible and audible in and near the wheelhouse.

1.7.3 Requirements relating to the hoisting gear drive

The gear for hoisting and lowering the wheelhouse is to have a power drive capable of functioning under all normal conditions of ship's operation.

The wheelhouse is to be equipped with an emergency lowering device independent of the power drive. Emer-gency lowering of the wheelhouse is to be effected under its own weight and is to be smooth and controllable.

The hoisting and lowering mechanism is to enable the wheelhouse to stop and remain fixed in any position, and safe access to and exit from the wheelhouse are to be possible in any position.

Automatic cutting out of the hoisting mechanism is to be provided in the terminal positions.

Lowering of the wheelhouse is to be effected by one person under all conditions.

Emergency lowering is to be possible from both inside and outside the wheelhouse. The speed of emergency lowering of the wheelhouse is to be not less than the speed of lowering effected by means of the main drive

The use of a self-braking hoisting mechanism is not permitted.

Connection of the hydraulic system for hoisting the wheelhouse to another hydraulic system is to be approved in each case.

The feed for the electric drive of the wheelhouse hoist-ing gear and the switchboard of the hoisting gear signal-ling system are to be supplied from busbars on the main distributor panel fed directly from the generator or trans-former. These electric drives are to be provided with inde-pendent feeders of their own.

Their feed from busbars on the emergency switchboard is to be assured in the same way.

SECTION 2 GENERAL ARRANGEMENT DESIGN

1 Rule application

1.1 General

1.1.1 The construction requirements of these Rules assume that in inland waterways where service is performed the significant wave height is not > 2 m.

If this is not ensured, scantlings are to be increased at the discretion of Tasneef which will assess this increase based on statistical data of waves that may be encoun-tered in the zones of service; such data are to be submit-ted by the Interested Party.

When service is performed in inland waterways where the significant wave height is significantly less than 2 m, at the discretion of Tasneef scantlings less than those required by these Rules may be accepted. In such case this is to be mentioned in the Certificate of Classification.

2 Proportions, vessels with unusual de-sign features

2.1

2.1.1 The requirements of these Rules assume that ships have ratios between the main dimensions as indicated in Tab 1.

Table 1

	Rivers, canals	Lakes
L/D	≤ 30	≤ 25
B/D	≤ 6	≤ 5

Ships having ratios between the main dimensions greater than indicated in the above-mentioned table or un-usual characteristics, or ships for which stresses greater than normal are expected, such as, for example:

- ships with high power propulsion plants, and/or propulsion plants arranged in an unusual manner,
- ships built in a non-traditional way or with significant structural discontinuities, or
- ships intended to carry non-uniformly distributed cargo,

will be specially considered by Tasneef in each case.

3 Definitions and symbols

3.1 Preamble

3.1.1 Definitions and symbols are given in [3.2].

The above-mentioned definitions and symbols having general validity are not normally repeated in the other parts, whereas the meanings of those symbols which have specific validity are specified in the relevant Sections and Chapters.

3.2 Symbols

3.2.1

L : rule length, i.e. the distance, in metres, on the load waterline from the forward side of the stem to the after side of the rudder post, or to the centre of the rudder stock where there is no rudder post. L is to be not less than 96 per cent and need not exceed 97 per cent of the extreme length on the load wa-terline. In ships with unusual stem or stern ar-rangements, the Rule length L will be specially considered. In general, in ships with inclined stem and/or stern, the length L is to be taken equal to the length on the load waterline;

B : the greatest moulded breadth, in metres;

D : depth, in metres, measured vertically on the trans-verse section at the middle of length L, from the moulded base line to the top of the deck beam at side on weather deck;

T : draught measured vertically, in metres, on the transverse section at the middle of the length L, from the moulded base line to the load line;

Δ : moulded displacement at draught T, in tonnes.

C_B : Total block coefficient derived as follows:

$$C_B = \frac{\Delta}{L \cdot B \cdot T}$$

K : Material factor for scantlings of structural members, as defined in Chapter 3.

h : Conventional design head, in metres, as defined in Chapter 4.

S : Conventional scantling span, in metres, as defined in Chapter 5.

s : Spacing of ordinary stiffeners, in metres.

4 Documents to be submitted

4.1

4.1.1 For each ship to be built under Tasneef supervision, the plans listed in Tab 2 are to be submitted in triplicate to Tasneef for prior examination and approval.

The said list is for guidance only; in particular, one plan may refer to more than one of the subjects listed in Tab 2.

Plans are to clearly indicate the dimensions and scant-lings, show details of the welded connections and specify the materials used.

Plans are also to indicate the acting loads and their distribution and contain possible indication of wave mo-tions and/or currents anticipated in the service zones.

Table 2 : Plans and documents to be submitted for approval

PLAN OR DOCUMENT	CONTAINING INTER ALIA INFORMATION ON
• midship section • shell expansion • longitudinal section and decks • framing plan	• characteristics of the class • openings on decks and on shell • loads on decks and mass densities of cargoes • actual spacing and inclination of stiffeners • location and height of air vent outlets of various compartments and, in the case of tankers, arrangement of pressure-vacuum valves of cargo tanks, where fitted
• double bottom	• location of overflows • indication of access
• pillar arrangement	• loads on decks and mass densities of cargoes
• watertight subdivision bulkheads • watertight tunnels	• openings, if any
• watertight bulkheads in cargo tanks, ballast tanks and deep tanks	• location of overflows • liquids contained and their mass density
• machinery space structure • foundations of propulsion machinery and boilers	• type, power and r.p.m. of propulsion machinery • mass of main machinery, boilers etc
• fore end structure • aft end structure	• location of overflows
• sternframe or sternpost • propeller shaft boss and brackets	
• rudder and rudder horn	• ship's speed • ice class notation, if any • material of rudder and rudder stock bearings
• superstructures, deckhouses and houses • machinery space casing	• extension and mechanical properties of the light alloy employed (where applicable)
• bulwarks and freeing ports	
• hatch coamings • hatch covers, their sealing and securing arrangement	• loads • spacing of locking bolts, their type and position
• general plan of outer doors and hatchways	
• general ventilation arrangement • pump room ventilation (for oil tankers, gas carriers, chemical tankers etc)	• use of spaces
• means of access to and escape from spaces	
• derricks and cargo gear	• hull strengthening and rigging • quality of materials
• sea chests	
• equipment number calculation	• geometrical elements for calculation • list of equipment

SECTION 3 MATERIALS

1 General

1.1 Characteristics of materials

1.1.1 The characteristics of the materials to be used in the construction of ships are to comply with the applicable requirements of Part D.

1.1.2 Materials with different characteristics may be accepted, provided their specification (manufacture, chemical composition, mechanical properties, welding, etc.) is submitted to Tasneef for approval.

1.2 Testing of materials

1.2.1 Materials are to be tested in compliance with the applicable requirements of Part D.

1.3 Manufacturing processes

1.3.1 The requirements of this Section presume that welding and other cold or hot manufacturing processes are carried out in compliance with current sound working practice and the applicable requirements of Part D. In particular:

- parent material and welding processes are to be approved within the limits stated for the specified type of material for which they are intended
- specific preheating may be required before welding
- welding or other cold or hot manufacturing processes may need to be followed by an adequate heat treatment.

2 Steels for hull structure

2.1 Application

2.1.1 Tab 1 gives the mechanical characteristics of steels currently used in the construction of ships.

2.1.2 Higher strength steels other than those indicated in Tab 1 are considered by Tasneef on a case-by-case basis.

2.1.3 When steels with a minimum guaranteed yield stress R_{eH} other than 235 N/mm² are used on a ship, hull scantlings are to be determined by taking into account the material factor k defined in [2.3].

2.1.4 Characteristics of steels with specified through thickness properties are given in Pt D, Ch 2, Sec 1, [9].

2.2 Information to be kept on board

2.2.1 A plan is to be kept on board indicating the steel types and grades adopted for the hull structures. Where steels other than those indicated in Tab 1 are used, their mechanical and chemical properties, as well as any workmanship requirements or recommendations, are to be available on board together with the above plan.

2.2.2 It is also recommended that a plan is kept on board indicating the hull structures built in normal strength steel of grades D or E.

Table 1 : Mechanical properties of hull steels

Steel grades	Minimum yield stress R_{eH}, in N/mm²	Ultimate minimum tensile strength R_m, in N/mm²
A-B-D-E t ≤ 100mm	235	400 - 520
AH32-DH32-EH32 t ≤ 100mm FH32 t ≤ 50mm	315	440 - 590
AH36-DH36-EH36 t ≤ 100mm FH36 t ≤ 50mm	355	490 - 620
AH40-DH40-EH40 FH40 t ≤ 50mm	390	510 - 650
Note 1: Reference in Part D: Pt D, Ch 2, Sec 1, [2]		

2.3 Material factor k

2.3.1 General

Unless otherwise specified, the material factor k has the values defined in Tab 2, as a function of the minimum guaranteed yield stress R_{eH}.

For intermediate values of R_{eH} , k may be obtained by linear interpolation.

Steels with a yield stress lower than 235 N/mm² or greater than 390 N/mm² are considered by Tasneef on a case-by-case basis.

Table 2 : Material factor k

R_{eH} , in N/mm²	k
235	1
315	0,78
355	0,72
390	0,68

2.4 Grades of steel

2.4.1 For the purpose of the selection of steel grades to be used for the various structural members, the latter are divided into categories (SECONDARY, PRIMARY and SPECIAL),as indicated in Tab 3.

Tab 3 also specifies the classes (I, II and III) of the materials to be used for the various categories of structural members.

2.4.2 Materials are to be of a grade not lower than that indicated in Tab 4 depending on the material class and structural member gross thickness.

2.4.3 For strength members not mentioned in Tab 3, grade A/AH may generally be used.

2.4.4 The steel grade is to correspond to the as-fitted gross thickness when this is greater than the gross thickness obtained from the net thickness required by this Rules.

2.4.5 Steel grades of plates or sections of gross thickness greater than the limiting thicknesses in Tab 1 are considered by Tasneef on a case-by-case basis.

2.4.6 In specific cases, such as [2.4.7], with regard to stress distribution along the hull girder, the classes required within 0,4L amidships may be extended beyond that zone, on a case-by-case basis.

2.4.7 The material classes required for the strength deck plating, the sheerstrake and the upper strake of longitudinal bulkheads within 0,4L amidships are to be maintained for an adequate length across the poop front and at the ends of the bridge, where fitted.

2.4.8 Rolled products used for welded attachments on hull plating, such as gutter bars and bilge keels, are to be of the same grade as that used for the hull plating in way.

Where it is necessary to weld attachments to the sheerstrake or stringer plate, attention is to be given to the appropriate choice of material and design, the workmanship and welding and the absence of prejudicial undercuts and notches, with particular regard to any free edges of the material.

2.4.9 In the case of grade D plates with a nominal thickness equal to or greater than 36 mm, or in the case of grade DH plates with a nominal thickness equal to or greater than 31 mm, Tasneef may, on a case by case basis, require the impact test to be carried out on each original “rolled unit”, where the above plates:

- either are to be placed in positions where high local stresses may occur, for instance at breaks of poop and bridge, or in way of large openings on the strength deck and on the bottom, including relevant doublings, or
- are to be subjected to considerable cold working.

2.4.10 In the case of full penetration welded joints located in positions where high local stresses may occur perpendicular to the continuous plating, Tasneef may, on a case by case basis, require the use of rolled products having adequate ductility properties in the through thickness direction, such as to prevent the risk of lamellar tearing (Z type steel, see Part D).

2.4.11 In highly stressed areas, Tasneef may require that plates of gross thickness greater than 20 mm are of grade D/DH or E/EH.

2.4.12 For certain uses, grade B steel with controlled toughness at 0°C may be required for plates of gross thickness less than 25 mm.

Table 3 : Application of material classes and grades

Structural member category	Material class or grade	
	Within 0,4L amidships	Outside 0,4L amidships
SECONDARY: • Longitudinal bulkhead strakes, other than that belonging to the Primary category • Deck plating exposed to weather, other than that belonging to the Primary or Special category • Side plating	I	A / AH
PRIMARY: • Bottom plating (including keel plate) • Strength deck plating, excluding that belonging to the Special category • Continuous longitudinal members above strength deck, excluding hatch coamings • Uppermost strake in longitudinal bulkhead • Vertical strake (hatch side girder) and uppermost sloped strake in top wing tank	II	A / AH
SPECIAL: • Sheer strake at strength deck **(1) (8)** • Stringer plate in strength deck **(1) (8)** • Deck strake at longitudinal bulkhead **(2) (8)** • Strength deck plating at outboard corners of cargo hatch openings in container carriers and other ships with similar hatch opening configuration **(3)** • Strength deck plating at corners of cargo hatch openings in bulk carriers, ore carriers, combination carriers and other ships with similar hatch opening configuration **(4)** • Bilge strake **(5) (6) (8)** • Longitudinal hatch coamings of length greater than 0,15 L **(7)** • End brackets and deckhouse transition of longitudinal cargo hatch coamings **(7)**	III	II (I outside 0,6L amidships)

(1) To be not less than grade E/EH within 0,4L amidships in ships with length exceeding 250 metres.
(2) Excluding deck plating in way of inner-skin bulkhead of double hull ships.
(3) To be not less than class III within the length of the cargo region.
(4) To be not less than class III within 0,6L amidships and class II within the remaining length of the cargo region.
(5) May be of class II in ships with a double bottom over the full breadth and with length less than 150 metres.
(6) To be not less than grade D/DH within 0,4L amidships in ships with length exceeding 250 metres.
(7) To be not less than grade D/DH.
(8) Single strakes required to be of class III or of grade E/EH and within 0,4L amidships are to have breadths not less than (800+5L) mm, but not necessarily greater than 1800 mm, unless limited by the geometry of the ship design.

Note 1: Plating materials for sternframes, rudders, rudder horns and shaft brackets are generally to be of grades not lower than those corresponding to class II.
For rudder and rudder body plates subjected to stress concentrations (e.g. in way of lower support of semi-spade rudders or at upper part of spade rudders) class III is to be applied.

Note 2: Bedplates of seats for propulsion and auxiliary engines inserted in the inner bottom are to be of class I. In other cases, the steel may generally be of grade A. Different grades may be required by Tasneef on a case-by-case basis.

Note 3: Plating at corners of large hatch openings on decks located below the strength deck, in the case of hatches of holds for refrigerated cargoes, and insert plates at corners of large openings on side shell plating are generally to be of class III.

Table 4 : Material grade requirements for classes I, II and III

Class	I		II		III	
Gross thickness, in mm	NSS	HSS	NSS	HSS	NSS	HSS
t ≤ 15	A	AH	A	AH	A	AH
15 < t ≤ 20	A	AH	A	AH	B	AH
20 < t ≤ 25	A	AH	B	AH	D	DH
25 < t ≤ 30	A	AH	D	DH	D	DH
30 < t ≤ 35	B	AH	D	DH	E	EH
35 < t ≤ 40	B	AH	D	DH	E	EH
40 < t ≤ 50	D	DH	E	EH	E	EH
Note 1:"NSS" and "HSS" mean, respectively: "Normal Strength Steel" and "Higher Strength Steel".						

2.5 Grades of steel for structures exposed to low air temperatures

2.5.1 For ships intended to operate in areas with low air temperatures (-20°C or below), e.g. regular service during winter seasons to Arctic or Antarctic waters, the materials in exposed structures are to be selected based on the design temperature t_D, to be taken as defined in [2.5.2].

2.5.2 The design temperature t_D is to be taken as the lowest mean daily average air temperature in the area of operation, where:

Mean : Statistical mean over observation period (at least 20 years)

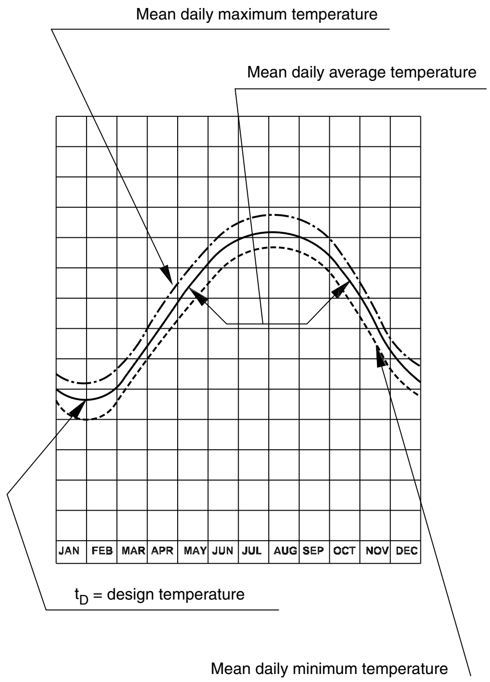
Average : Average during one day and night

Lowest : Lowest during one year

Fig 1 illustrates the temperature definition.

For seasonally restricted service, the lowest value within the period of operation applies.

Figure 1 : Commonly used definitions of temperatures



2.5.3 For the purpose of the selection of steel grades to be used for the structural members above the lowest ballast waterline and exposed to air, the latter are divided into categories (SECONDARY, PRIMARY and SPECIAL), as indicated in Tab 5.

Tab 5 also specifies the classes (I, II and III) of the materials to be used for the various categories of structural members.

For non-exposed structures and structures below the lowest ballast waterline, see [2.4].

2.5.4 Materials may not be of a lower grade than that indicated in Tab 8 to Tab 10 depending on the material class, structural member gross thickness and design temperature t_D.

For design temperatures t_D < -55°C, materials will be specially considered by Tasneef on a case by case basis.

2.5.5 Single strakes required to be of class III or of grade E/EH of FH are to have breadths not less than (800+5L) mm, but not necessarily greater than 1800 mm.

Table 5 : Application of material classes and grades for structures exposed to low air temperatures

Structural member category	Material class	
	Within 0,4L amidships	Outside 0,4L amidships
SECONDARY: Deck plating exposed to weather (in general) Side plating above T_B **(1)** Transverse bulkheads above T_B **(1)**	I	I
PRIMARY: Strength deck plating **(2)** Continuous longitudinal members above strength deck (excluding longitudinal hatch coamings of ships equal to or greater than 90 m in length) Longitudinal bulkhead above T_B **(1)** Topside tank bulkhead above T_B **(1)**	II	I
SPECIAL: Sheer strake at strength deck **(3)** Stringer plate in strength deck **(3)** Deck strake at longitudinal bulkhead **(4)** Continuous longitudinal hatch coamings of ships equal to or greater than 90 m in length **(5)**	III	II

(1) T_B is the draught in light ballast condition, defined in Ch 5, Sec 1, [2.4.3].
(2) Plating at corners of large hatch openings to be considered on a case by case basis.
Class III or grade E/EH to be applied in positions where high local stresses may occur.
(3) To be not less than grade E/EH within 0,4 L amidships in ships with length exceeding 250 m.
(4) In ships with breadth exceeding 70 metres at least three deck strakes to be class III.
(5) To be not less than grade D/DH.
Note 1: Plating materials for sternframes, rudder horns, rudders and shaft brackets are to be of grades not lower than those corresponding to the material classes in [2.4].

2.6 Grades of steel within refrigerated spaces

2.6.1 For structural members within or adjacent to refrigerated spaces, when the design temperatures is below 0°C, the materials are to be of grade not lower than those indicated in Tab 9, depending on the design temperature, the structural member gross thickness and its category (as defined in Tab 3).

2.6.2 Unless a temperature gradient calculation is carried out to assess the design temperature and the steel grade in the structural members of the refrigerated spaces, the temperatures to be assumed are specified below:

- temperature of the space on the uninsulated side, for plating insulated on one side only, either with uninsulated stiffening members (i.e. fitted on the uninsulated side of plating) or with insulated stiffening members (i.e. fitted on the insulated side of plating)
- mean value of temperatures in the adjacent spaces, for plating insulated on both sides, with insulated stiffening members, when the temperature difference between the adjacent spaces is generally not greater than 10 °C (when the temperature difference between the adjacent spaces is greater than 10°C, the temperature value is established by Tasneef on a case by case basis)
- in the case of non-refrigerated spaces adjacent to refrigerated spaces, the temperature in the non-refrigerated spaces is to be conventionally taken equal to 0°C.

2.6.3 Situations other than those mentioned in [2.6.1] and [2.6.2] or special arrangements will be considered by Tasneef on a case by case basis.

2.6.4 Irrespective of the provisions of [2.6.1], [2.6.2] and Tab 9, steel having grades lower than those required in [2.4], Tab 3 and Tab 4, in relation to the class and gross thickness of the structural member considered, may not be used.

Table 6 : Material grade requirements for class I at low temperatures

Gross thickness, in mm	-20°C / -25°C		-26°C / -35°C		-36°C / -45°C		-46°C / -55°C	
	NSS	HSS	NSS	HSS	NSS	HSS	NSS	HSS
t ≤ 10	A	AH	B	AH	D	DH	D	DH
10 < t ≤ 15	B	AH	D	DH	D	DH	D	DH
15 < t ≤ 20	B	AH	D	DH	D	DH	E	EH
20 < t ≤ 25	D	DH	D	DH	D	DH	E	EH
25 < t ≤ 30	D	DH	D	DH	E	EH	E	EH
30 < t ≤ 35	D	DH	D	DH	E	EH	E	EH
35 < t ≤ 45	D	DH	E	EH	E	EH	ϕ	FH
45 < t ≤ 50	E	EH	E	EH	ϕ	FH	ϕ	FH
Note 1:“NSS” and “HSS” mean, respectively, “Normal Strength Steel” and “Higher Strength Steel”. **Note 2:**“ϕ” = not applicable.								

Table 7 : Material grade requirements for class II at low temperatures

Gross thickness, in mm	-20°C / -25°C		-26°C / -35°C		-36°C / -45°C		-46°C / -55°C	
	NSS	HSS	NSS	HSS	NSS	HSS	NSS	HSS
t ≤ 10	B	AH	D	DH	D	DH	E	EH
10 < t ≤ 20	D	DH	D	DH	E	EH	E	EH
20 < t ≤ 30	D	DH	E	EH	E	EH	ϕ	FH
30 < t ≤ 40	E	EH	E	EH	ϕ	FH	ϕ	FH
40 < t ≤ 45	E	EH	ϕ	FH	ϕ	FH	ϕ	ϕ
45 < t ≤ 50	E	EH	ϕ	FH	ϕ	FH	ϕ	ϕ
Note 1:“NSS” and “HSS” mean, respectively, “Normal Strength Steel” and “Higher Strength Steel”. **Note 2:**“ϕ” = not applicable.								

Table 8 : Material grade requirements for class III at low temperatures

Gross thickness, in mm	-20°C / -25°C		-26°C / -35°C		-36°C / -45°C		-46°C / -55°C	
	NSS	HSS	NSS	HSS	NSS	HSS	NSS	HSS
t ≤ 10	D	DH	D	DH	E	EH	E	EH
10 < t ≤ 20	D	DH	E	EH	E	EH	ϕ	FH
20 < t ≤ 25	E	EH	E	EH	ϕ	FH	ϕ	FH
25 < t ≤ 30	E	EH	E	EH	ϕ	FH	ϕ	FH
30 < t ≤ 35	E	EH	ϕ	FH	ϕ	FH	ϕ	ϕ
35 < t ≤ 40	E	EH	ϕ	FH	ϕ	FH	ϕ	ϕ
40 < t ≤ 50	ϕ	FH	ϕ	FH	ϕ	ϕ	ϕ	ϕ
Note 1:“NSS” and “HSS” mean, respectively, “Normal Strength Steel” and “Higher Strength Steel”. **Note 2:**“ϕ” = not applicable.								

Table 9 : Material grade requirements for members within or adjacent to refrigerated spaces

Design temperature, in °C	Gross thickness, in mm	Structural member category	
		Secondary	Primary or Special
$-10 \le t_D < 0$	$t \le 20$	B / AH	B / AH
	$20 < t \le 25$	B / AH	D / DH
	$t > 25$	D / DH	E / EH
$-25 \le t_D < -10$	$t \le 15$	B / AH	D / DH
	$15 < t \le 25$	D / DH	E / EH
	$t > 25$	E / EH	E / EH
$-40 \le t_D < -25$	$t \le 25$	D / DH	E / EH
	$t > 25$	E / EH	E / EH

3 Steels for forging and casting

3.1 General

3.1.1 Mechanical and chemical properties of steels for forging and casting to be used for structural members are to comply with the applicable requirements of Part D.

3.1.2 Steels of structural members intended to be welded are to have mechanical and chemical properties deemed appropriate for this purpose by Tasneef on a case by case basis.

3.1.3 The steels used are to be tested in accordance with the applicable requirements of Part D.

3.2 Steels for forging

3.2.1 For the purpose of testing, which is to be carried out in accordance with the applicable requirements of Part D, the above steels for forging are assigned to class 1 (see Pt D, Ch 2, Sec 3).

3.2.2 Rolled bars may be accepted in lieu of forged products, after consideration by Tasneef on a case-by-case basis.

In such case, compliance with the provisions of Pt D, Ch 2, Sec 1, relevant to the quality and testing of rolled parts accepted in lieu of forged parts, may be required.

3.3 Steels for casting

3.3.1 Cast parts intended for stems, sternframes, rudders, parts of steering gear and deck machinery in general may be made of C and C-Mn weldable steels of quality 1, having tensile strength R_m = 400 N/mm^2 or 440 N/mm^2, in accordance with the applicable requirements of Pt D, Ch 2, Sec 4.

Items which may be subjected to high stresses may be required to be of quality 2 steels of the above types.

3.3.2 For the purpose of testing, which is to be carried out in accordance with Pt D, Ch 2, Sec 4, [1.11], the above steels for casting are assigned to class 1 irrespective of their quality.

3.3.3 The welding of cast parts to main plating contributing to hull strength members is considered by Tasneef on a case-by-case basis.

Tasneef may require additional properties and tests for such casting, in particular impact properties which are appropriate to those of the steel plating on which the cast parts are to be welded and non-destructive examinations.

3.3.4 Heavily stressed cast parts of steering gear, particularly those intended to form a welded assembly and tillers or rotors mounted without key, are to be subjected to non-destructive examination to check their internal structure.

4 Aluminium alloy structures

4.1 General

4.1.1 The characteristics of aluminium alloys are to comply with the requirements of Pt D, Ch 3, Sec 2.

Series 5000 aluminium-magnesium alloys or series 6000 aluminium-magnesium-silicon alloys are generally to be used (see Pt D, Ch 3, Sec 2, [2]).

4.1.2 In the case of structures subjected to low service temperatures or intended for other specific applications, the alloys to be employed are defined in each case by Tasneef which states the acceptability requirements and conditions.

4.2 Extruded plating

4.2.1 Extrusions with built-in plating and stiffeners, referred to as extruded plating, may be used.

4.2.2 In general, the application is limited to decks, bulkheads, superstructures and deckhouses. Other uses may be permitted by Tasneef on a case-by-case basis.

4.2.3 Extruded plating is preferably to be oriented so that the stiffeners are parallel to the direction of main stresses.

4.2.4 Connections between extruded plating and primary members are to be given special attention.

4.3 Influence of welding on mechanical characteristics

4.3.1 Welding heat input lowers locally the mechanical strength of aluminium alloys hardened by work hardening (series 5000 other than condition 0 or H111) or by heat treatment (series 6000).

4.3.2 Consequently, where necessary, a drop in the mechanical characteristics of welded structures with respect to those of the parent material is to be considered in the heat-affected zone.

The heat-affected zone may be taken to extend 25 mm on each side of the weld axis.

4.3.3 Aluminium alloys of series 5000 in 0 condition (annealed) or in H111 condition (annealed flattened) are not subject to a drop in mechanical strength in the welded areas.

4.3.4 Aluminium alloys of series 5000 other than condition 0 or H111 are subject to a drop in mechanical strength in the welded areas.

The mechanical characteristics to consider are normally those of condition 0 or H111.

Higher mechanical characteristics may be taken into account, provided they are duly justified.

4.3.5 Aluminium alloys of series 6000 are subject to a drop in mechanical strength in the vicinity of the welded areas.

The mechanical characteristics to be considered are normally indicated by the supplier.

4.4 Material factor k

4.4.1 The material factor k for aluminium alloys is to be obtained from the following formula:

$$k = \frac{235}{\eta R_{p0,2}}$$

where:

- η : Joint coefficient for the welded assembly, corresponding to the aluminium alloy considered, given in Tab 10
- $R_{p0,2}$: Minimum guaranteed yield stress, in N/mm^2, of the parent material in delivery condition.

4.4.2 In the case of welding of two different aluminium alloys, the material factor k to be considered for the scantlings is the greater material factor of the aluminium alloys of the assembly.

5 Other materials and products

5.1 General

5.1.1 Other materials and products such as parts made of iron castings, where allowed, products made of copper and copper alloys, rivets, anchors, chain cables, cranes, masts, derrick posts, derricks, accessories and wire ropes are generally to comply with the applicable requirements of Part D.

5.1.2 The use of plastics or other special materials not covered by these Rules is to be considered by Tasneef on a case-by-case basis. In such cases, Tasneef states the requirements for the acceptance of the materials concerned.

5.1.3 Materials used in welding processes are to comply with the applicable requirements of Part D.

5.2 Iron cast parts

5.2.1 As a rule, the use of grey iron, malleable iron or spheroidal graphite iron cast parts with combined ferritic/perlitic structure is allowed only to manufacture low stressed elements of secondary importance.

5.2.2 Ordinary iron cast parts may not be used for windows or sidescuttles; the use of high grade iron cast parts of a suitable type will be considered by Tasneef on a case-by-case basis.

Table 10 : Joint coefficient for aluminium alloys

Aluminium alloy	η
Alloys without work-hardening treatment (series 5000 in annealed condition 0 or annealed flattened condition H111)	1
Alloys hardened by work hardening (series 5000 other than condition 0 or H111)	$R'_{p0,2}/R_{p0,2}$
Alloys hardened by heat treatment (series 6000) **(1)**	$R'_{p0,2}/R_{p0,2}$

(1) When no information is available, coefficient η is to be taken equal to the metallurgical efficiency coefficient β defined in Tab 11.

Note 1:

$R'_{p0,2}$: Minimum guaranteed yield stress, in N/mm^2, of material in welded condition (see [4.3]).

Table 11 : Aluminium alloys
Metallurgical efficiency coefficient β

Aluminium alloy	Temper condition	Gross thickness, in mm	β
6005 A (Open sections)	T5 or T6	$t \le 6$	0,45
		$t > 6$	0,40
6005 A (Closed sections)	T5 or T6	All	0,50
6061 (Sections)	T6	All	0,53
6082 (Sections)	T6	All	0,45

SECTION 4 WELDING AND WELD CONNECTIONS

1 General

1.1 Application

1.1.1

The requirements of this Section apply to the preparation, execution and inspection of welded connections in hull structures.

The general requirements relevant to fabrication by welding and qualification of welding procedures are given in Part D, Chapter 5. As guidance, see also the indications given in the “Guide for Welding”.

The requirements relevant to the non-destructive examination of welded connections are given in the Rules for carrying out non-destructive examination of welding.

1.1.2 Weld connections are to be executed according to the approved plans. Any detail not specifically represented in the plans is, in any event, to comply with the applicable requirements.

1.1.3 It is understood that welding of the various types of steel is to be carried out by means of welding procedures approved for the purpose, even though an explicit indication to this effect may not appear on the approved plans.

1.1.4 The quality standard adopted by the shipyard is to be submitted to Tasneef and applies to all constructions unless otherwise specified on a case-by-case basis.

1.2 Base material

1.2.1 The requirements of this Section apply to the welding of hull structural steels or aluminium alloys of the types considered in Part D or other types accepted as equivalent by Tasneef

1.2.2 The service temperature is intended to be the ambient temperature, unless otherwise stated.

1.3 Welding consumables and procedures

1.3.1 Approval of welding consumables and procedures

Welding consumables and welding procedures adopted are to be approved by Tasneef

The requirements for the approval of welding consumables are given in Pt D, Ch 5, Sec 2.

The requirements for the approval of welding procedures for the individual users are given in Pt D, Ch 5, Sec 4 and Pt D, Ch 5, Sec 5.

1.3.2 Consumables

For welding of hull structural steels, the minimum consumable grades to be adopted are specified in Tab 1 depending on the steel grade.

For welding of other materials, the consumables indicated in the welding procedures to be approved are considered by Tasneef on a case-by-case basis.

Table 1 : Consumable grades

Steel grade	Consumable minimum grade	
	Butt welding, partial and full T penetration welding	Fillet welding
A	1	1
B - D	2	
E	3	
AH32 - AH36 DH32 - DH36	2Y	2Y
EH32 - EH36	3Y	
FH32 - FH36	4Y	
AH40	2Y40	2Y40
DH40 - EH40	3Y40	
FH40	4Y40	

Note 1:
Welding consumables approved for welding higher strength steels (Y) may be used in lieu of those approved for welding normal strength steels having the same or a lower grade; welding consumables approved in grade Y40 may be used in lieu of those approved in grade Y having the same or a lower grade.
Note 2:
In the case of welded connections between two hull structural steels of different grades, as regards strength or notch toughness, welding consumables appropriate to one or the other steel are to be adopted.

1.3.3 Electrodes for manual welding

Basic covered electrodes are to be used for the welding of structural members made in higher strength steels and irrespective of the steel type, for the welding of special and primary structural members as defined in Sec 3 Table 3.

Non-basic covered electrodes are generally allowed for manual fillet welding of structural members of moderate thickness (gross thickness less than 25 mm) made in normal strength steels.

1.4 Personnel and equipment

1.4.1 Welders

Manual and semi-automatic welding are to be performed by welders certified by Tasneef in accordance with recognised standards (see Pt D, Ch 5, Sec 1, [2.2.3] and Pt D, Ch 5, Sec 1, [2.2.5]); the welders are to be employed within the limits of their respective approval.

1.4.2 Automatic welding operators

Personnel manning automatic welding machines and equipment are to be competent and sufficiently trained.

1.4.3 Organisation

The internal organisation of the shipyard is to be such as to ensure compliance in full with the requirements in [1.4.1] and [1.4.2] and to provide assistance for and inspection of welding personnel, as necessary, by means of a suitable number of competent supervisors.

1.4.4 NDE operators

Non-destructive tests are to be carried out by operators qualified according to the requirements of Pt D, Ch 1, Sec 1, [3.6.4].

The qualifications are to be appropriate to the specific applications.

1.4.5 Technical equipment and facilities

The welding equipment is to be appropriate to the adopted welding procedures, of adequate output power and such as to provide for stability of the arc in the different welding positions.

In particular, the welding equipment for special welding procedures is to be provided with adequate and duly calibrated measuring instruments, enabling easy and accurate reading, and adequate devices for easy regulation and regular feed.

Manual electrodes, wires and fluxes are to be stocked in suitable locations so as to ensure their preservation in good condition.

1.5 Documentation to be submitted

1.5.1 The structural plans to be submitted for approval, according to Ch 1, Sec 2, are to contain the necessary data relevant to the fabrication by welding of the structures and items represented. Any detail not clearly represented in the plans is, in any event, to comply with the applicable Rule requirements.

For important structures, the main sequences of prefabrication, assembly and welding and non-destructive examination planned are also to be represented in the plans.

1.5.2 A plan showing the location of the various steel types is to be submitted at least for outer shell, deck and bulkhead structures.

1.6 Design

1.6.1 General

For the various structural details typical of welded construction in shipbuilding and not dealt with in this Section, the rules of good practice, recognised standards and past experience are to apply as agreed by Tasneef

1.6.2 Plate orientation

The plates of the shell and strength deck are generally to be arranged with their length in the fore-aft direction. Possible exceptions to the above will be considered by Tasneef on a case by case basis; tests as deemed necessary (for example, transverse impact tests) may be required by Tasneef

1.6.3 Overall arrangement

Particular consideration is to be given to the overall arrangement and structural details of highly stressed parts of the hull.

Special attention is to be given to the above details in the plan approval stage; accurate plans relevant to the special details (special structural details characterised by complex geometry associated with high or alternate stress) are to be submitted.

1.6.4 Prefabrication sequences

Prefabrication sequences are to be arranged so as to facilitate positioning and assembling as far as possible.

The amount of welding to be performed on board is to be limited to a minimum and restricted to easily accessible connections.

1.6.5 Distance between welds

Welds located too close to one another are to be avoided. The minimum distance between two adjacent welds is considered on a case by case basis, taking into account the level of stresses acting on the connected elements.

In general, the distance between two adjacent butts in the same strake of shell or deck plating is to be greater than two frame spaces.

2 Type of connection and preparation

2.1 General

2.1.1 The type of connection and the edge preparation are to be appropriate to the welding procedure adopted, the structural elements to be connected and the stresses to which they are subjected.

2.2 Butt welding

2.2.1 General

In general, butt connections of plating are to be full penetration, welded on both sides except where special procedures or specific techniques, considered equivalent by Tasneef are adopted.

Connections different from the above may be accepted by Tasneef on a case-by-case basis; in such cases, the relevant detail and workmanship specifications are to be approved.

2.2.2 Welding of plates with different thicknesses

In the case of welding of plates with a difference in gross thickness equal to or greater than:

- 3 mm, if the thinner plate has a gross thickness equal to or less than 10 mm
- 4 mm, if the thinner plate has a gross thickness greater than 10 mm,

a taper having a length of not less than 4 times the difference in gross thickness is to be adopted for connections of plating perpendicular to the direction of main stresses. For connections of plating parallel to the direction of main stresses, the taper length may be reduced to 3 times the difference in gross thickness.

When the difference in thickness is less than the above values, it may be accommodated in the weld transition between plates.

2.2.3 Edge preparation, root gap

Typical edge preparations and gaps are indicated in the "Guide for welding".

The acceptable root gap is to be in accordance with the adopted welding procedure and relevant bevel preparation.

2.2.4 Butt welding on permanent backing

Butt welding on permanent backing, i.e. butt welding assembly of two plates backed by the flange or the face plate of a stiffener, may be accepted where back welding is not feasible or in specific cases deemed acceptable by Tasneef

The type of bevel and the gap between the members to be assembled are to be such as to ensure a proper penetration of the weld on its backing and an adequate connection to the stiffener as required.

2.2.5 Section, bulbs and flat bars

When lengths of longitudinals of the shell plating and strength deck within 0,6 L amidships, or elements in general subject to high stresses, are to be connected together by butt joints, these are to be full penetration. Other solutions may be adopted if deemed acceptable by Tasneef on a case-by-case basis.

The work is to be done in accordance with an approved procedure; in particular, this require-ment applies to work done on board or in condi-tions of difficult access to the welded connection.

Special measures may be required by Tasneef

2.3 Fillet welding

2.3.1 General

In general, ordinary fillet welding (without bevel) may be adopted for T connections of the various simple and composite structural elements, where they are subjected to low stresses (in general not exceeding 30 N/mm^2) and adequate precautions are taken to prevent the possibility of local laminations of the element against which the T web is welded.

Where this is not the case, partial or full T penetration welding according to [2.4] is to be adopted.

2.3.2 Fillet welding types

Fillet welding may be of the following types:

- continuous fillet welding, where the weld is constituted by a continuous fillet on each side of the abutting plate (see [2.3.3])
- intermittent fillet welding, which may be subdivided (see [2.3.4]) into:
  - chain welding
  - scallop welding
  - staggered welding.

2.3.3 Continuous fillet welding

Continuous fillet welding is to be adopted:

- for watertight connections
- for connections of brackets, lugs and scallops
- at the ends of connections for a length of at least 75mm
- where intermittent welding is not allowed, according to [2.3.4].

Continuous fillet welding may also be adopted in lieu of intermittent welding wherever deemed suitable, and it is recommended where the spacing p, calculated according to [2.3.4], is low.

2.3.4 Intermittent welding

The spacing p and the length d, in mm, of an intermittent weld, shown in:

- Fig 1, for chain welding
- Fig 2, for scallop welding
- Fig 3, for staggered welding

are to be such that:

$$\frac{p}{d} \leq \varphi$$

where the coefficient φ is defined in Tab 2 and Tab 3 for the different types of intermittent welding, depending on the type and location of the connection.

In general, staggered welding is not allowed for connections subjected to high alternate stresses.

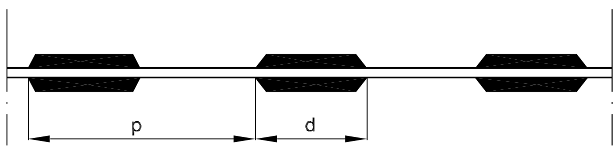
In addition, the following limitations are to be complied with:

- chain welding (see Fig 1):

  d ≥ 75 mm

  p-d ≤ 200 mm

Figure 1 : Intermittent chain welding



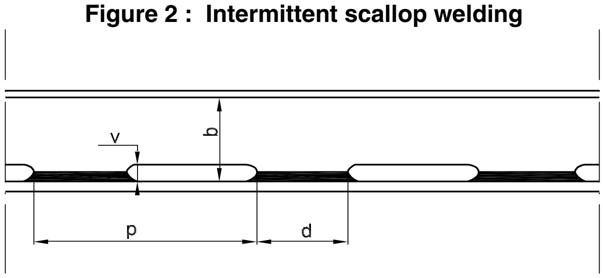
- scallop welding (see Fig 2):

  d ≥ 75 mm

  p-d ≤ 150 mm

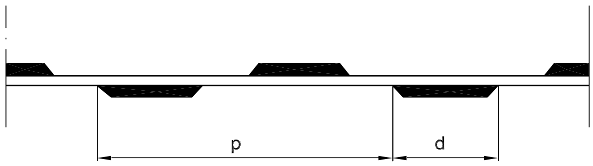
  v ≤ 0,25b, without being greater than 75 mm

Figure 2 : Intermittent scallop welding



- staggered welding (see Fig 3):
  $d \geq 75$ mm
  $p-2d \leq 300$ mm
  $p \leq 2d$ for connections subjected to high alternate stresses.

Figure 3 : Intermittent staggered welding



2.3.5 Throat thickness of fillet weld T-connections

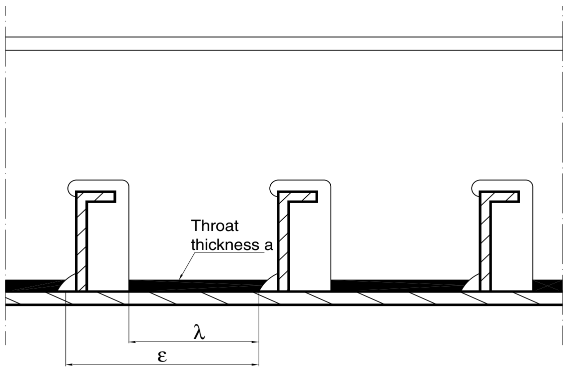
The throat thickness, in mm, of fillet weld T-connections is to be obtained from the following formula:

$$t_T = w_F t \frac{p}{d}$$

where:

- w_F : Welding factor, defined in Tab 2 for the various hull structural connections; for connections of primary supporting members belonging to single-skin structures and not mentioned in Tab 2.
- t : Actual gross thickness, in mm, of the structural element which constitutes the web of the T-connection
- p, d : Spacing and length, in mm, of an intermittent weld, defined in [2.3.4].

Figure 4 : Continuous fillet welding between cut-outs



For continuous fillet welds, p/d is to be taken equal to 1.

In no case may the throat thickness be less than:

- 3,0 mm, where the gross thickness of the thinner plate is less than 6 mm
- 3,5 mm, otherwise.

The throat thickness may be required by Tasneef to be increased, depending on the results of structural analyses.

The leg length of fillet weld T-connections is to be not less than 1,4 times the required throat thickness.

2.3.6 Weld dimensions in a specific case

Where intermittent fillet welding is adopted with:

- length $d = 75$ mm
- throat thickness t_T specified in Tab 4 depending on the thickness t defined in [2.3.5],

the weld spacing may be taken equal to the value p_1 defined in Tab 2. The values of p_1 in Tab 2 may be used when $8 \leq t \leq 16$ mm.

For thicknesses t less than 8 mm, the values of p_1 may be increased, with respect to those in Tab 2, by:

- 10 mm for chain or scallop welding
- 20 mm for staggered welding,

without exceeding the limits in [2.3.4].

For thicknesses t greater than 16 mm, the values of p_1 are to be reduced, with respect to those in Tab 2, by:

- 10 mm for chain or scallop welding
- 20 mm for staggered welding.

Figure 5 : Intermittent scallop fillet welding between cut-outs

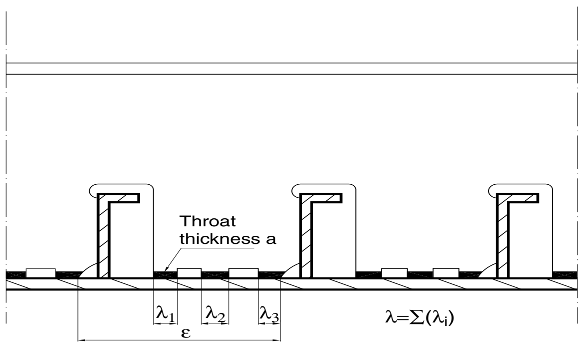


Table 2 : Welding factors w_F and coefficient φ for the various hull structural connections

Hull area	Connection			w_F **(1)**	φ **(2) (3)**			p_1, in mm (see [2.3.6]) **(3)**
	of	to			CH	SC	ST	
General, unless otherwise specified in the table	watertight plates	boundaries		0,35				
	webs of ordinary stiffeners	plating		0,13	3,5	3,0	4,6	ST 260
		face plate of fabricated stiffeners	at ends **(4)**	0,13				
			elsewhere	0,13	3,5	3,0	4,6	ST 260
Bottom and double bottom	longitudinal ordinary stiffeners	bottom and inner bottom plating		0,13	3,5	3,0	4,6	ST 260
	centre girder	keel		0,25	1,8	1,8		CH/SC 130
		inner bottom plating		0,20	2,2	2,2		CH/SC 160
	side girders	bottom and inner bottom plating		0,13	3,5	3,0	4,6	ST 260
		floors (interrupted girders)		0,20	2,2			CH 160
	floors	bottom and inner bottom plating	in general	0,13	3,5	3,0	4,6	ST 260
			at ends (20% of span) for longitudinally framed double bottom	0,25	1,8			CH 130
		inner bottom plating in way of brackets of primary supporting members		0,25	1,8			CH 130
		girders (interrupted floors)		0,20	2,2			CH 160
	partial side girders	floors		0,25	1,8			CH 130
	web stiffeners	floor and girder webs		0,13	3,5	3,0	4,6	ST 260
Side	ordinary stiffeners	side and plating		0,13	3,5	3,0	4,6	ST 260
Deck	strength deck	side plating		Partial penetration welding				
	non-watertight decks	side plating		0,20	2,2			CH 160
	ordinary stiffeners and intercostal girders	deck plating		0,13	3,5	3,0	4,6	ST 260
	hatch coamings	deck plating	in general	0,35				
			at corners of hatchways for 15% of the hatch length	0,45				
	web stiffeners	coaming webs		0,13	3,5	3,0	4,6	ST 260
Bulkheads	watertight bulkhead structures	boundaries		0,35				
	non-watertight bulkhead structures	boundaries	wash bulkheads	0,20	2,2	2,2		CH/SC 160
			others	0,13	3,5	3,0	4,6	ST 260
	ordinary stiffeners	bulkhead plating	in general **(5)**	0,13	3,5	3,0	4,6	ST 260
			at ends (25% of span), where no end brackets are fitted	0,35				
Structures located forward of 0,75 L from the AE **(6)**	bottom longitudinal ordinary stiffeners	bottom plating		0,20	2,2			CH 160
	floors and girders	bottom and inner bottom plating		0,25	1,8			CH 130
	side frames in panting area	side plating		0,20	2,2			CH 160
	webs of side girders in single side skin structures	side plating and face plate	A< 65 cm² **(7)**	0,25	1,8	1,8		CH/SC 130
			A ≥ 65 cm² **(7)**	See Tab 3				

Hull area	Connection of	Connection to		w_F (1)	φ (2) (3) CH	φ (2) (3) SC	φ (2) (3) ST	p_1, in mm (see [2.3.6]) (3)
After peak (6)	internal structures	each other		0,20				
	side ordinary stiffeners	side plating		0,20				
	floors	bottom and inner bottom plating		0,20				
Machinery space (6)	centre girder	keel and inner bottom plating	in way of main engine foundations	0,45				
			in way of seating of auxiliary machinery and boilers	0,35				
			elsewhere	0,25	1,8	1,8		CH/SC 130
	side girders	bottom and inner bottom plating	in way of main engine foundations	0,45				
			in way of seating of auxiliary machinery and boilers	0,35				
			elsewhere	0,20	2,2	2,2		CH/SC 160
	floors (except in way of main engine foundations)	bottom and inner bottom plating	in way of seating of auxiliary machinery and boilers	0,35				
			elsewhere	0,20	2,2	2,2		CH/SC 160
	floors in way of main engine foundations	bottom plating		0,35				
		foundation plates		0,45				
	floors	centre girder	single bottom	0,45				
			double bottom	0,25	1,8	1,8		CH/SC 130
Superstructures and deckhouses	external bulkheads	deck	in general	0,35				
			engine and boiler casings at corners of openings (15% of opening length)	0,45				
	internal bulkheads	deck		0,13	3,5	3,0	4,6	ST 260
	ordinary stiffeners	external and internal bulkhead plating		0,13	3,5	3,0	4,6	ST 260
Pillars	elements composing the pillar section	each other (fabricated pillars)		0,13				
	pillars	deck	pillars in compression	0,35				
			pillars in tension	Full penetration welding				
Ventilators	coamings	deck		0,35				

Hull area	Connection			w_F **(1)**	φ **(2) (3)**			p_1, in mm (see [2.3.6]) **(3)**
	of	to			CH	SC	ST	
Rudders	webs in general	each other		0,20		2,2		SC 160
		plating	in general	0,20		2,2		SC 160
			top and bottom plates of rudder plating	0,35				
		solid parts or rudder stock		According to Ch 10, Sec 1, [7.4] or Ch 10, Sec 1, [7.5]				
	horizontal and vertical webs directly connected to solid parts	each other		0,45				
		plating		0,35				

(1) In connections for which $w_F \geq 0,35$, continuous fillet welding is to be adopted.
(2) For coefficient φ, see [2.3.4]. In connections for which no φ value is specified for a certain type of intermittent welding, such type is not permitted and continuous welding is to be adopted.
(3) CH = chain welding, SC = scallop welding, ST = staggered welding.
(4) Ends of ordinary stiffeners means the area extended 75 mm from the span ends. Where end brackets are fitted, ends means the area extended in way of brackets and at least 50 mm beyond the bracket toes.
(5) In tanks intended for the carriage of ballast or fresh water, continuous welding with $w_F = 0,35$ is to be adopted.
(6) For connections not mentioned, the requirements for the central part apply.
(7) A is the face plate sectional area of the side girders, in cm^2.

2.3.7 Throat thickness of welds between cut-outs

The throat thickness of the welds between the cut-outs in primary supporting member webs for the passage of ordinary stiffeners is to be not less than the value obtained, in mm, from the following formula:

$$t_{TC} = t_T\frac{\varepsilon}{\lambda}$$

where:

t_T : Throat thickness defined in [2.3.5]

ε, λ : Dimensions, in mm, to be taken as shown in:

- Fig 4, for continuous welding
- Fig 5, for intermittent scallop welding.

2.3.8 Throat thickness of welds connecting ordinary stiffeners with primary supporting members

The throat thickness of fillet welds connecting ordinary stiffeners and collar plates, if any, to the web of primary supporting members is to be not less than $0,35t_W$, where t_W is the web gross thickness, in mm. Further requirements are specified in Sec 2.

Table 3 : Welding factors w_F and coefficient φ for connections of primary supporting members

<table>
<tr><th rowspan="2">Primary supporting member</th><th colspan="3">Connection</th><th rowspan="2">w_F (1)</th><th colspan="3">φ (2) (3)</th><th rowspan="2">p_1, in mm (see [2.3.6]) (3)</th></tr>
<tr><th>of</th><th colspan="2">to</th><th>CH</th><th>SC</th><th>ST</th></tr>
<tr><td rowspan="6">General (4)</td><td rowspan="2">web, where A < 65 cm²</td><td rowspan="2">plating and face plate</td><td>at ends</td><td>0,20</td><td></td><td></td><td></td><td></td></tr>
<tr><td>elsewhere</td><td>0,15</td><td>3,0</td><td>3,0</td><td></td><td>CH/SC 210</td></tr>
<tr><td rowspan="3">web, where A ≥ 65 cm²</td><td colspan="2">plating</td><td>0,35</td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">face plate</td><td>at ends</td><td>0,35</td><td></td><td></td><td></td><td></td></tr>
<tr><td>elsewhere</td><td>0,25</td><td>1,8</td><td>1,8</td><td></td><td>CH/SC 130</td></tr>
<tr><td>end brackets</td><td colspan="2">face plate</td><td>0,35</td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="5">In tanks, where A < 65 cm² (5)</td><td rowspan="4">web</td><td rowspan="2">plating</td><td>at ends</td><td>0,25</td><td></td><td></td><td></td><td></td></tr>
<tr><td>elsewhere</td><td>0,20</td><td>2,2</td><td>2,2</td><td></td><td>CH/SC 160</td></tr>
<tr><td rowspan="2">face plate</td><td>at ends</td><td>0,20</td><td></td><td></td><td></td><td></td></tr>
<tr><td>elsewhere</td><td>0,15</td><td>3,0</td><td>3,0</td><td></td><td>CH/SC 210</td></tr>
<tr><td>end brackets</td><td colspan="2">face plate</td><td>0,35</td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="4">In tanks, where A ≥ 65 cm²</td><td rowspan="3">web</td><td rowspan="2">plating</td><td>at ends</td><td>0,45</td><td></td><td></td><td></td><td></td></tr>
<tr><td>elsewhere</td><td>0,35</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">face plate</td><td>0,35</td><td></td><td></td><td></td><td></td></tr>
<tr><td>end brackets</td><td colspan="2">face plate</td><td>0,45</td><td></td><td></td><td></td><td></td></tr>
</table>

(1) In connections for which $w_F \geq 0,35$, continuous fillet welding is to be adopted.
(2) For coefficient φ, see [2.3.4]. In connections for which no φ value is specified for a certain type of intermittent welding, such type is not permitted.
(3) CH = chain welding, SC = scallop welding, ST = staggered welding.
(4) For cantilever deck beams, continuous welding is to be adopted.
(5) For primary supporting members in tanks intended for the carriage of ballast or fresh water, continuous welding is to be adopted.

Note 1:
A is the face plate sectional area of the primary supporting member, in cm².

Note 2:
Ends of primary supporting members means the area extending 20% of the span from the span ends. Where end brackets are fitted, ends means the area extending in way of brackets and at least 100 mm beyond the bracket toes.

Figure 6 : End connection of ordinary stiffener Dimensions of the cut-out

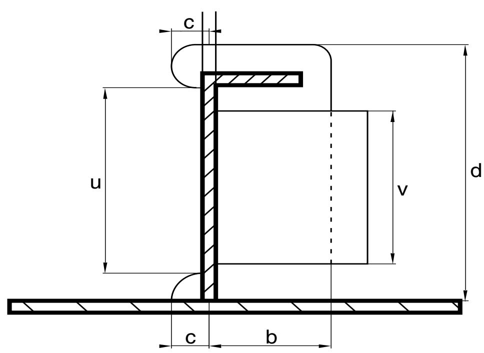


Table 4 : Required throat thickness

t, in mm	t_T, in mm	t, in mm	t_T, in mm
6	3,0	17	7,0
8	3,5	18	7,0
9	4,0	19	7,5
10	4,5	20	7,5
11	5,0	21	8,5
12	5,5	22	8,5
13	6,0	23	9,0
14	6,0	24	9,0
15	6,5	25	10,0
16	6,5	26	10,0

2.3.9 Throat thickness of deep penetration fillet welding

When fillet welding is carried out with automatic welding procedures, the throat thickness required in [2.3.5] may be reduced up to 15%, depending on the properties of the electrodes and consumables. However, this reduction may not be greater than 1,5 mm.

The same reduction applies also for semi-automatic procedures where the welding is carried out in the downhand position.

2.4 Partial and full T-penetration welding

2.4.1 General

Partial or full T-penetration welding is to be adopted for connections subjected to high stresses for which fillet welding is considered unacceptable by Tasneef

Typical edge preparations are indicated in:

- for partial penetration welds: Fig 7 and Fig 8, in which f, in mm, is to be taken between 3 mm and t/3, and α between 45° and 60°
- for full penetration welds: Fig 9 and Fig 10, in which f, in mm, is to be taken between 0 and 3 mm, and α between 45° and 60°

  Back gouging is generally required for full penetration welds.

2.4.2 Lamellar tearing

Precautions are to be taken in order to avoid lamellar tears, which may be associated with:

- cold cracking when performing T connections between plates of considerable thickness or high restraint
- large fillet welding and full penetration welding on higher strength steels.

2.5 Lap-joint welding

2.5.1 General

Lap-joint welding may be adopted for:

- peripheral connection of doublers
- internal structural elements subjected to very low stresses.

Elsewhere, lap-joint welding may be allowed by Tasneef on a case-by-case basis, if deemed necessary under specific conditions.

Continuous welding is generally to be adopted.

2.5.2 Gap

The surfaces of lap-joints are to be in sufficiently close contact.

2.5.3 Dimensions

The dimensions of the lap-joint are to be specified and are considered on a case-by-case basis. Typical details are given in the "Guide for welding".

Figure 7 : Partial penetration weld

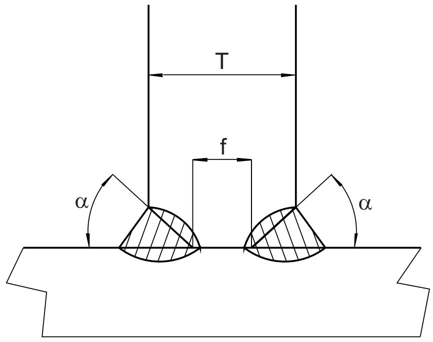


Figure 8 : Partial penetration weld

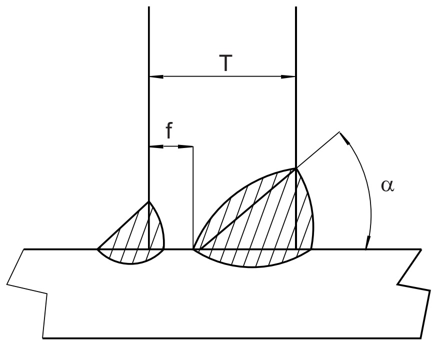


Figure 9 : Full penetration weld

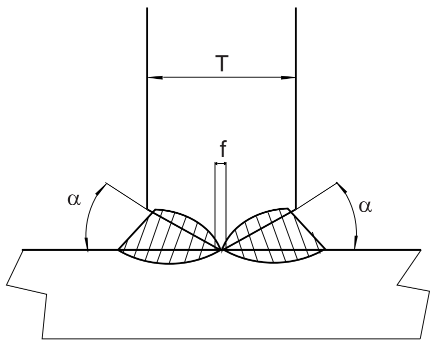
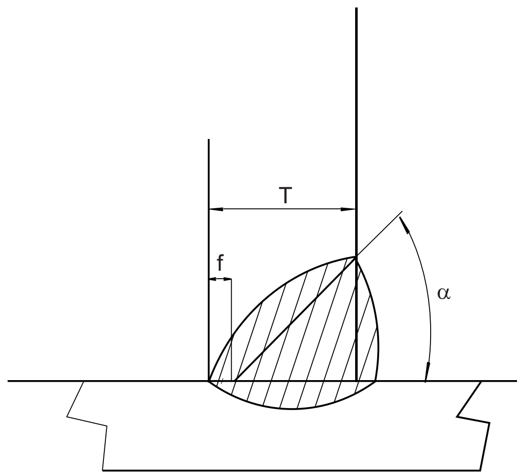


Figure 10 : Full penetration weld



2.6 Slot welding

2.6.1 General

Slot welding may be adopted. In general, slot welding of doublers on the outer shell and strength deck is not permitted within 0,6L amidships. Beyond this zone, slot welding may be accepted by Tasneef on a case-by-case basis.

Slot welding is, in general, permitted only where stresses act in a predominant direction. Slot welds are, as far as possible, to be aligned in this direction.

2.6.2 Dimensions

Slot welds are to be of appropriate shape (in general oval) and dimensions, depending on the plate thickness, and may not be completely filled by the weld.

Typical dimensions of the slot weld and the throat thickness of the fillet weld are given in the "Guide for welding".

The distance between two consecutive slot welds is to be not greater than a value which is defined on a case by case basis taking into account:

- the transverse spacing between adjacent slot weld lines
- the stresses acting in the connected plates
- the structural arrangement below the connected plates.

2.7 Plug welding

2.7.1 Plug welding may be adopted only when accepted by Tasneef on a case-by-case basis, according to specifically defined criteria. Typical details are given in the "Guide for welding".

3 Specific weld connections

3.1 Corner joint welding

3.1.1 Corner joint welding, as adopted in some cases at the corners of tanks, performed with ordinary fillet welds, is permitted provided the welds are continuous and of the required size for the whole length on both sides of the joint.

3.1.2 Alternative solutions to corner joint welding may be considered by Tasneef on a case-by-case basis.

3.2 Bilge keel connection

3.2.1 he intermediate flat, through which the bilge keel is connected to the shell, is to be welded as a shell doubler by continuous fillet welds.

The butt welds of the doubler and bilge keel are to be full penetration and shifted from the shell butts.

The butt welds of the bilge plating and those of the doublers are to be flush in way of crossing, respectively, with the doubler and with the bilge keel.

3.3 Connection between propeller post and propeller shaft bossing

3.3.1 Fabricated propeller posts are to be welded with full penetration welding to the propeller shaft bossing.

3.4 Bar stem connections

3.4.1 The bar stem is to be welded to the bar keel generally with butt welding.

The shell plating is also to be welded directly to the bar stem with butt welding.

4 Workmanship

4.1 Forming of plates

4.1.1 Hot or cold forming is to be performed according to the requirements of recognised standards or those accepted by Tasneef on a case-by-case basis depending on the material grade and rate of deformation.

Recommendations for cold and hot forming are given in the "Guide for welding".

4.2 Welding procedures and consumables

4.2.1 The various welding procedures and consumables are to be used within the limits of their approval and in accordance with the conditions of use specified in the respective approval documents.

4.3 Welding operations

4.3.1 Weather protection

Adequate protection from the weather is to be provided to parts being welded; in any event, such parts are to be dry.

In welding procedures using bare, cored or coated wires with gas shielding, the welding is to be carried out in weather protected conditions, so as to ensure that the gas outflow from the nozzle is not disturbed by winds and draughts.

4.3.2 Butt connection edge preparation

The edge preparation is to be of the required geometry and correctly performed. In particular, if edge preparation is carried out by flame, it is to be free from cracks or other detrimental notches.

Recommendations for edge preparation are given in the "Guide for welding".

4.3.3 Surface condition

The surfaces to be welded are to be free from rust, moisture and other substances, such as mill scale, slag caused by oxygen cutting, grease or paint, which may produce defects in the welds.

Effective means of cleaning are to be adopted particularly in connections with special welding procedures; flame or mechanical cleaning may be required.

The presence of a shop primer may be accepted, provided it has been approved by the Society.

Shop primers are to be approved by the Society for a specific type and thickness according to Pt D, Ch 5, Sec 3.

4.3.4 Assembling and gap

The setting appliances and system to be used for positioning are to ensure adequate tightening adjustment and an appropriate gap of the parts to be welded, while allowing maximum freedom for shrinkage to prevent cracks or other defects due to excessive restraint.

The gap between the edges is to comply with the required tolerances or, when not specified, it is to be in accordance with normal good practice.

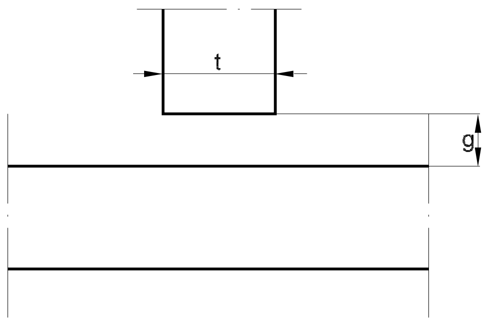
4.3.5 Gap in fillet weld T-connections

In fillet weld T-connections, a gap g, as shown in Fig 11, not greater than 2 mm may be accepted without increasing the throat thickness calculated according to [2.3.5] to [2.3.9], as applicable.

In the case of a gap greater than 2 mm, the above throat thickness is to be increased. Recom-mendations are also given in the "Guide for weld-ing".

In any event, the gap g may not exceed 4 mm.

Figure 11 : Gap in fillet weld T connections



4.3.6 Plate misalignment in butt connections

The misalignment m, measured as shown in Fig 12, between plates with the same gross thickness t is to be less than 0,15t, without being greater than 3 mm, where t is the gross thickness of the thinner abutting plate.

4.3.7 Misalignment in cruciform connections

The misalignment m in cruciform connections, measured on the median lines as shown in Fig 13, is to be less than:

- t/2, in general, where t is the gross thickness of the thinner abutting plate.

Tasneef may require lower misalignment to be adopted for cruciform connections subjected to high stresses.

Figure 12 : Plate misalignment in butt connections

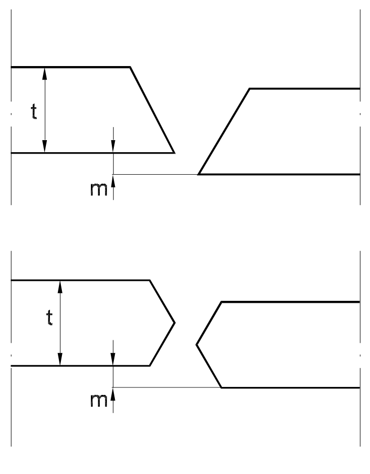
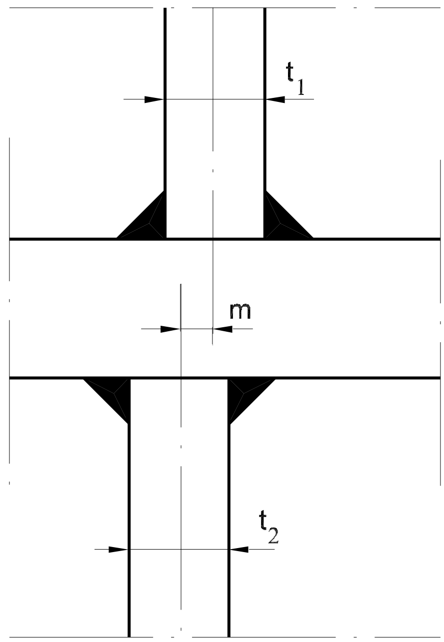


Figure 13 : Misalignment in cruciform connections



4.3.8 Assembling of aluminium alloy parts

When welding aluminium alloy parts, particular care is to be taken so as to:

- reduce as far as possible restraint from welding shrinkage, by adopting assembling and tack welding procedures suitable for this purpose
- keep possible deformations within the allowable limits.

4.3.9 Preheating and interpass temperatures

Suitable preheating, to be maintained during welding, and slow cooling may be required by Tasneef on a case-by-case basis.

4.3.10 Welding sequences

Welding sequences and direction of welding are to be determined so as to minimise deformations and prevent defects in the welded connection.

All main connections are generally to be completed before the ship is afloat.

Departures from the above provision may be accepted by Tasneef on a case-by-case basis, taking into account any detailed information on the size and position of welds and the stresses on the zones concerned, both during ship launching and with the vessel afloat.

4.3.11 Interpass cleaning

After each run, the slag is to be removed by means of a chipping hammer and a metal brush; the same precaution is to be taken when an inter-rupted weld is resumed or two welds are to be connected.

4.3.12 Stress relieving

It is recommended and in some cases it may be required that special structures subject to high stresses, having complex shapes and involving welding of elements of considerable thickness (such as rudder spades and sternframes), are prefabricated in parts of adequate size and stress-relieved in the furnace, before final assembly, at a temperature within the range 550°C ÷ 620°C, as appropriate for the type of steel.

4.4 Crossing of structural elements

4.4.1 In the case of T-crossing of structural elements (one element continuous, the other physically interrupted at the crossing) when it is essential to achieve structural continuity through the continuous element (continuity obtained by means of the welded connections at the crossing), particular care is to be devoted to obtaining the correspondence of the interrupted elements on both sides of the continuous element. Suitable systems for checking such correspondence are to be adopted.

5 Modifications and repairs during construction

5.1 General

5.1.1 Deviations in the joint preparation and in other specified requirements, in excess of the permitted tolerances and found during construction, are to be repaired as agreed with Tasneef on a case-by-case basis.

5.2 Gap and weld deformations

5.2.1 When the gap exceeds the required values, welding by building up or repairs are to be authorised by Tasneef Surveyor.

Recommendations for repairing gap and weld deformations not complying with the required standards are given in the "Guide for welding".

5.3 Defects

5.3.1 Defects and imperfections on the materials and welded connections found during construction are to be evaluated for possible acceptance on the basis of the applicable requirements of Tasneef

Where the limits of acceptance are exceeded, the defective material and welds are to be discarded or repaired, as deemed appropriate by the Surveyor on a case-by-case basis.

When any serious or systematic defect is detected either in the welded connections or in the base material, the Manufacturer is required to promptly inform the Surveyor and submit the repair proposal.

The Surveyor may require destructive or non-destructive examinations to be carried out for initial identification of the defects found and, in the event that repairs are undertaken, for verification of their satisfactory completion.

5.4 Repairs on structures already welded

5.4.1 In the case of repairs involving the replacement of material already welded on the hull, the procedures to be adopted are to be agreed with Tasneef on a case-by-case basis, considering these modifications as repairs of the in-service ship's hull.

6 Inspections and checks

6.1 General

6.1.1 Materials, workmanship, structures and welded connections are to be subjected, at the beginning of the work, during construction and after completion, to inspections suitable to check compliance with the applicable requirements, approved plans and standards.

6.1.2 The Manufacturer is to make available to the Surveyor a list of the manual welders and welding operators and their respective qualifications.

The Manufacturer's internal organisation is responsible for ensuring that welders and operators are not employed under improper conditions or beyond the limits of their respective qualifications and that welding procedures are adopted within the approved limits and under the appropriate operating conditions.

6.1.3 The Manufacturer is responsible for ensuring that the operating conditions, welding procedures and work schedule are in accordance with the applicable requirements, approved plans and recognised good welding practice.

6.2 Visual and non-destructive examinations

6.2.1 After completion of the welding operation and workshop inspection, the structure is to be presented to the Surveyor for visual examination at a suitable stage of fabrication.

As far as possible, the results of non-destructive examinations are to be submitted.

6.2.2 Non-destructive examinations are to be carried out with appropriate methods and techniques suitable for the individual applications, to be agreed with the Surveyor on a case-by-case basis.

6.2.3 Radiographic examinations are to be carried out on the welded connections of the hull in accordance with the Tasneef requirements, the approved plans and the Surveyor's instructions.

6.2.4 Tasneef may allow radiographic examinations to be partially replaced by ultrasonic examinations.

6.2.5 When the visual or non-destructive examinations reveal the presence of unacceptable defects, the relevant connection is to be repaired to sound metal for an extent and according to a procedure agreed with the Surveyor. The repaired zone is then to be submitted to non-destructive examination, using a method at least as effective as that adopted the first time and deemed suitable by the Surveyor to verify that the repair is satisfactory.

Additional examinations may be required by the Surveyor on a case-by-case basis.

6.2.6 Ultrasonic and magnetic particle examinations may also be required by the Surveyor in specific cases to verify the quality of the base material.

SECTION 5 LOADS

1 General

1.1

1.1.1 This Chapter specifies the minimum design heads which are to be used for the determination of structural scantlings according to this Section.

Internal loads are in general decisive for the determi-nation of scantlings of deck structures, whilst external loads are decisive for the determination of scantlings of side and bottom structures.

The capacity of the hull structures to bear internal loads is to be verified where the latter are represented by concentrated masses of considerable importance (tank vessels, containers, machinery etc).

2 Definitions and symbols

2.1

2.1.1

Tank type 1: space intended for liquids, the top of which coincides with the weather deck

Tank type 2: space intended for liquids, the top of which does not coincide with the weather deck

pdr : reference point, intended as the lower edge of the plate, or the centre of the area supported by the stiffener, depending on the case under consideration

h_E : external head, in m, calculated following the indi-cations given in [3]

h_S : static internal head, in m, in tanks, to be assumed as the greatest of the values given in (a) and (b) below, where applicable:

(a) Tank type 1:

- vertical distance from pdr to a point located at a height h_A, in m, above the top of the weather deck beam, h_A being equal to the greater of the values given by the following:

$$h_A = [1 + 0,05(L - 50)] \cdot \frac{1}{r}$$

$$h_A = \frac{100 p_{pv}}{r}$$

where L is to be assumed not lower than 50 m and not greater than 80 m, and p_{pv} is to be assumed equal to the positive set pressure, in N/mm², of cargo tank pressure/vacuum valves, where fitted

- vertical distance from pdr to a point located 1 m above the top edge of the hatch or trunk coamings
- two thirds of the vertical distance from pdr to the top of overflow

(b) Tank type 2:

- vertical distance from pdr to a point located at a height h_A, in m, above the top of the tank, excluding the hatchways, h_A being the height defined in (a) above
- two thirds of the vertical distance from pdr to the top of overflow

h_B : design head for subdivision bulkheads, in m, equal to the vertical distance from pdr to the highest point of the bulkhead

h_0 : vertical distance, in m, from pdr to the waterline at the draught T, which is always to be assumed positive

h_2 : vertical distance, in m, from pdr to the horizontal mean plane of the upper surface of the solid bulk cargo

r : mass density of cargo, in t/m³. In no case is r to be assumed smaller than 1.

3 External loads

3.1 General

3.1.1 The external head h_E, acting on the bottom and side structures is to be calculated from the formulae given in a) and b) below.

a) for structures having pdr below the waterline corresponding to the draught T:

$$h_E = 0,5L^{1/3} \cdot \left(1 - \frac{h_0}{2T}\right) + h_0$$

b) for structures having pdr above the waterline as de-fined in a):

$$h_E = 0,5L^{1/3} \cdot \left(\frac{10}{10 + h_0}\right)$$

4 Internal loads

4.1 Liquid cargoes

4.1.1 The internal head for tank structure calculation is to be taken equal to h_S, as defined in [2.1].

4.2 Solid bulk cargoes

4.2.1 The internal head h'_{IN} to be assumed for scantlings of cargo hold bulkheads, which are also to be verified as sub-division bulkheads, is to be obtained as follows:

$$h'_{IN} = r \cdot h_2 \cdot (\sin^2\alpha \cdot tg^2\beta + \cos^2\alpha)$$

where:

α : angle between the structural panel under con-sid-eration and the horizontal plane, in degrees

ϕ : angle of repose of the cargo, in degrees

β : 45 - (ϕ/2).

In the case of cargoes constituted by mineral concen-trates having moisture higher than the "transportable moisture limit", where no specific information is provided, the head to be assumed for the scantlings of cargo hold bulkheads is to be the greater of the values h_S, calculated for r = 1, and h'_{IN}, given by the formulae in a) and b) be-low.

a) for transverse bulkheads:

$$h'_{IN} = r \cdot \left(h_2 + 15,8\frac{L_{TB}}{L}\right)$$

b) for longitudinal bulkheads:

$$h'_{IN} = r \cdot (h_2 + 1,12L^{-0,5})$$

where:

L_{TB} : distance, in m, between transverse watertight bulkheads

b : cargo hold breadth, in m.

5 Deck loads

5.1

5.1.1 The head h_0, in m, to be assumed for deck scantlings is given in Tab 1.

Table 1

DECK	EXPOSED DECK AREAS	SHELTERED DECK AREAS (including areas partially sheltered by deckhouses or houses)	
		Deck intended for car-goes	Deck intended for accommo-dation
	h_0 (1)	h_0 (1)	h_0 (1)
Deck below pdc (pdc = design deck, see Chapter 10)	-	h_{TD}	0,6
pdc in single-deck ships	1,1	h_{TD}	0,6
pdc in ships with two or more decks	1,1	h_{TD}	0,6
Decks above pdc to which side shell plating ex-tends	1,0 (2)	h_{TD}	0,6
Decks above pdc to which side shell plating does not extend	0,5 (2)	h_{TD}	0,6

(1) In the cases of both open and enclosed deck ar-eas, the value of h_0 given in the Table is applicable to cargoes having a mass density equal to 0,7 t/m³ with a consequent load per square metre of deck surface, in kN/m², equal to 6,9 h_0. Therefore, where the carriage of cargoes having a mass den-sity higher than 0,7 t/m³ is envisaged, the value of h0 given in the Table is to be ade-quately increased.
In the case of particularly light cargoes giving rise to a special notation in the Register Book or, in any case, on the Certificate of Classification, the value of h_0 given in the Table may be adequately re-duced by Tasneef at its discretion.
In the case of machinery space flats, the value of h0 is to be taken not less than 2,5 m.

(2) In the case of higher decks for sheltering purposes only and therefore not carrying loads, the value of h_0 may be reduced down to the minimum value of 0,30 m.

SECTION 6 GENERAL REQUIREMENTS FOR SCANTLINGS

1 General

1.1 Application

1.1.1 This Chapter contains general requirements for the scantlings of hull structures. Special requirements applicable to the single structural elements are given in the specific Sections and Chapters.

2 Definitions and symbols

2.1

2.1.1 Girders: primary supporting members of ordinary stiffeners such as deck girders, beams and web frames, side stringers and transverse girders of bulkheads, floors, centre and side bottom girders, and similar;

Ordinary stiffeners: supporting members of shell plating, decks, double bottom or tank top plating, bulkheads and similar.

- S_L : overall length of the girder, in m
- b_F : actual width of the load bearing plating, i.e. one-half of the overall distance between parallel stiffen-ers adjacent to that considered, in m
- t_s : mean thickness, in mm, of the attached plating
- A_S : area of the attached plating, in cm^2
- t_a : web thickness, in mm, in built sections
- d_a : web depth in built sections, measured between the inside of the face plate and the inside of the at-tached plating, in mm
- A_S : area of the attached plating, in cm^2
- t_a : web thickness, in mm, in built sections
- A_a : web area, in cm^2, in built sections
- b_p : face plate width, in mm, in built sections
- A_p : face plate area, in cm^2, in built sections
- e : length of bracket free edge, in mm.

3 Plating attached to girders

3.1 Primary supporting members

3.1.1 The section modulus and the moment of inertia of pri-mary supporting members is to be calculated in association with an effective area A_S, in cm^2, of the attached load bearing plating obtained from the following:

$$A_s = 10C \cdot b_F \cdot t_s$$

where:

- for $S_L / b_F < 8$,

$$c = 0,25\left(\frac{S_L}{b_F}\right) - 0,016\left(\frac{S_L}{b_F}\right)^2$$

- for $S_L / b_F \geq 8$, $c = 1$

In the case of members located along the edge of openings, the effective area of the attached plating is to be assumed equal to 7/10 of the value of A_S calculated by assuming b_F equal to half the distance between the member considered and its adjacent member.

For corrugated bulkhead primary supporting members, the area A_S under consideration is to be determined as follows:

a) when the member is parallel to the corrugation, A_S is not to exceed the area of the plating connected at right angles to the member web;

b) when the member is fitted at right angles to the corrugations, A_S is to be assumed equal to the area of the face plate of the member.

3.2 Ordinary stiffeners

3.2.1 Unless otherwise expressly stated, the section modulus and the moment of inertia of the ordinary stiff-eners are to be calculated in association with an effective load bearing plating having width equal to the spacing of the stiffeners and thickness equal to the mean thickness of the attached plating.

3.3 Special cases

3.3.1 In way of fore and aft regions and, in general, where the web of the section is at an angle a less than 90° to the attached plating, the actual section modulus is to be calculated taking account of the inclination of the attached plating.

Where the above angle a is less than 75°, the actual section modulus of the stiffener may be approximately calculated by multiplying the section modulus of a stiff-ener having the web fitted at right angles to the attached plating by cos(90 α).

4 Calculation of section modulus

4.1 Primary supporting members

4.1.1 The section modulus W_T, in cm^3, of a built section with attached plating of area A_S, in cm^2, may be calculated us-ing the following formula:

$$W_T = \frac{A_p \cdot d_a}{10} + \frac{t_a \cdot d^2{}_a}{6000} \cdot \left[1 + \frac{200(A_s - A_p)}{200A_s + t_a \cdot d_a}\right]$$

In cases of symmetrical sections, the section modulus may be calculated as follows:

$$W_T = \frac{A_p \cdot d_a}{10} + \frac{t_a \cdot d^2_a}{6000}$$

As a rule, A_S is to be greater than A_p; in this respect, the thickness of the attached plating is to be locally in-creased accordingly where necessary.

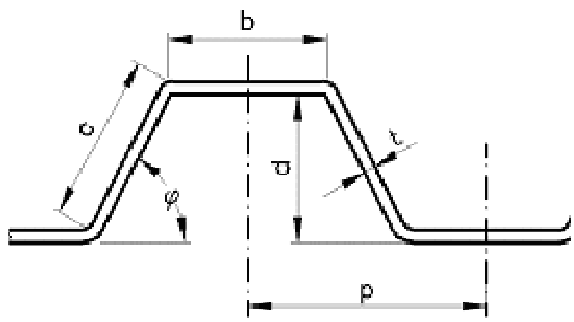
4.2 Corrugated bulkheads

4.2.1 The section modulus W_C, in cm^3, of a corrugation may be derived from the following formula:

$$W_C = \frac{d \cdot t \cdot (3b + c)}{6000}$$

where the symbols are as shown in Fig 1 and are expressed in mm. In no case is the angle φ to be taken as less than 40º.

Figure 1



5 Moment of inertia of ordinary stiffeners and of primary supporting members

5.1

5.1.1 Unless otherwise expressly stated, the moment of inertia of ordinary stiffeners or girders is, in general, to be not less than the value J, in cm^4, given by the following formula:

$J = m_1 \cdot S \cdot Z$

where:

S : conventional scantling span, in m, as defined in [6];

Z : section modulus, in cm^3, required for ordinary stiffeners or for primary supporting members made of normal strength steel (K = 1);

m_1 : 2,3, for ordinary stiffeners;

2,5, for primary supporting members, except for those supporting vertical ordinary stiffeners

3 S/H, for primary supporting members bearing side frames or vertical bulkhead stiffeners, H being the distance, in m, between two consecutive decks, or between double bottom and the lowest deck, through which the vertical stiffeners ex-tend. If the value of m1 calculated as above is less than 2,5, it is to be taken equal to 2,5; if it is greater than 3,3, it may be taken equal to 3,3.

6 Conventional scantling span

6.1 Ordinary stiffeners

6.1.1 Unless otherwise stated in the specific requirements valid for particular cases, the conventional scantling span S, in m, is the same as the overall span, i.e. the distance between the supporting elements at the ends of the stiffener (see Fig 2).

The Fig 2 shows examples of conven-tional scantling spans and refer to end brackets of stiffen-ers, where fitted, having the Rule dimensions specified in [7].

The connections shown in Fig 3 are considered as lug connections; in these cases the conventional scantling span S is to be assumed as indicated in the Fig 2.

Where one or both of the arms of end brackets have dimensions other than the Rule dimensions, the conven-tional scantling span S is to be calculated as specified in a) to g) below.

a) Each end bracket is to be considered in all cases as a 45° bracket having both arms equal to the shorter arm of the bracket actually fitted.

b) If both arms of the end brackets have dimensions equal to or greater than S/8, the conventional scantling span S is to be assumed equal to the following value:

   $S = 1,33 \cdot S_0$

   where:

   S_0 : distance, in m, to be measured as shown in Figures (a) and (b) of Fig 4.

c) If, at one end of the stiffener, a bracket is fitted whose shorter arm dimension is equal to or greater than S/8 and at the other end a lug is fitted as shown in Tab 2, the conventional scantling span S is to be as-sumed equal to the following value:

   $S = 1,14 \cdot S_0$

   where:

   S_0 : distance, in m, to be measured:
   - as shown in (b) above, for the end with the bracket
   - from the internal side of the lug, for the end with the lug.

d) if the shorter arms of both end brackets have dimensions less than S/8, the conventional scantling span S is to be assumed equal to S_0, where:

S_0 : distance, in m, to be measured as shown in Figures (c) and (d) of Fig 4, from a point lo-cated at a distance x from the apex of the 45° conventional bracket. The distance x is to be assumed as follows:

- in the case of frames:

  $x = 0,5 d_{R,}$ for $S^*_0 \le 10\ d_R$

  $x = d_{R,}$ for $S^*_0 \ge 20\ d_R$

  $x = S^*_0/20$, for $10\ d_R \le S^*_0 \le 20\ d_R$

  S^*_0 being the distance, in m, given in Fig-ures (c) and (d) of FIg 4 and d_R the height of the ordinary stiffener, in m;

- in the case of beams:

  $x = 2\ d_R$

Should the S_0 value be greater than the actual dis-tance between the supporting elements of the stiffener under examination, the conventional scantling span S may be taken equal to the latter distance.

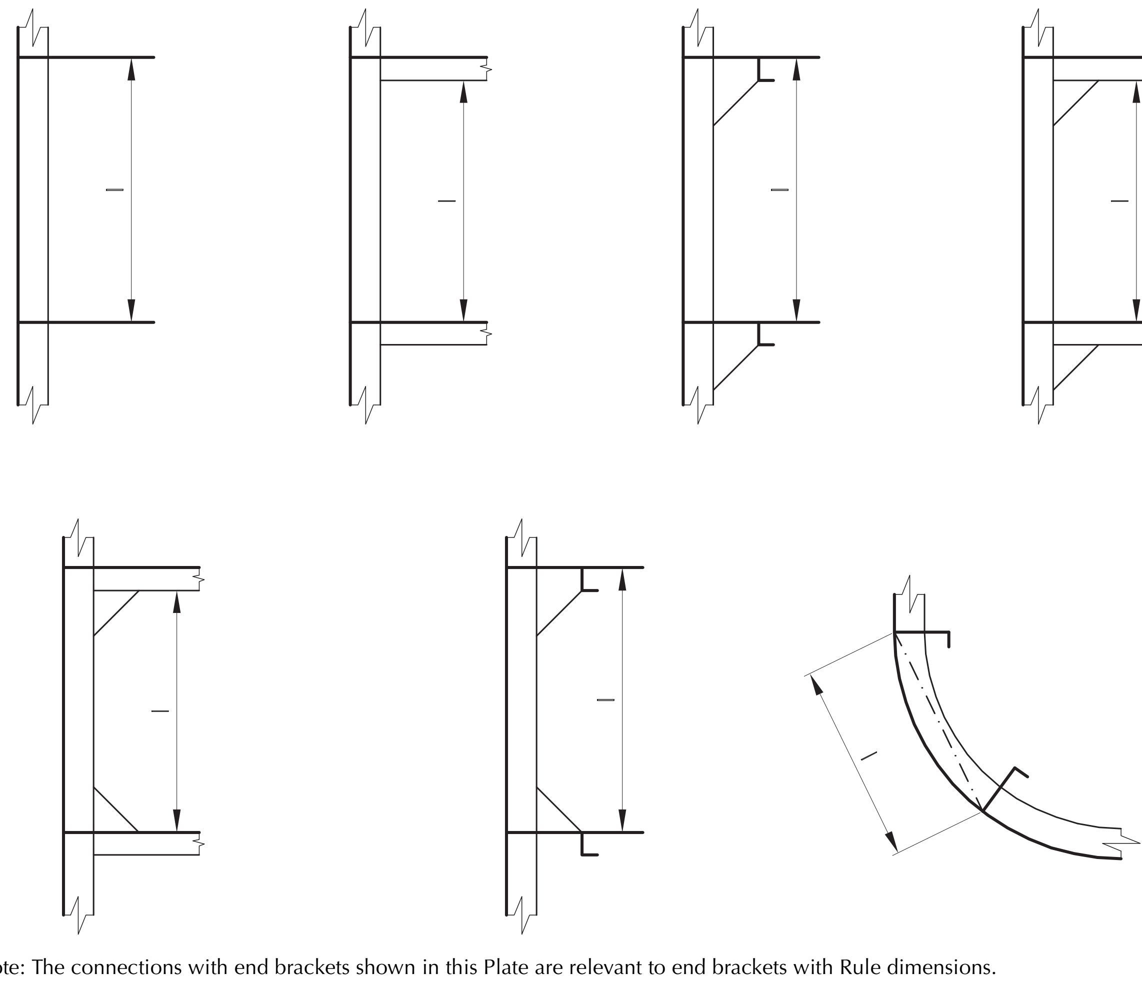
e) if, at one end of the stiffener, a bracket is fitted whose shorter arm dimension is equal to or greater than S/8 and at the other end a bracket is fitted whose shorter arm dimension is less than S/8, the conventional scantling span S is assumed equal to the following value:

$S = 1,14 \cdot S_0$

where:

S_0 : distance, in m, to be measured:

Figure 2 : Examples of conventional scantling spans of ordinary stiffeners



Note: The connections with end brackets shown in this Plate are relevant to end brackets with Rule dimensions.

Figure 3 : Examples of conventional scantling spans of ordinary stiffeners in the case of end lug connections

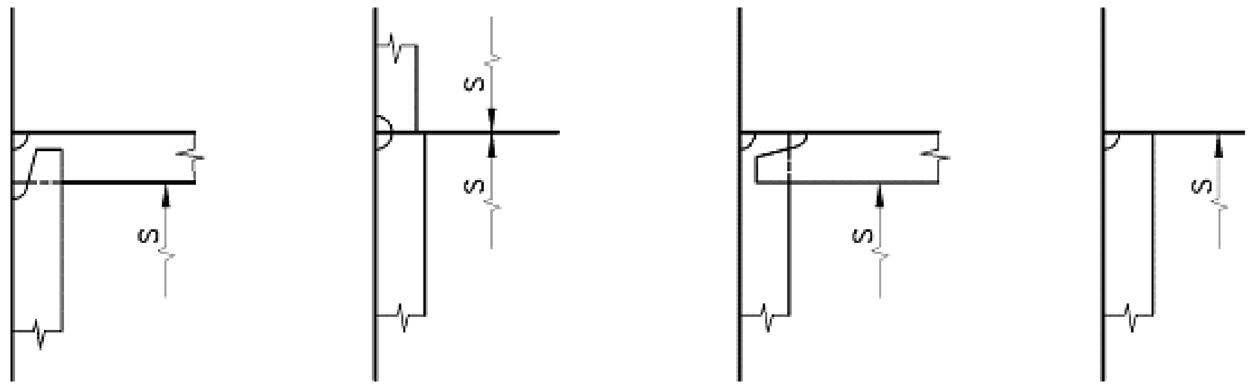


Figure 4 : Examples of conventional scantling spans of ordinary stiffeners in the case of connections with end brackets having dimensions other than rule dimensions

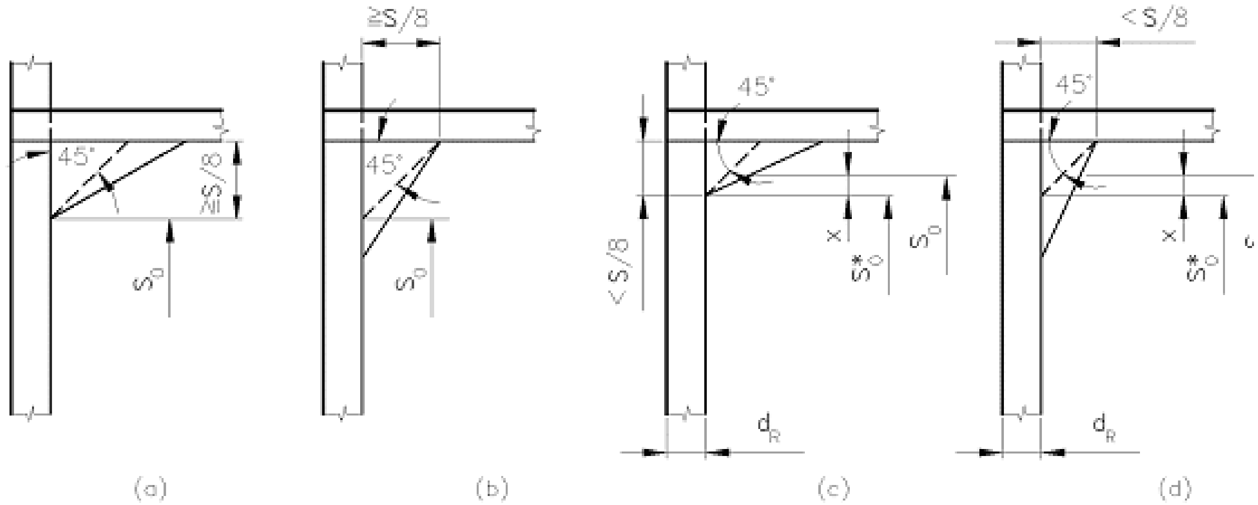


Figure 5 : Examples of conventional scantling spans of primary supporting members

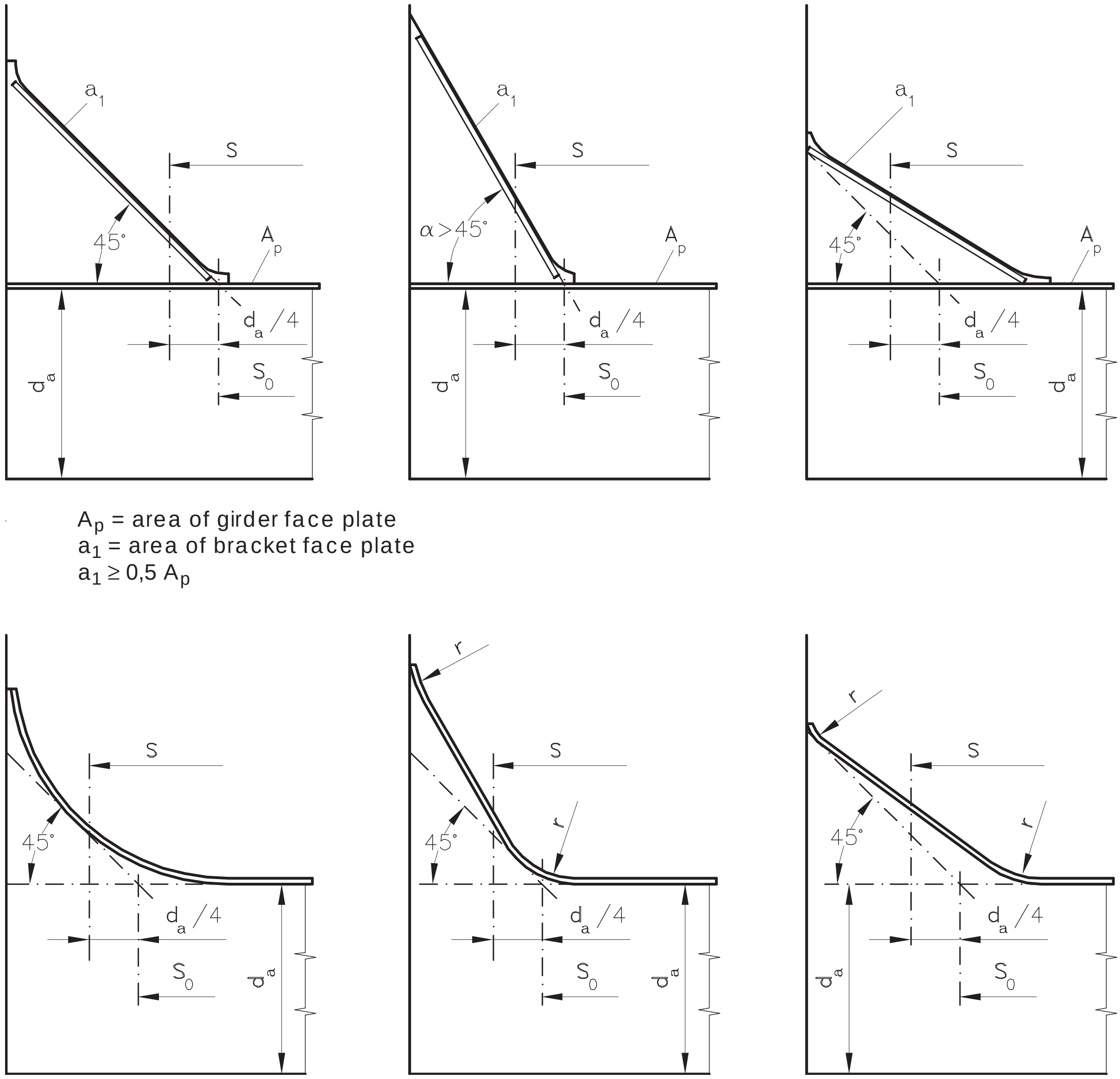
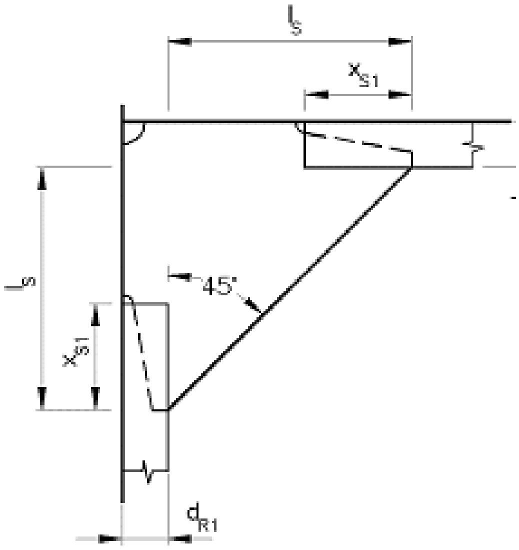


Figure 6



- as shown in (b) above, for the end with the bracket whose shorter arm dimension is equal to or greater than S/8
- as shown in (d) above, for the end with the bracket whose shorter arm dimension is less than S/8.

f) If, at one end of the stiffener, a bracket is fitted whose shorter arm dimension is less than S/8 and at the other end a lug is fitted as shown in Tab 2, the conventional scantling span S is to be assumed equal to S_0, where:

S_0 : distance, in m, to be measured:

- as shown in (d) above, for the end with the bracket whose shorter arm dimension is less than S/8
- from the internal side of the lug, for the end with the lug.

g) The scantling of the stiffener under examination is to be checked assuming the values of the coefficient relevant to the end connection which is applicable to the actual arrangement of the connection, and in de-tail:

- each connection formed by a bracket whose di-mensions are equal to or greater than the Rule di-mensions is to be considered as a bracket for the structural element under consideration;
- each connection formed by a bracket whose shorter arm dimension is less than the Rule di-mension is to be considered as a lug for the struc-tural element under consideration.

Table 1

Bracket arm l_S, in mm	Plate thickness, in mm		Flange widht in mm
	Plain bracket	Flangebracket	
150	6,5	-	-
175	7,0	-	-
200	7,0	6,5	30
225	7,5	6,5	30
250	8,0	6,5	30
275	8,0	7,0	35
300	8,5	7,0	35
325	9,0	7,0	40
350	9,0	7,5	40
375	9,5	7,5	45
400	10,0	7,5	45
425	10,0	8,0	45
450	10,5	8,0	50
475	11,0	8,0	50
500	11,0	8,5	55
525	11,5	8,5	55
550	12,0	8,5	55
600	12,5	9,0	60
650	13,0	9,5	65
700	14,0	9,5	70
750	14,5	10,0	75
800	-	10,5	80
850	-	10,5	85
900	-	11,0	90
950	-	11,5	90
1000	-	11,5	95
1050	-	12,0	100
1100	-	12,5	105
1150	-	12,5	110
1200	-	13,0	110

6.2 Primary supporting members

6.2.1 The conventional scantling span of primary supporting members is to be taken as given in the examples in Fig 5. Special consideration will be given to conditions dif-ferent from those shown.

The conventional scantling span is in no case to be less than 1,1 S_0, S_0 being the distance between the inter-nal ends of the conventional brackets as indicated in Fig 5, or, where there are no brackets, be-tween the ends of the members.

6.3 Corrugated bulkheads

6.3.1 The conventional scantling span of corrugated bulkheads is to be measured between the structures (e.g. stools) to which the corrugation ends are welded.

7 Rule end brackets

7.1 Ordinary stiffeners

7.1.1 The shape of a Rule bracket is shown in Fig 2. Its arm lS, in mm, is equal to S/8, S being the conventional scantling span, as defined in [6.1], expressed in mm.

Where the bracket connects two different types of stiffeners (frame and beam, bulkhead web and longitudi-nal stiffener etc) the value of S to be taken for the calcula-tion of l_S is to be that relevant to the member with the greater span. The thickness of the plate and the width of the flange, in the case of flanged brackets, are given in Tab 1, in mm, as a function of l_S, lS being the Rule bracket arm or the average of the arms, in cases of brackets other than Rule brackets.

Nevertheless, the width of the flange is in no case to be less than e/14.

The overlap x_S, in mm, between the stiffener having section modulus W and the bracket is to be not less than the greater of the following values:

- the stiffener depth d_R, expressed in mm
- 11 $W^{0,5}$, W being expressed in cm^3.

7.2 Primary supporting members

7.2.1 All primary supporting members are to be provided with brackets at their ends. These brackets are to be flanged or strengthened by a face plate having a width, in mm, not less than e/10 and an area not less than half of the largest area of the face plates of the connected members.

In the case of members having a considerable face plate area, the above-mentioned value may be increased to the satisfaction of Tasneef

Where the bracket free edge e exceeds 1600 mm in length, a stiffener equal to or exceeding 100 mm in depth is to be fitted parallel to the flange, at a distance not ex-ceeding 1/5 of the bracket throat width, and in general not exceeding 400 mm.

The bracket thickness is, in general, to be equal to the greater thickness of the connected members.

In the case of brackets having considerable dimen-sions, stiffeners are in general to be fitted; in such cases the above requirement for minimum thickness and mini-mum width of the face plate may be waived.

In tankers, the bracket thickness is to be not less than the minimum given in Part E.

The connection between brackets and flanged mem-bers will be given special consideration by Tasneef

8 Effectiveness of constraints at the ends of ordinary stiffeners

8.1 Ordinary stiffeners

8.1.1 The effectiveness of the constraints at the ends of the conventional span of ordinary stiffeners is measured by the coefficient f_R or f_C which appears in the specific formulae given in Chapters 9 and 11 for the various stiffener types.

In the calculation of the Rule section modulus of ordi-nary stiffeners connected by brackets having an arm $l_S < S/8$ or a shape other than that of Rule brackets (see [7]), the reduced effectiveness of such connection is to be taken into account by applying the requirements given in Sec 4, [6].

The effectiveness of large end brackets of corrugated bulk-heads will be given special consideration by Tasneef

9 Minimum thickness

9.1 Minimum thickness of deck plating in way of girders and beams

9.1.1 The thickness t, in mm, of deck plating which forms the higher face plate of girders or beams with an area of the lower face plate A_p, in cm², is to be not less than that derived from the following:

$$t = \frac{0,075 A_p}{c \cdot b_F}$$

b_F being the plating width, in m, as defined in [2.1] and c the coefficient as defined in [3.1].

9.2 Minimum thickness of webs of primary sup-porting members

9.2.1 The minimum thickness of the web of a primary sup-porting member t_a, in mm, is, in general, to be not less than that given by the following equations:

$$t_a = (4,5 + 0,005\, d_a) \cdot K^{0,5}$$

In addition, for oil tankers, the above thickness is to be not less than given in Part E.

10 Minimum depth of webs of primary sup-porting members

10.1 Ordinary ships

10.1.1 The depth of webs of primary supporting members is, in general, to be not less than twice the depth of the cut-outs for the passage of ordinary stiffeners. Smaller depths may be accepted, in cases of members having stiffened webs, where primary supporting members and stiffeners are connected by lugs and a check of shear stresses is carried out.

10.2 Tankers

10.2.1 In tankers, the minimum depth of webs of primary supporting members is, in general, to be not less than the maximum value given in Tab 2.

The symbols d_F, d_M and d_B are defined as follows:

d_F = depth of the cut-out for longitudinals, in mm

d_M = minimum depth of bottom transverse, in mm

d_B = minimum depth of deck transverse, in mm.

Primary supporting members with a depth smaller than the Rule value obtained from Tab 2 will be given spe-cial con-sideration by Tasneef

11 Maximum and minimum areas of face plates

11.1

11.1.1 The face plate area of primary supporting members is, in general, to be not less than 1/8 and not more than 2/3 of the minimum cross-sectional area of the web plate.

12 Openings

12.1 Influence of openings in the calculation of section modulus

12.1.1 Elliptical openings exceeding 2,5 m in length and 1,2 m in width with the major axis arranged longitudinally and circular openings exceeding 0,9 m in diameter, where they are cut in the members contributing to the longitudi-nal strength of the hull, are to be deducted in the calcula-tion of the midship section modulus, unless they are fully compensated.

Compensation of smaller openings is not required, provided that the following conditions (a) and (b) are com-plied with.

a) The total sum of all widths Σ b is not to exceed the following values in any transverse section:
   - strength deck, single bottom and double bottom: 0,1 (B - Σ b)
   - for lower decks: 0,15 (B - Σ b)
   - for longitudinals and girders: 0,2 d_a (up to a maximum of 75 mm for longitudinals).

b) The midship section modulus, calculated de-ducting all openings, is to be not less than 97% of the required Rule value.

Openings in excess of the above stated val-ues are to be compensated.

Compensation is required, however, where, in exceptional circumstances, an opening in the plating cuts a longitudinal or primary supporting member.

Such compensation may be effected, as well as by a local increase in the plating thickness, by means of a local increase in the sectional area of the longitudinals or the addition of suitably long longitudinals immediately adjacent.

Moreover, where necessary for local strength, openings on longitudinals and primary supporting members are also to be compensated.

12.2 Openings in the strength deck

12.2.1 Openings in the strength deck are to be kept to a minimum and spaced as far apart from one another, hatchway corners and breaks of effec-tive superstructures as practicable.

When openings are cut within such areas, they are to be fully compensated.

The major axis of elliptical openings along the fore-and-aft direction are to be at least twice the minor axis.

Circular openings of more than 350 mm and less than 900 mm in diameter are to be fitted with a flat bar ring having a cross-sectional area at least equal to 0,25 times the area of the deck cut-out and a depth not exceeding 8 times the deck plating thickness; the flat bar ring is gener-ally to be welded symmetrically to the plane of the deck itself.

Circular openings less than 350 mm in di-ameter may be accepted without flat bar ring compensation.

The corners of hatch openings are to be rounded with a radius not smaller than 4% of their width, and in any case not less than 300 mm in way of 0,6 L amidships; elsewhere, not less than 300 mm.

In way of hatchway corners, insert plates are to be fitted having a thickness equal to the thick-ness t, in mm, used for the deck at the side of the hatchways, increased by 3 mm.

For hatch openings of considerable width and/or rounding radii less than indicated above, an increase greater than the thickness of insert plates may be required.

The length of insert plates is to be not less than one Rule frame spacing forward and aft of the corner, and their width is to be not less than 750 mm towards the ship's side or the ship's centreline from the corner. In all cases, the insert plate joints are to be sufficiently far from the ends of corner radii.

These requirements also apply to hatchways located aft of 0,3 L from amidships and com-prised in the area between midship and the break of the poop, where fitted.

Outside this area, insert plates may be re-duced in thickness, or even omitted subject to Tasneef approval.

Insert plates may also be omitted in the mid-ship portion where the plating cut-out at the hatchway corner has an elliptical or parabolic profile.

The half axes of elliptical openings or the dis-tances of tangency points to the intersection of the orthogonal tangents to the parabola are to be not less than:

- 1/20 of the hatchway width or 600 mm, whichever is the lesser, in the transverse di-rection
- twice the transverse dimension, in the fore-and-aft direction.

Corner radiusing, in the case of the arrange-ment of two or more hatchways athwartship, will be specially considered by Tasneef

12.3 Openings in decks below the strength deck

12.3.1 The details of such openings are similar to those described above for the strength deck, ex-cept that the strengthening of circular openings required above may be omitted.

Corners of hatchway openings are to be properly rounded, as specified for the strength deck; insert plates may, however, be omitted at the discretion of Tasneef

12.4 Openings in shell plating

12.4.1 The details of such openings are similar to those described above for the strength deck, ex-cept that the strengthening of circular openings required above may be omitted.

Corners of hatchway openings are to be properly rounded, as specified for the strength deck; insert plates may, however, be omitted at the discretion of Tasneef

a) Openings in the ship's sides, e.g. for cargo ports, are to be well rounded at the corners and located well clear of superstructure ends or any openings in the deck areas at sides of hatchways.

b) Openings for water intakes are to be well rounded at the corners and, within 0,6 L amidships, located outside the bilge strakes. Where arrangements are such that water in-takes are unavoidably located in the curved zone of the bilge strakes, such openings are to be elliptical with the major axis in the longi-tudinal direction. Water intake chests are generally to be as thick as the local shell plat-ing.

c) Openings under (a) and (b), as well as other openings of considerable size in the opinion of Tasneef are to be adequately compensated by means of insert plates of increased thick-ness or doublers sufficiently extended in length. Such compensation is to be partial or total depending on the actual stresses occur-ring in the area of the openings.

d) Circular openings on the sheerstrake need not be com-pensated where their diameter does not exceed 20% of the sheerstrake Rule depth or 380 mm, whichever is the lesser, and where they are located away from open-ings on deck at the side of hatchways or su-perstructure ends.

13 Structural stability

13.1

13.1.1 Where plating and stiffeners are subject to high compression stresses, structural stability checks may be required.

Such checks may be carried out adopting the criteria indi-cated in Tasneef Rules for the Classifica-tion of Ships.

Table 2 : Minimum depth of primary supporting members in tankers

Type of primary supporting mem-bers	Values depending on S	Values depending on d_F	Values depending on other parameters
Main bottom girders	S / 5	-	-
Intercostal bottom girders	-	-	0,55 d_M
Main deck girders	-	-	600 + 100 D
Intercostal deck girders	-	-	0,55 d_B
Bottom transverses	-	2,5 d_F	500 + 40 D
Deck transverses	-	2,5 d_F	500 + 40 D
Other members	-	2,5 d_F	-

SECTION 7 LONGITUDINAL STRENGTH

1 General

1.1 Application

1.1.1 The structural scantlings required in Part B are intended as appropriate for the purpose of the hull longitudinal strength of vessels having length L not exceeding 40 m, and openings in the strength deck having small width. For the above-mentioned vessels the check of the midship section is not required, except in the case of large openings or a non-uniform distribution of cargo or ballast.
For vessels having length L > 50 m, the longitudinal strength is to be checked according to the requirements of this Chapter.
The check of the longitudinal strength may also be required, irrespective of the ship's length, if wave motions occur in the inland waters where the vessel is authorised to sail.

2 Minimum section modulus of midship section

2.1

2.1.1 The scantlings of continuous longitudinal structures within 0,4 L amidships are to be such as to obtain, in way of each transverse section, values of the section moduli at deck Z_p and at keel Z_F, in cm³, not less than the value of the Rule section modulus Z, in cm³, calculated with the following formulae:

$Z = 34{,}5 \cdot D \cdot L \cdot (B + 12) \cdot K$, for $L \leq 75$ m

$Z = 0{,}46 \cdot D \cdot L^2 \cdot (B + 12) \cdot K$, for $L > 75$ m.

The moment of inertia of the transverse section J, in cm⁴, is to be not less than the value:

$J = 3 \cdot Z \cdot L$

Z being the value of the Rule section modulus calculated by taking K = 1.

In the case of ships built of light alloy, the value of J will be subject to special consideration.

As guidance, the value of J obtained is to be such as to guarantee the same stiffness as a steel hull having the same dimensions as the light alloy hull.

2.1.2 For ships with large openings in the strength deck for which at least one of the three following conditions occurs:

-b/B0 > 0,7

$L_A/L_0 > 0{,}89$

$b/B_0 > 0{,}6$ and $L_A/L_0 > 0{,}7$

b, B_0, L_A and L_0 being the dimensions indicated in Fig 1, the section modulus of the trans-verse section at deck calculated with the formulae in the previous paragraph is to be increased by 15 %.

In the case of more than one opening in the same transverse section, b is to be taken equal to the sum of the widths b_1 of the individual openings (see Fig 1).

2.1.3 Alternatively to the use of the formulae indicated in the previous paragraph, the longitudinal strength may be checked by direct calculations which take account of the maximum bending moment among all still water bending moments, in the transverse section in question, calculated for each realistic loading condition.

Whenever, in inland waters in which service is performed, wave motions occur which cannot be neglected for the purpose of hull longitudinal stresses (in general when the significant wave height is greater than 2 m), a wave bending moment is to be taken into account.

The value of such wave bending moment will be established by Tasneef based upon statistical data relative to the magnitude of the wave motion, to be submitted to Tasneef by the Interested Parties.

2.1.4 The stresses, calculated by dividing the absolute values of the total bending moments (still water bending moments plus wave bending moment, if any) by the value of the actual section modulus at deck and at keel, are not to exceed the limit of 175/K N/mm².

In addition, buckling checks of deck and bot-tom strength plating and of relevant longitudinal stiffeners may be required.

3 Calculation of section modulus of transverse sections

3.1

3.1.1 The value of the section modulus required in [2] is to be obtained at the bottom, at the strength deck and, in accordance with the following requirements, at any deck located above the strength deck which is presumed to contribute to longitudinal strength.

The strength deck is the lowest of the decks where the section modulus of the hull transverse section is to be not less than that required for longitudinal strength purposes.

The strength deck is chosen by the Designer, at his discretion, from among all the decks which definitely contribute to hull longitudinal strength.

In general the highest deck among those mentioned above is chosen in order to minimise the steel load.

3.1.2 In order to be considered as a strength deck, a deck is to have plating with a thickness not less than that required in Sec 8; however, where the actual section modulus is greater than the minimum required, or where the still water bending moment has very low values, the above thick-ness is to be not less than that required in order to resist buckling and prevent collapse.

The same deck is to also be connected to side shell plating complying with the following conditions:

a) it is not to have aligned openings excessive in number and width,

b) it is to have a thickness not smaller than the thickness t required in Chapter 1, Sec 8.

3.1.3 The midship section modulus at deck is obtained by dividing the moment of inertia of this section about the horizontal neutral axis by the distance from this axis to the moulded weather deck line at side. For ships having a rounded gunwale, except for special cases individually considered by Tasneef "moulded weather deck line at side" means the horizontal line through the intersection of the prolongation to side of the underside of the plane part of weather deck stringer plating with the prolongation upwards of the plane part of the innerside of the sheerstrake plating, amidships.

The midship section modulus at keel is obtained by dividing the moment of inertia of this section by the distance from the horizontal neutral axis to the moulded base line.

The transverse sections of all continuous longitudinal structural members contributing to longitudinal strength are to be included in the calculation of the moment of inertia, except for man-holes and other openings and cutouts, which are to be deducted in accordance with the requirements of Section 6.

In this calculation, continuous trunks and/or continuous hatch coamings may be included in the longitudinal section area, provided they are effectively supported by longitudinal bulkheads or primary supporting members. In this case, the midship section modulus at deck is obtained by dividing the moment of inertia of the same section by the distance y, in cm, obtained as follows:

$$y = y_T \cdot 0,9 + 0,2\frac{x_T}{B}$$

where:

y_T = vertical distance, in cm, from the top of the trunk or longitudinal hatch coaming to the neutral axis of the section;

x_T =horizontal distance, in m, from the top of the trunk or longitudinal hatch coaming to the centreline of the ship.

The distances x_T and y_T are to be measured in such a way as to obtain the maximum value of y.

In no case may y be taken less than the distance between the moulded weather deck line at side and the neutral axis.

Where deck structures are arranged with two or more openings abreast, a percentage of the longitudinal structure area (plate, primary sup-porting members and longitudinal coamings) may be taken into account in the calculation of the moment of inertia.

To this end, such longitudinal structures are to have slenderness ratio $L_0 / r \le 60$, either in relation to the horizontal or the vertical axis, and are to be connected at the ends in such a way as to ensure longitudinal continuity.

L_0 is the dimension, in m, shown in Fig 1 and r is the radius of gyration, in m, of the section of the longitudinal structures concerned.

The value of the portion of the area of the above-mentioned longitudinal structures to be considered in the calculation of the moment of inertia is given by $a \cdot A_{ST}$, where A_{ST} is the net area of the structures and a is a coefficient whose value is to be taken as follows:

- where the longitudinal structures are sup-ported in the lower part by longitudinal bulk-heads:

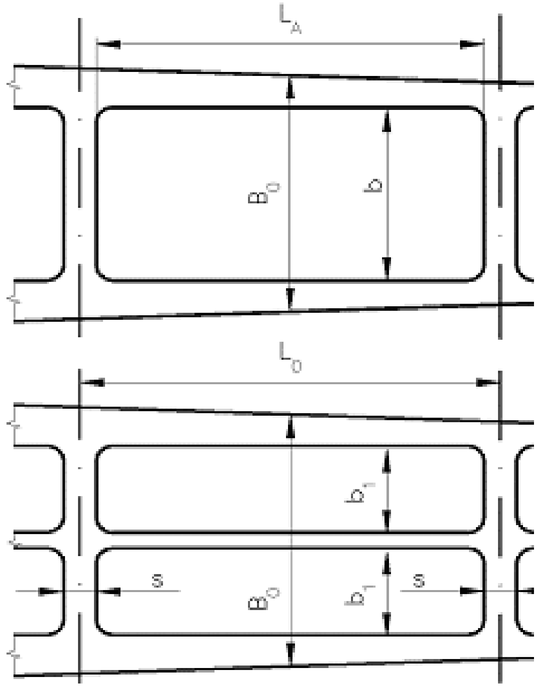
  a = 1

- in other cases:

$$a = 0,6 \cdot \left(\frac{s}{b_1} + 0,15\right)^{0,5}$$

b_1 and s being the dimensions, in m, shown in Fig 1.

Figure 1



SECTION 8 SHELL PLATING AND DECK PLATING

1 Scantlings of bottom and side shell plating

1.1 Thickness of bottom shell and bilge plating

1.1.1 The thickness of bottom shell and bilge plating is to be such as to obtain, when required, the Rule section modulus Z_F stipulated in Section 7.

Such thickness is to be not less than the value t, in mm, calculated by the following formula, but in no case less than $5K^{0,5}$ mm:

$t = (0,064\ L + 7 \cdot s - 0,3) \cdot K^{0,5}$

When the bottom is longitudinally framed, the thick-ness calculated by the above-mentioned formula may be reduced by 15%; however, in no case is it to be less than $4K^{0,5}$ mm.

1.1.2 The bilge plate in hulls with round bilge is to have the thickness required for the bottom.

Whenever the radius of curvature is greater than 350 mm, the bilge plate thickness is to be taken not less than the thickness of side shell plating increased by 1,5 mm.

1.1.3 For ships not exceeding 65 m in length, the thickness calculated in [1.1.1] is to be kept for the whole length L.

In ships having L > 65 m, the bottom thickness may be gradually reduced outside 0,6 L amidships to reach, in way of the fore and aft ends, a value equal to 85% of that calculated in [1.1.1], but in no case less than $5K^{0,5}$ mm.

1.2 Thickness of side shell plating

1.2.1 The thickness of side shell plating is to be not less than the value t, in mm, calculated by the following formula, but in no case less than $5K^{0,5}$ mm:

$t = (0,047\ L + 7 \cdot s + 0,2) \cdot K^{0,5}$

When the side is longitudinally framed, the thickness t calculated by the previous formula may be reduced by 15%; however, in no case is it to be less than $4K^{0,5}$ mm.

1.2.2 The above-mentioned thickness for ships not exceed-ing 65 m in length L is to be kept for the whole length L.

In ships having L > 65 m, the side shell thickness may be gradually reduced outside 0,6 L amidships to reach, in way of the fore and aft ends, a value equal to 85% of that calculated in [1.2.1], but in no case less than $5K^{0,5}$ mm.

1.3 Thickness of deck plating

1.3.1

The thickness t, in mm, of the strength deck is to be such as to obtain the Rule section modulus Z_P required in Sec 7.

If it is not intended to bear a load, such thickness is, in addition, to be not less than the value calculated by the following formula:

- if transversely framed

  $t = 1,5 \cdot s\ (L \cdot K)^{0,5}$

- if longitudinally framed

  $t = 1,3 \cdot s\ (L \cdot K)^{0,5}$

Such thickness is to be adopted for the whole length L in ships having L ≤ 65 m.

For ships having L > 65 m, this thickness may be gradually reduced outside 0,6 L amidships to reach, in way of the fore and aft ends, a value equal to 85% of that calculated by the above-mentioned formula, but in no case less than $4K^{0,5}$ mm.

1.3.2 The thickness t, in mm, of decks intended to bear a uniformly distributed load is to be not less than the value calculated by the following formula:

- if transversely framed

  $t = 0,30 \cdot s \cdot (L \cdot p \cdot K)^{0,5}$

- if longitudinally framed

  $t = 0,25 \cdot s \cdot (L \cdot p \cdot K)^{0,5}$

where:

p : specific load, uniformly distributed on the deck, in kN/m^2.

1.3.3 In ships with cargo hatches, the thickness calculated in [1.3.1] reduced by 15% may be adopted for hatch plating.

1.3.4 In ships having L > 90 m, a stringer is to be fitted hav-ing a thickness equal to that calculated for the deck by the formula in [1.3.1] increased by 1 mm.

1.3.5 Decks intended for the carriage of heavy vehicles

The thickness of decks intended for the carriage of heavy vehicles or of fork-lift trucks for loading and unload-ing operations is to be not less than the value t, in mm, given by the following formula:

$t = 0,45 \cdot (c \cdot p \cdot K)^{0,5}$

where:

c : coefficient given in Tab 1, as a function of the dimensions u and v of the tyre print (see Fig 1)

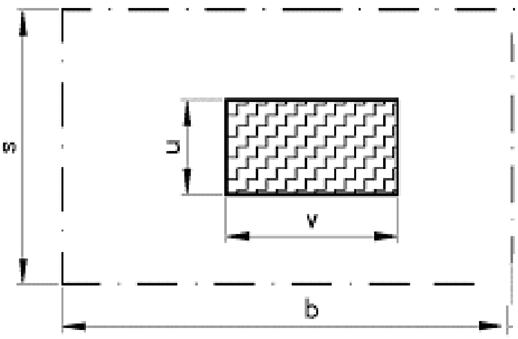
p : load on the tyre print, in kN.

Where there are double wheels, the tyre print consists of both.

Table 1

b/s	u/s → v/u ↓	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1,0
1	0,5	0,242	0,174	0,138	0,113	0,094	0,080	0,077	0,060	0,052	0,045
	1	0,222	0,160	0,122	0,099	0,079	0,066	0,055	0,045	0,037	0,030
	2	0,198	0,134	0,098	0,073	0,053	-	-	-	-	-
	3	0,175	-	-	-	-	-	-	-	-	-
1,4	0,5	0,228	0,189	0,158	0,128	0,111	0,096	0,083	0,073	0,064	0,056
	1	0,217	0,177	0,143	0,116	0,098	0,082	0,070	0,060	0,051	0,043
	2	0,196	0,153	0,119	0,092	0,072	0,058	0,046	-	-	-
	3	0,178	0,134	0,100	0,072	-	-	-	-	-	-
≥ 2,5	0,5	0,232	0,196	0,163	0,135	0,117	0,100	0,087	0,077	0,067	0,059
	1	0,219	0,184	0,150	0,123	0,105	0,088	0,076	0,066	0,056	0,048
	2	0,199	0,161	0,129	0,101	0,082	0,067	0,055	0,046	0,037	0,031
	3	0,185	0,142	0,108	0,083	0,064	0,051	0,038	0,028	0,019	0,012

Figure 1



For fork-lift trucks subject to tipping, where the load on print is not specified, the value of P is to be calculated considering the total mass of the vehicle, including that of the cargo handled, ap-plied to one axle only.

The Designer is to supply details of tyre pres-sure, wheel dimensions, loads on wheels and the tyre print dimensions. Where these data are not available, an approximate value of the thickness t, in mm, may be calculated by the following for-mula:

$t = 0,32K_1 \cdot (P_1 \cdot K)^{0,5}$

where:

K_1 : 3,6, for 4 wheels-per-axle vehicles
4,45, for 2 wheels-per-axle vehicles

P_1 : axle load, in kN.

Where it is proposed to use vehicles having steel wheels or tracks, the thickness of deck plat-ing will be specially considered by Tasneef on a case-by-case basis.

1.3.6 Decks forming steps in watertight bulkheads or forming the crown of tanks

The thickness of sections of watertight decks or watertight flats forming a step in watertight bulkheads or the crown of a tank, is to be calcu-lated in compliance with the requirements of Sec 12.

2 Side and stern doors and their securing arrangements

2.1 Arrangement

2.1.1 The requirements of this Article cover cargo and service doors in the ship side (abaft the colli-sion bulkhead) and stern area.

The side and stern doors are to be so fitted as to ensure tightness and are to have structural scantlings commensurate with their location and the surrounding structures.

Doors are preferably to open outwards.

2.2 Scantlings

2.2.1 General

In general the strength of the side and stern doors is to be equivalent to the strength of the surrounding structures.

Door openings in the shell are to have well-rounded corners.

Openings are also to be adequately stiffened with web frames at sides and stringers, or equivalent, above and below.

Doors are to be adequately stiffened, and means are to be provided to prevent movement of the doors when closed.

Adequate strength is to be provided in the connections of the lifting/manoeuvring arms and hinges to the door structure and to the ship's structure.

Where doors also serve as vehicle ramps, the design of the hinges is to take into account the ship angle of trim and list which may result in un-even loading of the hinges.

2.2.2 Plating

The thickness of door plating is to be not less than the side shell plating calculated with a frame spacing equal to the door stiffener spacing, and in no case is to it be less than the minimum re-quired shell plate thickness.

Where doors also serve as vehicle ramps, the plating thickness is to be not less than that re-quired for vehicle decks.

2.2.3 Stiffeners

The section modulus of horizontal or vertical stiffeners is to be not less than that required for the side framing on which the door is fitted.

Consideration is to be given, where neces-sary, to differences in fixity between ship's frames and door stiffeners.

Where doors also serve as vehicle ramps, the stiffener scantlings is to be not less than required for vehicle decks.

2.2.4 Girders

Where necessary, ordinary door stiffeners are to be supported by girders or stringers. The scantlings of such girders (section modulus and web thickness) are to be based on direct strength calculations. Normally, formulae for simple beam theory may be applied.

The load corresponding to the external head h_E defined in Sec 5 is to be taken as the design load. The permissible stresses are to be taken not greater than the following:

- Shear stress τ, in N/mm²:

  $\tau = 100 / K$

- Bending stress, σ, in N/mm²²:

  $\sigma = 150 / K$

- Equivalent stress, σ_{ID}, in N/mm²:

  $\sigma_{ID} = (\sigma^2 + 3\ \tau^2)^{0,5} = 180 / K$

The webs of girders and stringers are to be adequately stiffened, preferably in a direction perpendicular to the shell plating.

The girder system is to be given sufficient stiffness to ensure integrity against deformations of the boundary support of the door.

Edge stiffeners/girders of the doors are to be adequately stiffened against rotation and are to have a moment of inertia J, in cm⁴, not less than that calculated by the following formula:

$J = 6\ p_G \cdot d_s^4$

where:

p_G : packing line pressure along edges, to be taken not less than 5 N/mm

d_S : distance between closing devices, in m.

For edge girders supporting main door gird-ers between securing devices, the moment of inertia is to be increased in relation to the addi-tional force.

2.3 Closing and securing of doors

2.3.1 General

Side and stern doors are to be fitted with adequate means of closing and securing, com-mensurate with the strength of the surrounding structures.

Suitable additional devices are to be ar-ranged for doors to be secured in open position.

Where hinges are used as securing devices they are to be well integrated into the door struc-ture.

2.3.2 Arrangement

Closing devices are to be simple to operate and easily accessible.

The operating panel for remote controlled doors is to be accessible to authorised persons only.

A notice plate giving instructions to the effect that all closing devices are to be applied before leaving harbour is to be placed at the operating panel and is to be supplemented by warning indi-cator lights.

Where hydraulic cleating is applied, the sys-tem is to be mechanically lockable in the closed position so that in the event of failure of the hy-draulic system, the cleating will remain locked.

Packing material is to be of a relatively soft type, and the supporting forces are to be carried by the steel structure only.

Flat bars or similar fastening devices for packings are to have scantlings and welds de-termined with ample consideration given to wear and tear.

3 Grab loading

3.1 Strengthening requirements

3.1.1 General

When, as indicated in Part A, Ch 1, Sec 2 [6.1.4], the additional notation grabloading is assigned the scantlings of structural elements within the cargo hold are to be strengthened in compliance with [3.1.2].

3.1.2 Scantling increase

The scantlings of structural elements within the cargo hold are to be increased as follows:

- inner side and hold bulkheads
  - plating: $t = t_0 + 1,5$ mm
  - ordinary stiffeners: $w = 1,4\ w_0$
- inner bottom
  - plating: $t = t_0 + 2$ mm
  - longitudinals: $w = 1,4\ w_0$

where t_0 and w_0 are scantlings of corresponding structural elements in the case of no grab loading.

SECTION 9 BOTTOM STRUCTURES

1 Single bottom

1.1 Transversely framed single bottom

1.1.1 Floors

Single bottom floors is to be fitted at each frame and is to have a section modulus not less than the value Z, in cm^3, given by the following formula:

$Z = 6 \cdot s \cdot S^2 \cdot h_E \cdot K$

where:

S : span, in m, of the floor evaluated without taking account of keelsons, if any

h_E : external head, as defined in Chapter 4.

In addition, the floor thickness is to be not less than the value t, in mm, given by the follow-ing formula, but in no case less than 5 mm:

$t = 0{,}013 \cdot h_M \cdot K^{0,5}$

where:

h_M : floor depth, in mm, to be taken not less than 6 L.

Within the engine room, floors is to have a section modulus increased by 25% with respect to the above-mentioned value.

In hulls with rise of floor, the floor depth at the centreline is to be adequately increased so as to assure an adequate con-nection to the frames.

When the bottom is also the bottom of a tank, the section modulus Z, in cm^3, is to, in addition, comply with the fol-lowing:

$Z = 6 \cdot s \cdot S^2 \cdot D' \cdot K$

where:

D' : moulded depth D, in m, for ships without trunk
= D + 0,5 h_T, for ships with trunk, h_T being the trunk depth, in m.

1.1.2 All single bottom ships is to have a centre girder, formed by a vertical continuous or inter-costal web plate and a face plate continuous over the floors extended as far forward and aft as possible.

In ships having breadth B > 10 m, side gird-ers is to be fit-ted, distributed so as to divide the ship's breadth into approximately equal parts.

The centre girder is to have depth not less than the floor depth and thickness increased by 1 mm.

The centre girder face plate, continuous over the floors, is to have a sectional area a, in cm_2, not less than the value:

$a = (0{,}2\ L + 5)\ K^{0,5}$

The above-mentioned value is to be kept for 0,6 L amid-ships and then gradually reduced to reach, in way of fore and aft ends, 80% of such value.

Side girders are to have a depth not less than the local floor depth, a thickness not less than floor thickness, and a face plate having a sec-tional area a, in cm^2, not less than the value given by:

$a = (0{,}16\ L + 5)\ K^{0,5}$

Locally extended side girders are to be fitted in way of con-centrated loads.

1.2 Longitudinally framed single bottom

1.2.1 Bottom longitudinals

Bottom longitudinals are to have a section modulus Z, in cm^3, not less than the value given by the following formula:

$Z = 7{,}5 \cdot s \cdot S^2 \cdot h_E \cdot K$

where:

h_E : external head, in m, as defined in Chapter 4.

When the bottom is also the bottom of a tank, the section modulus Z, in cm^3, is, in addition, to be not less than that given by the formula:

$Z = 7{,}5 \cdot s \cdot S^2 \cdot D' \cdot K$

where:

D' : moulded depth D, in m, for ships without trunk
= D + 0,5 h_T, for ships with trunk, h_T being the trunk depth, in m.

1.2.2 Girders

The requirements under [1.1.2] apply. When girders repre-sent a support to floors, their scant-lings are to be suitably increased, and in no case are they to be less than those obtained by applying the formulae for floors given in [1.1.1].

2 Double bottom

2.1 General

2.1.1 The double bottom depth h_{DF}, in mm, is to be not less than that calculated by the following formula:

$h_{DF} = 5\ (B + T) + 550$

and in no case is it to be less than 700 mm in way of the centreline.

Openings in girders and floors are to be not larger than half the local depth of floors or girders.

If, for access reasons, manholes of greater size are needed, reinforcement rings are to be applied to manhole edges.

In hulls with rise of floor, the double bottom depth is to assure, as far as possible, access to side areas and in any case at least visual inspec-tion of such areas.

Double bottom structures are to be fitted with holes for drainage of liquids and passage of air located as near as possible to the bottom and to the inner bottom, respectively.

Bilge wells are to be limited in depth and their bottom and wall thickness is to be not less than that of watertight floors.

For ships subject to subdivision requirements, bilge wells are to comply with the relevant provisions.

2.2 Girders

2.2.1 The centre girder thickness t_P, in mm, is to be not less than the greater of the following values.

$t_P = (0,035\ L + 5)\ K^{0,5}$

$t_P = (0,125\ h_{DF} + 2)\ K^{0,5}$

The side girder thickness t_P in mm, is to be not less than the greater of the following values:

$t_P = (0,035\ L + 3)\ K^{0,5}$

$t_P = 0,125\ h_{DF} \cdot K^{0,5}$

Furthermore, the thickness of watertight gird-ers is to be not less than that calculated by the formulae in Sec 12.

2.3 Floors

2.3.1 The thickness t, in mm, of solid floors is to be not less than the greater of the following values:

$t = (0,035\ L + 3)\ K^{0,5}$

$t = 0,125\ h_{DF} \cdot K^{0,5}$

In addition, the thickness of watertight floors is to be not less than that calculated by the for-mulae in Sec 12.

2.4 Inner bottom plating

2.4.1 The thickness of inner bottom plating is to be not less than the value t, in mm, calculated by the following formula:

$t = (0,032\ L + 4s + 1,5)\ K^{0,5}$

The above-mentioned thickness is to be kept within 0,4 L amidships. Outside that interval this thickness may be gradually reduced to reach the value 0,9 t in way of 0,1 L from the fore and after ends.

If the inner bottom plating also forms a tank top or bottom, its thickness is to be not less than that calculated by the formulae in Sec 12.

In cargo holds, where there is no ceiling un-der the hatchways and 600 mm beyond the pro-jection of the latter, the thickness of inner bottom plating calculated by means of the above-mentioned formula is to be increased by 2 mm.

This increase is not required where the inner bottom is only intended for the carriage of cargo on fixed supports (e.g. containers).

When unloading by buckets is foreseen, the thickness calculated by the above-mentioned formulae is to be increased by 5 mm if a suitable ceiling is not fitted.

Furthermore, in ships intended for the car-riage of dry cargoes in bulk, the inner bottom thickness is to be not less than the value t, in mm, calculated by the following formula:

$t = 4,25 \cdot s\ (\gamma_C \cdot h_C \cdot K^{0,5})$

where:

γ_C : value of the mass density, in t/m², of the cargo

h_C : mean height of cargo on double bottom specified by the Designer or, when un-available, distance between inner bottom and weather deck at centreline.

2.5 Transversely framed double bottom

2.5.1 Side girders

In ordinary ships, side girders, which are in general intercostal girders between solid floors, are to be fitted so that their spacing and their dis-tance from the centre girder and the margin plate do not, as a rule, exceed 4,5 m.

In way of bracket floors, side girders are to be provided with vertical stiffeners having thickness not less than the girder thickness and adequate depth, in general not less than 150 mm.

2.5.2 Solid floors

In ordinary ships, solid floors, having the thickness required in [2.3], are to be fitted in the following areas:

- for 0,25 L from the bow;
- in way of machinery spaces;

Solid floors are also to be fitted:

- in way of boiler foundations;
- in way of transverse watertight bulkheads;
- in way of double bottom steps.

Elsewhere solid floors may be arranged with spacing not exceeding 3 m; bracket floors are to be fitted in way of intermediate frames.

Floors exceeding 900 mm in depth are to be adequately provided with vertical stiffeners.

2.5.3 Bracket floors

At each frame between solid floors, bracket floors consisting of a frame connected to the shell plating and a reverse frame connected to the inner bottom plating are to be arranged and attached to each other in way of the centre girder, the side girders and the margin plate by means of flanged brackets having a thickness as required in [2.3] and a width of flange not less than 1/10 of the local double bottom depth.

Where frames and reverse frames are inter-rupted in way of girders, double brackets are to be fitted.

The frame section modulus Z_C, in cm², is to be not less than that calculated by the following formula:

$Z_C = 7s \cdot S^2 \cdot h_E \cdot K$

where h_E is as defined in Sec 5.

The reverse frame section modulus ZR is to be not less than 85% of that of the frame section modulus ZC.

Where tanks intended for liquid cargoes are arranged above the double bottom, the size of reverse frames is to be as required for liquid cargo tank stiffeners.

Where tanks intended for liquid cargoes are arranged inside the double bottom, the size of reverse frames is to be as required for deep tank stiffeners, as are to the size of frames calculated as specified in Sec 12 by adopting a design head h reduced by a value not greater than 0,3 T.

In addition, in ships intended for the carriage of dry cargoes in bulk, the reverse frame section modulus is to be not less than the value Z_R, in cm^3, calculated by the following formula:

$Z_R = 6{,}5\ s \cdot S^2 \cdot \gamma_C \cdot h_C \cdot K$

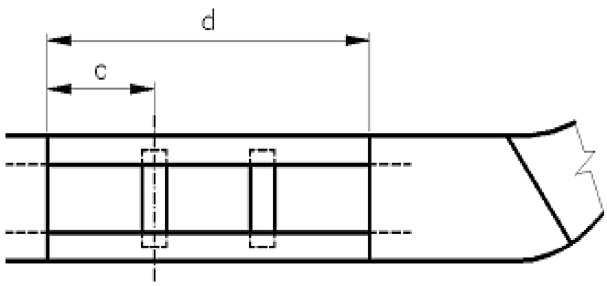
Where struts of the size required in [2.6.6] are fitted and arranged in such a way as to sub-divide the span into approximately equal lengths, Z_R and Z_C may be calculated as stated above, assuming as conventional span the greater of the following values of S, in m.

- S = 1,4 c
- S = 0,75 d

where c and d are the distances given in Fig 1.

In no case is the value of S to be assumed less than 1,2 m.

Figure 1



2.6 Longitudinally framed double bottom

2.6.1 Side girders

In ordinary ships, side girders are to be fitted so that their spacing and their distance from the centre girder and the margin plate do not exceed 6,5 m. In engine rooms the number of girders is to be adequately increased and additional girders are, in any case, to be fitted in way of foundations.

The thickness of side girders is 10% less than that required in [2.2].

Side girder plates are, in general, to be pro-vided with stiffeners at a spacing not exceeding 1,2 m.

2.6.2 Floors

In ordinary ships, the spacing of floors in the cargo area is generally not to exceed the lesser of the values 0,05 L and 3,80 m.

In engine rooms, solid floors are to be fitted at every second frame.

Additional floors are to be fitted in way of wa-tertight bulkheads and foundations of main en-gines and other important machinery.

The thickness of floors is to be at least 10% more than that required in [2.3].

Floor plates are generally to be provided with vertical stiffeners in way of longitudinals.

2.6.3 Stiffening brackets for centre girder and margin plate

Transverse stiffening brackets are to be pro-vided on both sides of the centre girder and on the margin plate, generally spaced not more than 1,2 m apart. These brackets, having the thick-ness required in [2.3], are to be extended from the centreline and margin plate to at least the ad-jacent longitudinal and stiffened at the edge with a flange having a width not less than 1/10 of the local double bottom depth.

If necessary, Tasneef may require a welded flat bar to be arranged in lieu of the flange.

2.6.4 Bottom and inner bottom longitudinals

The section modulus Z_{LF}, in cm^3, of bottom longitudinals is to be not less than that calculated by the following formula:

$Z_{LF} = 7{,}5\ s \cdot S^2 \cdot h_E \cdot K$

where:

h_E : design head, in m, as defined in Chapter 4.

The section modulus of inner bottom longitudinals Z_{LD}, in cm^2, is to be not less than 85% of the section modulus Z_{LF} required for bottom lon-gitudinals.

Where tanks for liquid cargoes are arranged above the double bottom, the size of inner bot-tom longitudinals is to be as required for liquid cargo tank stiffeners.

Where tanks intended for liquid cargoes are arranged inside the double bottom, the size of inner bottom longitudinals is to be as required for deep tank stiffeners, as is the size of bottom lon-gitudinals calculated as specified in Sec 12 by adopting a design head h reduced by a value not greater than 0,3 T.

In tankers and bulk carriers, the section modulus of inner bottom longitudinals is, in addi-tion, to be not less than the value Z'_{LD}, in cm^3, calculated by the following formula:

$Z'_{LD} = 7{,}5\ s \cdot S^2 \cdot h \cdot K$

where:

h : design head, in m, obtained from the following formulae:
- for tankers
  $h = (D' - h''_{dF}) \cdot r$
- for bulk carriers
  $h = \gamma_C \cdot h_C$

D′ : the greater of the values obtained from the following formulae:
$D' = D + (F / r)$
$D' = D + h_m + (1/r)$

h''_{DF} : local depth of double bottom, in m, in way of the longitudinal considered

h_m : depth of the hatchway coaming or half depth of the trunk, in m

F : 1 + 0,05 (L - 50), L being the length of the ship, to be taken, in any case, not less than 50 m and not greater than 80 m.

Where struts of the size required in [2.6.6] are fitted in such a way as to subdivide the span into approximately equal lengths, the section modulus of bottom and inner bottom longitudinals may be calculated in accordance with the above, assuming as conventional span the greater of the following values S, in m:

S = 1,4 c

S = 0,75 d

c and d being the distances, in m, given in Fig 2.

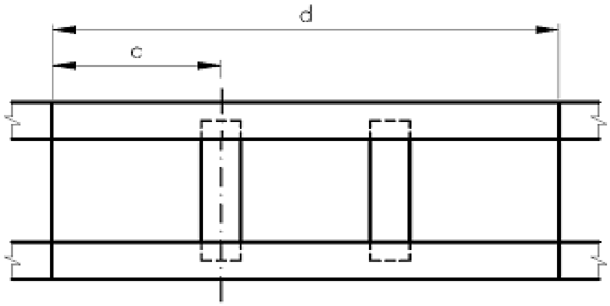
In no case is the value of S to be assumed less than 1,2 m.

The fitting of struts is generally not permitted in ships for which unloading by buckets is fore-seen.

Where full depth side girders are fitted every second inner bottom longitudinal, the section modulus of the latter may be reduced by 10%.

Bottom and inner bottom longitudinals are, as a rule, to be continuous through the floors; where they are interrupted, the continuity is to be pro-vided by adequate double brackets for attach-ment to each other and to the floor web.

Figure 2



2.6.5 Structure of hopper side tanks in bulk carriers or combination carriers

The section modulus of longitudinals of hop-per side tanks is to be calculated by applying the formulae given in [2.6.4], for inner bottom longi-tudinal section modulus, assuming h_C equal to the distance from the longitudinal under consid-eration either to the weather deck, or to the cor-responding point of sloped plating of the topside tank, whichever is the lesser.

The section modulus of the vertical stiffeners Z_{MR}, in cm^3, in the said area is to be not less than that calculated by the following formula:

$Z_{MR} = 10 \, s \cdot S^2 \cdot h \cdot K$

where:

- s : spacing of vertical stiffeners, in m
- S : conventional span, in m, to be assumed not less than 3 m
- h : greater of the values h_S and $\gamma \cdot h_C$, as-suming h_C as specified for longitudinals in the first sentence of this paragraph.

The scantlings of stiffeners in transversely framed hopper side tanks are to be calculated by applying the formulae in Sec 12 for the scantlings of the stiffeners for deep tanks, assuming as de-sign head the greater of the values h_S and $\gamma \cdot h_C$, and assuming h_C as stated above for longitudinals.

2.6.6 Vertical struts

Where vertical struts are fitted, their area A, in cm^2, and minimum moment of inertia J, in cm^4, are to be not less than those given by the following formulae:

$A = 1{,}7 \, s \cdot h_E \cdot d' \cdot K$

$$J = \frac{H \cdot A \cdot h'_{DF}}{K}$$

where:

- d′ : mean span of frames (or longitudinals) adjacent to the strut under considera-tion, in m;
- h_E : external head mentioned in Chapter 4, in m;
- h'_{DF} : double bottom depth, reduced by the sum of the depths of the frames con-nected by the strut, in m.

SECTION 10 SEA AND WING TANK STRUCTURES

1 General

1.1

1.1.1 This Chapter outlines the criteria for the scantlings of side stiffening structures, which may be either transverse or longitudinal. Transverse structure consists of vertical ordinary stiffeners (frames), which may or may not be supported by side girders, while longitudinal structure consists of longitudinal ordinary stiffeners (longitudinals) supported by web frames.

2 Definitions and symbols

2.1 Definitions

2.1.1

Hold frames:

Vertical ordinary stiffeners located between the after peak bulkhead and the collision bulkhead, connected at the bottom to the floor or the inner bottom and at the top to the deck or the lowest flat.

'Tweendeck frames:

Vertical ordinary stiffeners located between the after peak bulkhead and the collision bulkhead, extending in line with the hold frames up to the deck of the highest superstruc-ture and having scantlings which may vary from one 'tweendeck to another depending on the characteristics of the various 'tweendecks.

2.2 Symbols

2.2.1

S : conventional span, in m, to be measured, for the scantlings of frames in the different areas, in the sections indicated below:

- between the after peak bulkhead and 0,25 L from the forward perpendicular: in way of the section amidships, measuring the span vertically;
- between 0,25 L and the collision bulkhead: in way of the section at 0,15 L.

In the case of stepped decks, the span S is to be measured ideally extending the interrupted deck to reach the measurement points indicated above.

In the case of ships having unusual sheer or particular body shape, the value of S will be given special consideration by Tasneef

In any case, the following is to be complied with:

$S \geq 0,2\ L_1^{0,5}$

h_E : external dynamic head, in m, as defined in Chapter 4 and calculated in the same sections where S is to be measured, taking d = T.

h_2 : sum of the heights of all 'tweendecks above the deck at the top of the frame, in way of the section where S is to be measured.

For every 'tweendeck intended for accommodation and located above the pdc as defined in Chapter 10, half the height of the 'tweendeck may be assumed.

For every 'tweendeck above a deck having longi-tudinal stiffeners and supported by deep beams, a height equal to zero may be assumed.

For frames below the pdc, the value of h^2 is to be not less than the sum of the heights of 'tweendecks, located between the deck above the frame (or the bottom of a deep tank, in the case of a bulk carrier) and the pdc increased by 2,5 m, calculated as above.

In Fig 2 the values of h^2 for some typical cases are indicated as examples.

3 Ordinaty stiffeners

3.1 Frames

3.1.1 Section modulus

The section modulus Z_C of frames, in cm³, is to be not less than that calculated by the following formula:

$$Z_C = 6s \cdot S^2 \cdot f_C \cdot \left(h_E + \frac{B \cdot h_2}{120}\right) \cdot R' \cdot K$$

R′ : 0,8, for hold frames of ordinary ships and machinery space frames and 1,0, for hold frames of bulk carriers

R′ : the lesser of the values $(6 / S)^{0,5}$ and 1,4 for 'tweendeck frames, where S < 6 m

1,0, for 'tweendeck frames, where S ≥ 6 m

f_C : coefficient, the value of which is to be taken from Tab 1 depending on the type of span, end connection and frames

B : maximum ship's breadth, in m, or, in ships with pillaring lines or any other deck supports complete from deck to bottom, distance, in m, from the said supports to the ship side.

Where the conventional span is of the same type, it is not necessary to assume the Rule section modulus of 'tweendeck frames greater than that of the frames below.

For the calculation of the section modulus of the frames of tankers, R' is to be assumed equal to 1; furthermore, in the case of tankers having deck and bottom longitudinally framed, f_C is to be taken equal to 1, both for single span and upper and lower end span, and f_C is to be taken equal to 1,2 for the span between longitudinals.

Moreover, the section modulus of the frames in tank-ers is to be not less than that required for vertical ordinary stiffen-ers of deep tank bulkheads in Sec 12.

3.1.2 End connections

Frames are to have end connections like those given in Tab 1. In particular, the upper end of hold and machinery space frames is to be provided with a bracket. The lower end of these frames is also to be provided with a bracket, except in the case of double bottoms raised at the side or ships having special service needs. In these cases the value of the coeffi-cient f_C will be decided by Tasneef depending on the type of end connection foreseen. The upper end of 'tweendeck frames is to be provided with a bracket, which may be omit-ted for special service needs only.

When fitted, brackets are to have scantlings as re-quired in Sec 6.

End connections in way of longitudinally framed deck or bottom will be given special consideration by Tasneef

Table 1

Type of span	Type of connection	Type of frame	f_C
1,2,3	Brackets at both ends	hold frames	0,62
1,2,3	Brackets at both ends	'tweendeck frames	0,80
1,2	Bracket at one end and clip at the other	hold or 'tweendeck frames	1,00
3	Bracket at one end and clip at the other	hold or tweendeck frames	1,20
1,2,3	Clips at both ends	hold or 'tweendeck frames	1,20

Note 1:
The numbers in the first column of the table indicate the following types of span:
1 = single span
2 = lower or upper end span
3 = span between stringers

3.1.3 Alternate frames

Transverse side framing may consist of ordinary frames, hav-ing the same scantlings every two frames or different scant-lings, and having a section modulus such that the sum of section moduli of two adjacent frames is not lower than the total section modulus obtained by add-ing together the sec-tion moduli of the various frames cal-culated in accordance with the provisions of [3.1.1]. The section modulus of each frame is, in no case, to be less than 65% of that calculated as in [3.1.1].

3.2 Section modulus of longitudinals

3.2.1 The section modulus Z_{CL}, in cm^3, of longitudinals is to be not less than that calculated by the following formula:

$Z_{CL} = 6\ s \cdot S^2 \cdot k \cdot h_E \cdot K$

where:

k : 0,90, for longitudinals of ordinary ships

$\frac{1,6D}{1,77D - 0,34d_{CL}}$ for tanker longitudinals located below 0,5D

$\frac{1,6D}{D + 1,2d_{CL}}$ for tanker longitudinals located above 0,5D

d_{CL} : distance, in m, from the longitudinal consid-ered to the moulded line of the strength deck.

Furthermore, in tankers, the section modulus of longi-tudi-nals is to be not less than that required in Sec 12 for longitu-dinals of longitudinal bulkheads.

Where groups of equal longitudinals are fitted, the section modulus of each longitudinal may be taken equal to the mean value of section moduli calculated for each longitudi-nal of the group. The mean value is, in no case, to be less than 90% of the maximum required for longitu-dinals cal-culated individually.

3.3 Section modulus of ordinary stiffeners of tanks

3.3.1 In addition to complying with the requirements of Chapter 9, the section modulus of web frames or longitu-dinals inside deep tanks and cargo tanks is to be not less than the value required in Chapter 11 for ordinary stiffen-ers of bulkheads and deep tanks.

4 Primary supporting members

4.1 Ordinary ships

4.1.1 The section modulus Z_{TR}, in cm^3, of web frames and side stringers is to be not less than that calculated by the fol-lowing formula:

$$Z_{TR} = k_{CR} \cdot s \cdot S^2 \cdot \left(h_E + \frac{B \cdot h_2}{120}\right) \cdot K$$

where:

K_{CR} :
- 3, for web frames located outside machinery spa-ces and not associated with side string-ers, in ships where the side shell is vertically stiffened with or-dinary stiffeners
- 4, for web frames located inside machinery spaces and not associated with side string-ers, in ships where the side shell is vertically stiffened with ordinary stiffeners
- 7, in all other cases

s : web frame or side stringer spacing, in m.

In addition, the section modulus Z_{TR}, in cm³, of web frames not associated with side stringers, in ships where the side shell is vertically stiffened by ordinary stiffeners is to be not less than the value calculated by the following formula:

$$Z_{TR} = 6s \cdot S^2 \cdot \left(h_E + \frac{B \cdot n_s \cdot h_2}{120}\right) \cdot K$$

where:

s : frame spacing, in m.

n_s : number of frame spaces between web frames.

When the side is inclined, it is recommended that web frames with a depth greater than that of longitudinals should be envisaged such that the latter may be con-nected to the web frames by means of brackets.

The section modulus of web frames in deep tanks or cargo tanks is to be not less than the values required in Sec 12 for the relevant primary supporting members of bulkheads and tanks.

In ships with double sides, Tasneef may require the veri-fica-tion of primary supporting members and struts by also applying the Rules for tankers as stated in [4.2].

4.2 Tankers

4.2.1 Ships with longitudinally framed sides - Side transverses

Side transverses may, or may not, be connected to the verti-cal webs of the longitudinal bulkheads facing by means of struts.

The section modulus Z_{CR}, in cm³, of side transverses is to be not less than the value given by the following formula:

$$Z_{TR} = k'_{CR} \cdot s \cdot S^2 \cdot h'_0 \cdot K$$

where:

h'_0 : distance in m, from the mid-span and moulded deck line, increased by a value equal to half of the actual depth of trunk, if any

K_{CR} :
- 6,5, for side transverses without struts
- 4,4, for side transverses with one strut
- 3, for side transverses with two or more struts.

In the case of transverses without struts, the span S is to be taken not less than 0,4 D.

The thickness of the web plate of side transverses is to be such that the net area A_{CR}, in cm², of each horizontal sec-tion, including any bracket, is not less than the value given by the following formula:

$$A_{CR} = \frac{T \cdot K}{7,35}$$

where T is the shear force, in kN, in the section under con-sideration, obtained from the diagram in Fig 1; the values of T_1, T_2 and x, shown in the above figure, may be obtained as follows:

$T_1 = 8\ [\ 0,205\ (d_1 / DM)^2 + 0,220] \cdot s \cdot D_M \cdot D_C$

$T_2 = 8\ [\ 0,050\ (d_1 / DM)^2 + 0,120] \cdot s \cdot D_M \cdot D_C$

$x = [1 - (T_2 / T_1)] \cdot [0,214\ (d_1 / D_M)^2 + 0,261] \cdot D_C$

where D_M, D_C and d_1 are as given in Fig 1.

In the case of transverses without struts it is to be assumed that $d_1/D_M = 1$, so that T_1, T_2 and x may be obtained as fol-lows:

$T_1 = 3,4\ s \cdot D_M \cdot D_C$

$T_2 = 1,36\ s \cdot D_M \cdot D_C$

$x = 0,475 \cdot [1 - (T_2 / T_1)] \cdot D_C$

Side transverses supported by a strut and two diagonals converging on the former will be given special considera-tion by Tasneef

As a first approach, the section modulus Z_{CR}, in cm³, may be taken equal to that given by the following formula:

$Z_{CR} = 85\ s \cdot (S - C_0)^2 \cdot K$

where:

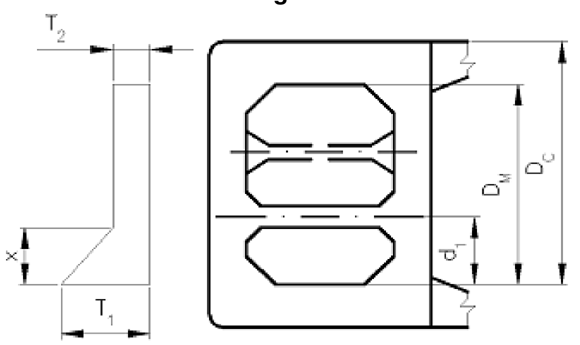
$C_0 = (D - 2)/2$, for $D \le 10$ m;

$= 4$, for $D > 10$ m.

The depth of side transverses may be gradually tapered from bottom to deck, and the value of the depth to be consid-ered for the calculation of the section modulus is that corre-sponding to the middle of the span S adopted in the scantling formulae.

In the case of liquid cargoes having mass density higher than 1 t/m³, the scantlings of side transverses will be spe-cially considered by Tasneef

Figure 1



4.2.2 Ships with transversely framed sides - Side transverses and side girders

Where the side is strengthened by means of vertical ordinary frames, these are to be supported by side girders if D > 6 m.

These girders are to be supported by side trans-verses spaced no more than 3,7 m apart.

The section modulus of such side transverses is to be not less than that obtained by the formula given in [4.2.1], increasing the value of K'_{CR} by 30% where only one side girder is fitted, and by 15% where two are fitted.

The section modulus Z'_{CR}, in cm³, of the side girders is to be not less than that obtained from the following formula:

$Z'_{CR} = K''_{CR} \cdot b \cdot h_{CR} \cdot S^2 \cdot K$

where:

K''_{CR} : coefficient to be assumed as follows:
- where one side girder is fitted:
  $K''_{CR} = 11$
- where two or more side girders are fitted:
  $K''_{CR} = 11$, for the lower and intermediate side girders
  $K''_{CR} = 13$, for the upper side girder

h_{CR} : distance, in m, from the side girder to the moulded line, increased by a value equal to half the depth of trunk, if any; however, this distance is to be taken not less than the value given by the following formula:

$$h_{CR} = \frac{6L}{420 - L}$$

b : half the distance, in m, from the side girders adjacent to that under consideration, or from the bottom or the deck to the adjacent side girder.

In general, the number of side girders is to be such that b ≤ 3,75 m.

In the case of ships having 4,5 < D ≤ 6 m, where ordinary frames are not supported by side girders, side transverses are to be fitted, in general not more than 5 Rule frame spaces apart.

Such side transverses are to form part of the transverse ring structure consisting of the bottom, side shell, deck transverses and longitudinal bulkheads, and their section modulus is to be not less than that obtained by the formula given in [4.2.1] assuming $K'_{CR} = 6{,}4$.

4.2.3 Struts

The area A, in cm², of the transverse section of struts connecting the side transverses to the bulkhead vertical webs facing is to be not less than that derived from the following formula:

$$A = \frac{0{,}8s \cdot b_P \cdot h_S \cdot K}{C_P}$$

where:

s : distance, in m, between the side transverses

b_P : half the distance, in m, from the mid-lengths of the struts adjacent to that under consideration, or the mid-length of the bottom transverse or deck transverse, to the mid-length of the adjacent strut

C_P : 1, for $d_P / r_P \le 70$
1,7 - 0,01 d_P / r_P, for $70 < d_P / r_P \le 140$

d_P : distance in cm, from the face plate of the side transverse and that of the bulkhead vertical web, connected by the strut, measured at the level of the strut

r_P : $(J / A_E)^{0,5}$

J : minimum moment of inertia of the strut considered, in cm⁴

A_E : actual area of the transverse section of the strut considered, in cm².

Where side transverses and bulkhead vertical webs are connected by a strut and two diagonals converging on the web frame, the crosssectional area A of the strut is to be not less than 90% of the value obtained by applying the formula given above in the case of one strut, while the transverse section area of the diagonals may be not less than 85% of the same area.

Struts are generally to be connected to side transverses and bulkhead vertical webs by means of suitable vertical and horizontal brackets and web plates are to be stiffened in compliance with the requirements of Chapter 5.

5 Structure of wing tanks of bulk carriers

5.1 Ordinary stiffeners

5.1.1 The section modulus of ordinary stiffeners of top side tanks and hopper side tanks is to be not less than the greater of that required for ordinary stiffeners of deep tanks or cargo tanks, or that required for ordinary stiffeners of the bottom, the double bottom, the side and the deck, according to the location of the tank under consideration.

5.2 Primary supporting members

5.2.1 The section modulus Z_{TR}, in cm³, of primary supporting members, apart from the stiffeners of hopper side tank sloped plating, is to be not less than that calculated by the following formula:

$Z_{TR} = 8\, s \cdot S^2 \cdot h \cdot K$

where:

s : primary supporting member spacing, in m

S : conventional span, in m, as defined in Chapter 5, to be assumed in all cases not less than 3 m

h : the greatest of the values of the applicable heads h_S, h_{IN}, and h_E, as defined in Sec 5.

Figure 2 : Typical h_2 heights (a)

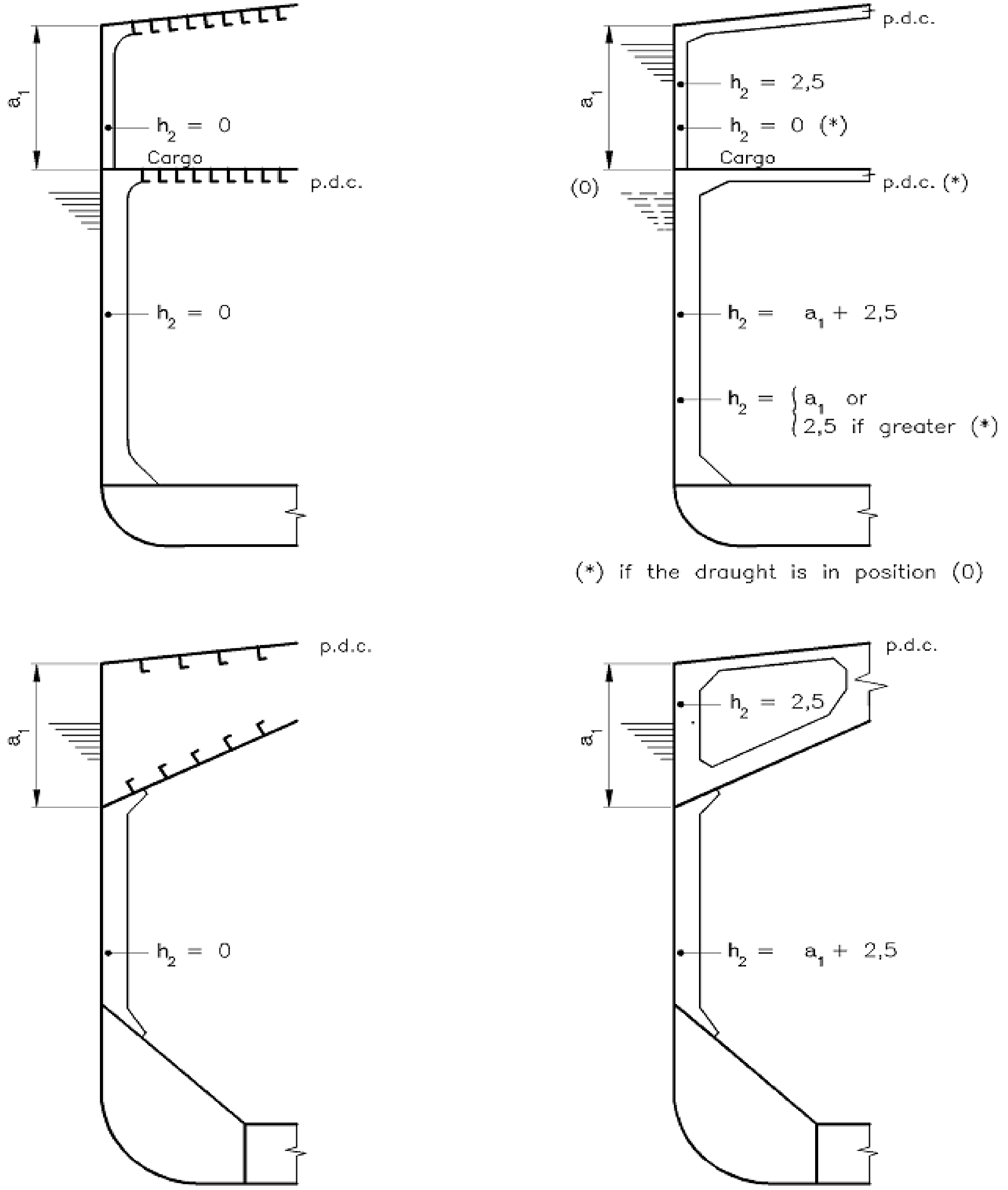
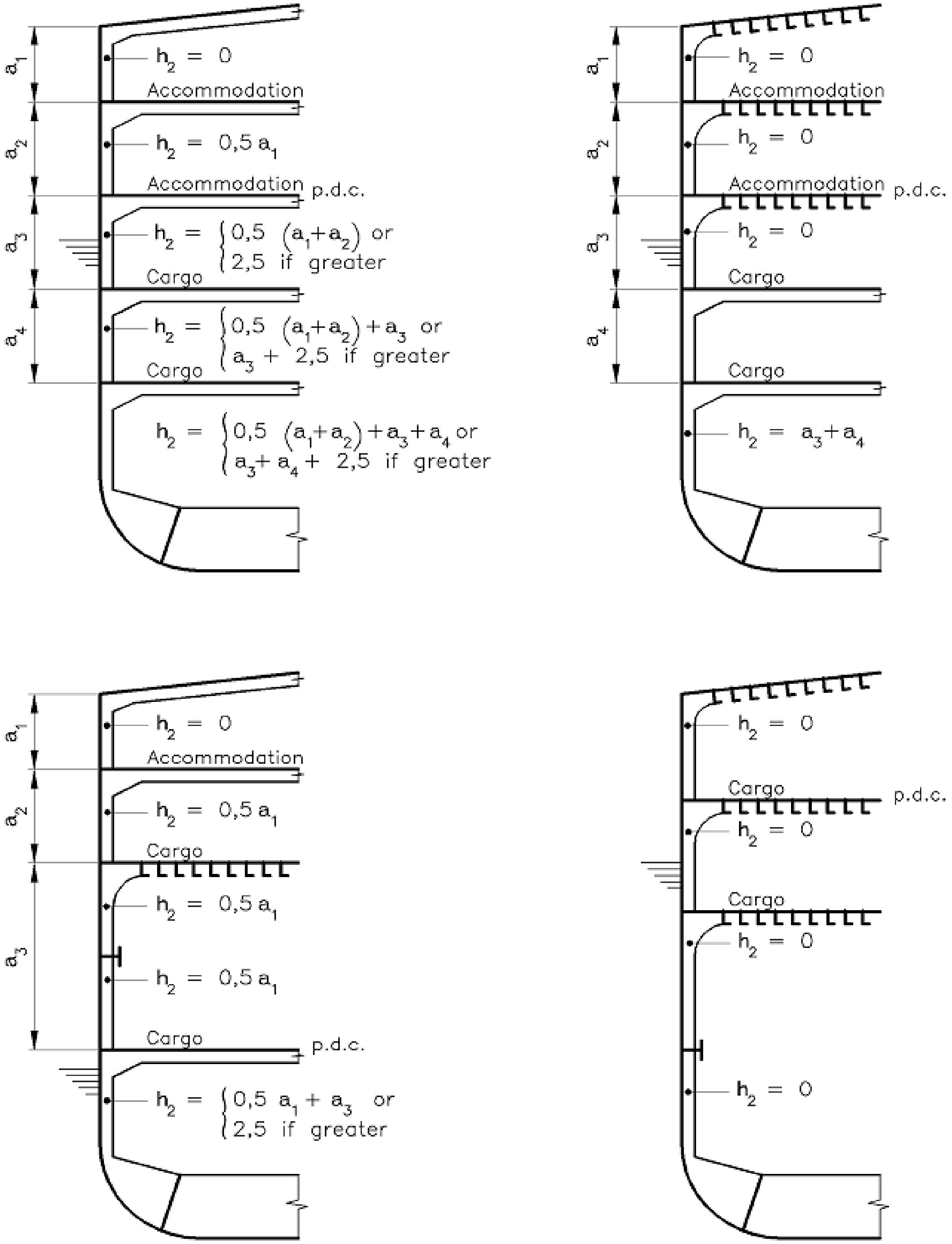


Figure 3 : Typical h_2 heights (b)



SECTION 11 DECK STIFFENING ANS SUPPORTING STRUCTURES

1 General

1.1

1.1.1 This Chapter gives the criteria and formulae for the scantlings of deck and flat stiffening and supporting structures.

The deck stiffening and supporting structure consists of ordinary stiffeners (beams or longitudinals), transversely or longitudinally arranged, supported by primary supporting lines constituted by systems of deck girders and/or deck transverses, which may in turn be supported by pillars.

Where beams are fitted, these are to be effectively supported by at least two longitudinal girders located in way of longitudinal hatch coamings to which they are to be connected by brackets and/or clips.

For deck areas inside the line of openings, a transverse structure is, as a rule, to be adopted and beams are to be adequately supported by girders and extend up to the second longitudinal from the longitudinal hatch coam-ing toward the bulwark. Where this is impracticable, intercostal stiffeners are to be fitted between the hatch coaming and the second longitudinal.

Supporting lines of different decks are to be arranged so that pillars are fitted in the same vertical line, whenever possible.

Tight or non-tight bulkheads having scantlings as re-quired in Chapter 11 may be considered as pillars.

Deck supporting structures under deck machinery, cranes, and king posts are to be adequately stiffened.

Pillars or other supporting structures are, as a rule, to be fitted under heavy, concentrated cargoes.

Specific arrangements, such as girders supported by cantilever webs, will be given special consideration by Tasneef

Where devices for vehicle lashing arrangements and/or corner fittings for containers are directly attached to deck plating, provision is to be made for the fitting of suitable additional reinforcements of the sizes required by the load carried.

Suitable stiffeners are also to be provided in way of the ends and corners of deckhouses and partial superstructures.

The forecastle deck is also to comply with the re-quirements of Sections 13 and 14.

The deck supporting structure of the weather deck or forecastle deck in the area within 0,075 L from the bow is generally to consist of girders associated with deck trans-verses and supported by pillars; girder spacing is not, in general, to exceed 3,5 m and the spacing of deck trans-verses is not to exceed 1,5 m.

2 Definitions and symbols

2.1

2.1.1

pdc : design deck, intended as the first deck above the full load waterline extending for at least 0,6 L and constituting an effective support for side struc-tures. This deck, defined for the purpose of identifying the design head, is ideally to be considered as extending for the entire length of the ship

h_{TD} : cargo 'tweendeck height at side, in m

$h_{0,}$: values given in Tab 1

D_0 : distance, in m, measured amidships from the moulded deck line of the pdc to the base line

d_P : distance, in m, from the deck under consideration to the pdc

S : conventional span, in m, as defined in Chapter 5; in no case is S to be assumed less than 2 m for beams

s : spacing of transverse or longitudinal stiffeners, in m.

3 Ordinary stiffeners

3.1 Section moduli

3.1.1 The section modulus Z, in cm^3, of ordinary stiffeners is to be not less than that calculated by the following formula:

$$Z = 6{,}5\ s \cdot S^2 \cdot h_0 \cdot C_1 \cdot C_2 \cdot K$$

where:

C_1 : 1, for $L \geq 110$

$(L / 110)^{0{,}5}$, for $L < 110$ m; in no case is C_1 to be taken less than 0,6

C_2 : coefficient given in Tab 1.

The section modulus of ordinary stiffeners of decks or flats constituting the top or bottom of tanks is to be as required in Sec 12.

In the special case of ordinary stiffeners intended for decks bearing heavy concentrated cargoes, the value of the section modulus is to be adequately increased.

Ordinary stiffeners of tankers are to have a section modulus not less than that required for ordinary ships.

3.2 Construction details of ordinary stiffeners

3.2.1 In general, strength deck longitudinals are to be continuous through the watertight bulkheads and/or deck transverses.

When longitudinals are interrupted in way of watertight bulkheads and/or deck transverses, structural continuity is to be ensured by means of brackets fore and aft of the bulkhead, welded to the latter and adopting special procedures for carrying out the welded connection.

Frame brackets, in ships with transversely framed sides, are in general to have their horizontal arm extended to the adjacent longitudinal.

3.2.2 Where the strength deck is transversely framed, beam brackets also forming the butt strap for the corresponding frame are also to be flanged.

4 Primary supporting members

4.1 General

4.1.1

The scantlings of deck transverses and girders sup-porting longitudinals and beams, respectively, as well as longitudinal hatch coamings and hatch end beams, are to comply with the scantling requirements given in [4.2] and [4.3].

In general, hatch end beams and deck transverse structures are to be in line with bottom and side transverse structures, so as to form a strengthened ring.

The section modulus of girders consisting of longitudinal hatch coamings adequately extended below the deck and provided with a flange or face plate on the lower edge may be calculated considering, in addition to the section below the deck and the deck plating, the part of the coaming above the deck up to and including the horizontal coaming stiffener.

To this end, however, the elements below the deck forming the girder are to extend up to the adjacent bulkhead or, where the girder ends on a pillar or deck transverse located in way of the hatchway corner, beyond that point the section of coaming above the deck is to be adequately tapered and the girder below the deck is to extend for two frame spaces.

The section modulus of primary supporting members of decks or flats constituting the top or bottom of tanks is, in general, to be as required in Section 12.

4.2 Section modulus of primary supporting members

4.2.1

The section modulus Z, in cm^3, and the moment of inertia J, in cm^4, of girders and deck transverses, are to be not less than those calculated by the following formulae:

$Z = C_4 \cdot K \cdot (M + M' + M'')$

$J = 2{,}5\ Z \cdot S / K$

where C_4 is a coefficient given in Tab 3 and M, M' and M'' are values calculated by the following formulae:

$M = 0{,}5\ S^2 \cdot b_S \cdot (h_0 + m_0) \cdot C_5$

$M' = 0{,}22\ Q' \cdot S$

$M'' = 1{,}75\ Q'' \cdot (d_Q^2 / S^2) \cdot (S - d_Q)$

where:

- Q : conventional concentrated loads, if any, from pillars or primary supporting members above, applied to the girder on the middle third of the span, in kN
- Q'' : conventional concentrated loads, if any, from pillars or primary supporting members above, ap-plied to the girder outside the middle third of the span, in kN
- b_S : mean width of the deck plating attached to the girder, in m; in the calculation of b_S, the openings of hatchways, skylights etc provided with closing devices are not to be considered and therefore the deck is to be regarded as intact
- d_Q : the greater of the distances from the point of application of Q'' to the ends of the member span, in m.

Where the carriage of loads having a mass density exceeding 0,7 t/m^3 is foreseen for an open deck, the value given in the following formula is to be assumed for h0 in the calculation of M:

$$h_0 = \frac{P}{6,9C_5}$$

where P is the load per square metre of deck, in kN/m^2.

4.3 Section modulus of primary supporting members in tankers

4.3.1 The section modulus Z, in cm^3, of primary supporting members in tankers is to be not less than that obtained from the relevant formula in Tab 4.

4.4 Intercostal girders in tankers

4.4.1 In tankers, where a primary supporting bottom centre-line girder is not fitted, an intercostal centreline girder may be arranged instead of the primary supporting deck girder; the depth of such girder is, as a rule, to be between 55% and 75% of the depth of deck transverses.

Any other intercostal girders in centre tanks and side tanks are to have similar scantlings.

4.5 Direct calculations

4.5.1 The scantlings of primary supporting members of complex systems and/or decks subject to particular concentrated loads and/or distributed differently from those mentioned above are to be generally based on direct calculations carried out by accepted calculation procedures which take into account the grillage effect. In such cases, when loads are defined in accordance with Sec 5, the resulting stresses are not to exceed the permissible values given in Tab 3.

5 Pillars

5.1

5.1.1 The minimum area A, in cm², of the section of a pillar is to be not less than that calculated by the following formula:

$$A = \frac{Q}{12,5 - 0,045\lambda}$$

where:

λ : slenderness of the pillar, i.e. the ratio between the pillar length and the minimum radius of gyration of the pillar cross-section

Q : load acting on the pillar, in kN, obtained by the following formula:

$Q = 6,87\ A_{PG} \cdot h_P + Q_C$

where:

A_{PG} : area of the section of the deck acting on the pillar, in m²

Q_C : load from pillars above, if any, or any other con-centrated load, in kN

h_P : design head, in m, the value of which is to be taken as stated in (a) to (c), inclusive, below:

- (a) In the case of pillars located below exposed deck spaces:

  $h_P = 0,3$

- (b) In the case of pillars located below unex-posed deck spaces:

  $h_P = 0,6\ h_0$, if the pillar considered supports decks intended for living quarters and is located above the upper continuous deck or the strength deck, where the latter exceeds 0,6 L in length

  $h_P = h_0$, in all other cases.

- (c) Where the carriage on a deck of cargoes having a mass density greater than 0,7 t/m³ is envisaged, h_P is to be taken as follows:

  $h_P = P / 6,9$

  where P is the load per square metre of deck, in kN/m².

The value h_0 mentioned in (b) is that indicated in Sec 5, Tab 1.

The formula for the calculation of Q applies in the case of solid, tubular or prismatic pillars of steel having a tensile strength R_M= 400 to 490 N/mm², inclusive, as well as pillars consisting of seamless pipes made of steel having R_M = 440 to 540 N/mm², inclusive.

Where materials having characteristics other than those mentioned above are used, the required area may be modified in accordance with instructions from Tasneef

Stiffeners ensuring an efficient load distribution are to be fitted at the ends of pillars.

Where, in exceptional circumstances, pillars support eccentric loads, the scantlings are to be adequately increased to resist the bending moment due to the eccentricity of the load.

Where pillars on the inner bottom are not located in way of intersections of floors and girders, partial floors or girders or equivalent structures suitable to support the pillar load are to be arranged.

Insert plates are to be fitted to the inner bottom under pillars and also to deck structure under large pillars. Such insert plates may be substituted by doubling, except in the case of pillars which may also work under tension such as those in tanks.

In tanks, solid or open section pillars are generally to be fitted; this requirement is compulsory for pillars located in spaces intended for products which may produce explosive gases.

Heads and heels of pillars are to be continuously welded or connected by full penetration welding as specified in Section 4.

The welded connections of structures directly involved in the arrangement of pillars are to be adequately stiffened where necessary.

The thickness of tubular or closed section pillars is, in general, to be not less than 1/35 of the nominal diameter or larger side of the section. In no case is this thickness to be less than 5 mm. The thickness of face plates of built-up pillars is to be not less than 1/18 of the unsupported width of the face plate.

Table 1

Type and location of supporting members		C_2
Beams	End span or single span	0,56
	Intermediate span	0,63
Longitudinals	of weather deck of tankers	1,2
	• of strength deck and decks below, within 0,4 L amidships (1) • of decks of superstructures extending more than 0,15 L, within 0,4 L amidships	1
	of strength deck, forward of 0,12 L from the bow (1)	0,8
	• of strength deck and decks below, within 0,3 L from the stern • of decks below the strength deck, forward of 0,12 L from the bow • of decks of superstructures other than those mentioned above, and deckhouses or houses • of flats or deck areas between hatchways	0,63
(1) In intermediate zones, section moduli are to be gradually reduced from the value within 0,4 L amidships to that required at the ends.		

Table 2

Type and location of supporting members		C_4
Deck girders	Constituting longitudinal coamings of hatchways on the weather deck	6,5
	On the strength deck and decks below, within 0,4 L amidships, in the case of continuous deck girders ex-tending more than 0,15 L	7
	In all other cases	4
Beams	Constituting front beams of hatchways on the weather deck (1)	5
	On the weather deck, in the remaining zones and on the other decks, including those of superstructures	4
(1) Front beams of hatchways supporting deck girders at the side of the hatchways and provided with pillars in way of the centreline only are to be considered as members subject to a concentrated load corresponding to that which would be carried by a pillar located in way of the hatchway corners or the intersection between the deck girder and deck transverse.		

Table 3

Type and location of supporting members		Permissibile stresses N/mm^2
Deck girders	Constituting longitudinal coamings of hatchways on the weather deck	106
	On the strength deck and decks below, within 0,4 L amidships, in the case of continu-ous deck girders extending more than 0,15 L	70
	In all other cases	160
Beams	Constituting front beams of hatchways on the weather deck	135
	On the weather deck, in the remaining zones and on the other decks, including those of superstructures	160

Table 4

Type and location of supporting members		Section modulus Z, in cm^3 **(1)**
Centre tanks	Load bearing deck girder	$Z_A = 0,1\ b_C \cdot L \cdot S^2 \cdot K / (n_A + 1)$
	Deck transverses	$Z_{Ba} = K_1 \cdot s_R \cdot S^2 \cdot K$ **(2)**
Wing tanks	Load bearing deck girder	$Z_A = 0,10\ b'_L \cdot L \cdot S^2 \cdot K / (n_A + 1)$
	Deck transverses	$Z_{Ba} = 35\ m_1 \cdot s_R \cdot S^2 \cdot K$

(1) In the formulae given in the table:

- K_1 = 6, where no load bearing deck girders are fitted
  = 3,5, where one load bearing centreline girder is fitted
  = 1,8, where a longitudinal centreline girder is fitted
- m_1 = coefficient whose value, depending on the value of L, is to be taken as follows:
  0,3 when $L \leq 75$ m
  0,014 L - 0,75, when $75 < L \leq 125$ m
  1, when $L > 125$ m
- b_C = centre tank breadth, in m, measured between the longitudinal watertight bulkheads forming the boundaries of the tank, or between the face plates of the vertical webs of such longitudinal bulkheads when these webs are in the centre tank
- b'_L = distance, in m, between the face plates of side transverses and vertical webs of longitudinal bulkheads
- s_R = deck transverse spacing, in m
- n_A = number of load bearing deck girders.

(2) The span S is to be measured between the two bulkheads without taking account of any load bearing deck girders or longitudinal centre bulkheads fitted.

SECTION 12 BULKHEADS

1 Watertight bulkheads

1.1 General

1.1.1 The number and location of watertight bulkheads are generally to be in accordance with the relevant requirements given in Section 1.

Bulkheads may be plane or corrugated. Longitudinal corrugated bulkheads are generally to have horizontal corrugations.

Transverse corrugated bulkheads having horizontal corrugations are to be fitted with vertical webs of number and size sufficient to ensure the required vertical stiffness of the bulkhead.

1.2 Openings in watertight subdivision bulkheads

1.2.1 In addition to the provisions in 1.3 of Section 1, water-tight doors required to be capable of being opened at sea are generally to be of the sliding type and are also to be capable of being operated from an easily accessible position above the bulkhead deck. Means are to be provided at such position to indicate whether the door is open or closed, as well as arrows indicating the direction in which the operating gear is operated.

Watertight doors may be of the hinged type if they are always intended to be closed during navigation. These doors are to be substantially framed and capable of being secured watertight by handle-operated wedges which are to be suitably spaced.

1.3 Scantlings

1.3.1 Symbols

s : ordinary stiffener spacing, in m.

In the case of corrugated bulkheads, for the purpose of calculation of the Rule thickness of bulk-head plating, s is to be taken equal to the greater of the values b and c, in m, shown in Figure 6.1 of Section 6; for the purpose of calculation of bulkhead stiffeners, s is to be taken equal to the value p, in m, also shown in Sec 6, Fig 1;

S : conventional scantling span, in m, as defined in Section 6;

r : mass density of cargo, in t/m^3;

h : design head, in m

h_B, h_S, h_{IN} and H_0: as defined in Section 5.

Other symbols used in Section 12 have the meanings specified in Section 2.

1.3.2 Plating

The thickness t_B, in mm, of watertight bulkhead plating is to be not less than that obtained from the following formula, subject to the minimum value $t_{B,MIN}$ given in Tab 1:

$t_B = k_1 \cdot s \cdot (h \cdot K \cdot r)^{0,5}$

The coefficient k_1 and the head h are those given in Tab 1.

The lowest strake of subdivision bulkheads and of the collision bulkhead is to have a thickness 1 mm more than that obtained as above and a depth in general not less than 900 mm; where an inner bottom terminates on a bulkhead, the lowest strake of the bulkhead forming the watertight floor of the double bottom is, however, to ex-tend at least 300 mm above the inner bottom.

In ships having L > 90 m, where the longitudinal watertight bulkheads contribute to longitudinal strength (e.g. in tankers), the depth of top and bottom strakes is to be not less than 0,1 D, and the thickness of plating t_B, in mm, is to be not less than that given by the following formulae:

- for the bottom strake:

  $t_B = 4,45\ s \cdot (D + 2,5)^{0,5} \cdot K^{0,5}$
- for the top strake:

  $t_B = 4,45\ s \cdot (D + 2,5)^{0,5} -1,5$

The above thicknesses need not, however, be greater than those required for the corresponding strake of the side shell plating, according to the requirements given in Section 8.

Table 1

Bulkhead	k_1	h (m)	$t_{B,MIN}$ (mm) (1)
Collision bulkhead	4	h_B	5,5
Subdivision bulkhead	3,4	h_B	4,5
Tank bulkhead	3,8	h_B	5
Bulkhead separating engine room from pump room, in tankers	3,7	h_B	5
Bulkheads of cargo holds intended for solid car-goes in bulk	3,8	see (2)	6

(1) In ore carriers having L > 90 m, the thickness $t_{B,MIN}$ is to be not less than 7 mm for plane bulkheads, and not less than 8 mm for corrugated bulkheads.

(2) The value of the product h · r is to be taken equal to the value h'_{IN} according t_o Sec 5, [4.2].

1.3.3 Ordinary stiffeners

The section modulus Z, in cm^3, of ordinary stiffeners is to be not less than that obtained from the following formula:

$Z = 6,5\ s \cdot S^2 \cdot h \cdot K \cdot c \cdot f_R \cdot r$

The values of coefficient c and head h are those specified in Tab 2 and the values of coefficient f_R are those in Tab 3.

In tankers, where transverse bulkheads have vertical ordinary stiffeners and horizontal girders with end brackets which do not terminate in way of side transverses or bulkhead vertical webs, the scantlings of longitudinals of side shell and longitudinal bulkheads in way of such girders are to be reinforced locally.

The nature and extent of such reinforcement will be decided by Tasneef in each case.

For the application of the specification of Tab 3, connections of the types shown in Fig 3 are to be considered as clip connections.

1.3.4 Primary supporting members

a) Horizontal and vertical girders of subdivision bulkheads

The section modulus Z, in cm³, of horizontal or vertical girders in watertight bulkheads having vertical or horizontal ordinary stiffeners, respectively, is to be not less than that derived from the following formula:

$Z = 5{,}5\ b \cdot S^2 \cdot h_B \cdot K$

b being the width, in m, of bulkhead plating supported by the horizontal or vertical girder.

The value of section modulus obtained from the above formula is to be increased by 25% for collision bulkhead horizontal and vertical girders.

b) Horizontal and vertical girders of tank bulkheads

The section modulus Z, in cm³, of horizontal and vertical girders of tank bulkheads, except for girders of longitudinal bulkheads in tankers, is to be not less than that calculated by the following formula:

$Z = 9\ b \cdot S^2 \cdot h \cdot K \cdot r$

b being the width, in m, of bulkhead plating supported by the horizontal or vertical girder and h the head given in Tab 2.

c) Horizontal and vertical girders of longitudinal bulkheads in tankers

Vertical girders of longitudinal watertight bulkheads, with or without struts for connection to the side transverses facing, are to have a section modulus not less than that required in Section 10 for side transverses having the same geometrical shape and arrangement or, where such formulae are inapplicable, not less than that required in (b) above for vertical girders of transverse watertight bulkheads.

The thickness of vertical girder webs is to be such that the net sectional area A_T, in cm², of the web, including bracket, if any, at any horizontal section is not less than the value obtained from the following formula:

$$A_T = \frac{T}{7{,}35} \cdot K$$

T being the shear force, in k_N, at the section under consideration, obtained from a diagram constructed as shown in Fig 1. The values of T_1, T_2 and x, shown in the above Figure, may be obtained by the following formulae:

$T_1 = 8\ [0{,}137\ (d_1 / D_M)^2 + 0{,}288] \cdot s\ .\ D_M \cdot D_C$

$T_2 = 8\ [0{,}036\ (d_1 / D_M)^2 + 0{,}134] \cdot s \cdot D_M \cdot D_C$

$x = [1 - (T_2 / T_1)] \cdot [0{,}153\ (d_1 / D_M)^2 + 0{,}322]$

where D_M, D_C and d_1 are as shown in Fig 1.

Where no struts are provided, d_1/D_M is to be taken equal to 1, so that the values of T_1, T_2 and x may be obtained by the following formulae:

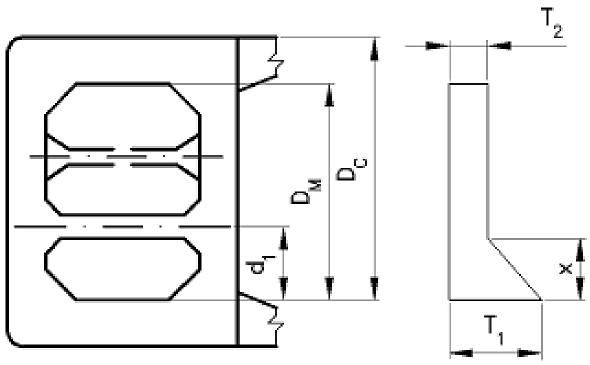
$T_1 = 3{,}4\ \ s \cdot D_M\ .\ D_C$

$T_2 = 1{,}36\ \ s \cdot D_M\ .\ D_C$

$x = 0{,}475 \cdot [1 - (T_2 / T_1)] \cdot D_C$

Where longitudinal bulkheads are framed with vertical ordinary stiffeners, the latter are to be supported by longitudinal girders having a section modulus not less than that required for side transverses in Sec 10.

Figure 1



2 Non-tight bulkheads

2.1 Non-tight bulkheads which do not act as pillars

2.1.1 The thickness of plating of non-tight bulkheads which do not act as pillars is to be not less than 3,5 mm in holds, and 3 mm in 'tweendecks, in association with vertical stiffeners spaced not more than 900 mm apart in transverse bulkheads, and not more than two frame spaces apart, subject to a maximum spacing of 1500 mm, in longitudinal bulkheads.

Vertical stiffeners are to have a section modulus Z, in cm³, (calculated in association with a width of plating equal to the stiffener spacing but not exceeding 750 mm) not less than that obtained from the following formula:

$Z = 2\ s \cdot S^2$

2.2 Non-tight bulkheads acting as pillars

2.2.1 The thickness of plating of non-tight bulkheads acting as pillars is to be not less than 4,5 mm in holds, and 4 mm in 'tweendecks, in association with vertical stiffeners spaced two frame spaces apart where the frame spacing does not exceed 750 mm, and at every frame where the frame spacing is greater.

The section modulus Z, in cm³, of vertical stiffeners (calculated in association with a width of plating equal to the stiffener spacing, but not exceeding 750 mm) is to be not less than that obtained from the following formula:

$Z = 2,65\ s \cdot S^2$

In addition, each vertical stiffener, in association with a width of plating equal to 50 times the plating thickness, is to comply with the requirements for pillars given in Sec 11, the load supported being determined in accordance with the same requirements.

In the case of non-tight longitudinal bulkheads sup-porting longitudinally framed decks, vertical girders are to be arranged in way of deck transverses. Intermediate vertical stiffeners are also to be arranged having scantlings in accordance with the requirements for bulkheads not acting as pillars.

3 Watertight tunnels

3.1 General

3.1.1 In mechanically propelled ships, arrangements are to be provided to permit ready access to the shafting for personnel. For this purpose, where the stern gland is not fitted on the after end bulkhead of the machinery space, the shafting is to be enclosed in a watertight tunnel of adequate size.

The after end of such tunnels in way of the stern gland is to form a recess large enough to permit drawing of the propeller shafts. Similar tunnels are to be arranged whenever communication between two non-adjacent watertight compartments is required or the passage of pipes is necessary.

Each tunnel is to be provided with two means of access; one may be through a watertight door, while the other is to be through a vertical trunk extending watertight up to the bulkhead deck.

3.2 Scantlings

3.2.1 Tunnels which do not form the boundaries of cargo tanks or deep tanks are to have scantlings as required for watertight subdivision bulkheads, except as follows:

- the thickness of plating on the rounded top may be determined using a stiffener spacing equal to 80% of the actual spacing. Under hatchways, for an adequate extent beyond the projected line of hatchway openings, the top plating is to be increased by 2,5 mm unless it is covered with wood ceiling;
- the scantlings of tunnel vertical stiffeners, which are normally arranged in line with frames and are not connected at their lower ends when rounded tops are adopted, are to be determined as for watertight bulkhead stiffeners, using the coefficient f_R = 0,95 and a span equal to the distance from the base tunnel to the top of the flat side. The head h may be measured at midlength of the tunnel from the midpoint of the span of the stiffeners to the bulkhead deck.

  Stiffeners are to be bracketed at their lower ends.

The scantlings of tunnels crossing tanks or deep tanks are to be as required for the latter.

Table 2

Stiffeners	h , in m	c
Stiffeners of collision bulkheads	h_B	0,78
Stiffeners of subdivision bulkheads	h_B	0,63
Stiffeners of bulkheads between engine room and pump room, in tankers	h_S	0,9
Stiffeners of tank bulkheads, except for longitudinals of longitudinal bulk-heads, in tankers or similar ships	h_S	1
Longitudinals of longitudinal bulkheads, in tankers or similar ships: a) below 0,5 D b) above 0,5 D	h_S or h_{IN} (1) h_S or h_{IN} (1)	$1,4D/(1,77D-0,34h_L)$ (2) (3) $1,4D/(D+1,2h_L)$ (2) (3)

h_L = distance, in m, from the longitudinal considered to the line of deck at side

(1) In no case is h to be taken less than $6,7\ L_1 / (420 - L_1)$.

(2) In no case is c be to taken less than 0,95.

(3) In the case of tankers having a trunk, h_L is to be increased by a value equal to $D + 0,5\ h_T$, h_T being the trunk depth.

Table 3

Stiffeners	f_R
a) Ordinary stiffeners of tanks and subdivision bulkheads	
1) Stiffeners having a single span:	
• brackets at both ends;	0.62
• bracket at one end and clip connection at the other;	0,78
• clip connection at both ends;	0,96
• no attachments at either end:	
- in subdivision bulkheads;	1,20
- in tank bulkheads.	1,40
2) Stiffeners having more than one span:	
(2.1) End span:	
- brackets at both ends;	0,62
- bracket at one end and clip connection or girder at the other;	0,78
- clip connection at one end and girder at the other	0,96
(2.2) Intermediate span:	
- brackets at both ends;	0,62
- bracket at one end and girder at the other;	0,88
- girder at both ends.	1,00
3) Corrugated bulkheads	0,96
b) Horizontal ordinary stiffeners having more than one span of longitudinal watertight bulkheads	1,00

SECTION 13 SUPERSTRUCTURES, DECKHOUSES

1 General

1.1

1.1.1 First-tier superstructures or deckhouses are intended as those which are situated directly above the uppermost continuous deck of the ship; the second-tier superstruc-ture is the next tier above and so on.

Where there is no access from inside the superstruc-tures, deckhouses or houses to 'tweendecks below or when one of the boundary bulkheads concerned is in a particularly shel-tered location, reduced scantlings, with respect to those stated in this Section, may be accepted at the discretion of Tasneef

2 Scantlings

2.1 Plating of boundary bulkheads

2.1.1 The thickness of boundary bulkhead plating is to be not less than the value t, in mm, calculated by the follow-ing formula:

$t = 3\ s \cdot (h \cdot K)^{0,5}$

where:

s : spacing of stiffeners, in m

h : conventional head, in m, given by:

- $h = 0,45\ L^{2/3}$, for first-tier bulkheads
- $h = 0,35\ L^{2/3}$, for bulkheads above the first-tier.

In no case is the value t to be less than 4 $K^{0,5}$ mm for first-tier bulkheads or 3,5 $K^{0,5}$ mm for bulkheads above the first tier.

2.2 Deck plating

2.2.1 The plating thickness of decks of first-tier superstruc-tures or deckhouses is to be not less than the value t, in mm, calculated by the following formula:

$t = (3,3 \cdot s + 0,0085\ L + 2,2)\ K^{0,5}$

In second-tier superstructures or deckhouses, the plating thickness t of decks obtained by the above formula may be reduced by 10 per cent; for each superstructure or deck-house above the second tier, the thickness may be reduced by a further 5 per cent.

In no case, however, is the thickness t of deck plating to be less than 3,5 $K^{0,5}$ mm.

2.3 Boundary bulkhead vertical stiffeners

2.3.1 The section modulus of boundary bulkhead vertical stiffeners is to be not less than the value Z, in cm^3, calcu-lated by the following formula:

$t = 3,5\ s \cdot S^2 \cdot h \cdot K$

where:

s : spacing of stiffeners, in m

S : conventional scantling span, in m, to be taken equal to the 'tweendeck height, but not less than 2m

h : conventional design head, in m, given by the formulae:

- $h = 0,6\ L^{1/4}$, for first-tier bulkheads
- $h = 0,5\ L^{1/4}$, for bulkheads above the first-tier.

These scantlings assume that all stiffeners, except those above the second tier, are connected at least by lugs or directly welded to decks.

2.3.2 The scantlings of superstructure frames extending from the side are to be in accordance with the require-ments of Section 10 for 'tweendeck frames and in no case less than those obtained by applying the requirements in [2.3.1].

2.4 Primary supporting members, ordinary stiffeners and deck pillars

2.4.1 The scantlings of deck stiffeners and of the primary supporting members and pillaring located below are to be in accordance with the requirements of Section 11.

2.5 Casings

2.5.1 The machinery space casing is to extend from the deck constituting the top of the machinery space up to an exposed deck, and its scantlings are to be the same as for subdivision bulkheads, for the parts below the weather deck, and the same as for superstructures, for parts above the weather deck.

3 Superstructures on elastic supports

3.1 General

3.1.1 The scantlings of structural members, plating and stiffeners may be determined by using the formulae in previ-ous paragraphs.

3.2

3.2.1 Structural check calculations are to be carried out for guides, elastic elements, anti-lifting devices and support-ing structures of the deckhouse bottom and hull connec-tion structures.

The above-mentioned check calculations are to be carried out by assuming the following loads:

- vertical: $P_V = 1,2$ P
- horizontal: $P_0 = 0,3$ P

where:

P : the total mass of the deckhouse including all outfitting and equipment parts.

The additional loads due to ship motions may, in general, be neglected.

4 Bulwarks

4.1 General

4.1.1 On decks to which persons may have access, the following are to be fitted:

- plate bulwarks, not less than 3 mm in thickness, and, in general, 900 mm in height, stiffened by shapes in way of the upper and lower edges and supported by stays effectively connected to deck structures;
- railings, as an alternative to bulwarks, having the same height and with horizontal rods spaced not more than 250 mm apart.

4.1.2 Irrespective of the requirements in [4.1.1], the Interested Parties are to comply with any State regulations of the Administration whose flag the ship is entitled to fly regarding bulwarks and other means of accident prevention intended to reduce the risk of persons falling.

SECTION 14 AFT AND FORE STRUCTURES, APPENDAGES

1 General

1.1

1.1.1 Forward zone:

The zone extending from the extreme bow to 0,2 L abaft the forward limit of L.

Inclined bow:

A bow having the bottom longitudinally inclined from the keel upwards to weather deck level. It is generally flat in the transverse direction.

After zone:

The zone abaft the after peak bulkhead.

2 Bow structure

2.1 Rounded bow ships

2.1.1 When the bow is of the rounded type, for an extent equal to the ship's breadth B from the forward perpendicular, the frame spacing is to be reduced to 300 mm, or intermediate frames are to be fitted having section modulus Z, in cm3, equal to 50 per cent of the value calculated by the formulae in Sec 10.

The ends of intermediate frames may be without connection; in such case, a longitudinal stiffener with a web having a depth not less than 1,5 times the frame depth is to be fitted.

If the structure is transversely framed, the following are to be fitted:

- floors with increased depth
- a side longitudinal, when D > 4 m, at a height of about 0,5 D. Such longitudinal is also to extend inside the forepeak.

If the structure is longitudinally framed, floors with increased depth are to be fitted, generally spaced not more than 1,5 m apart.

2.2 Inclined bow ships

2.2.1 In ships with bottom and deck longitudinally framed, the bow is to be strengthened by transverses spaced not more than 2 m apart.

Such structures are to extend from the forward end to the collision bulkhead, or to the point where the bow begins to rise, if such a point is located abaft the collision bulkhead.

The section modulus Z, in cm^3, of the transverses is to be not less than the values calculated by the following formulae:

a) bottom and side transverses:

$Z = 9\ b \cdot S^2 \cdot h \cdot K$

b) deck transverses:

$Z = 7\ b \cdot S^2 \cdot D$

where:

s : spacing, in m, of transverses

S : conventional span, in m, as defined in Sec 6

h : distance, in m, from the midlength of the girder considered to the weather deck.

3 Stern structure

3.1 General

3.1.1 The scantlings of the bulkhead and the deck of the af-ter peak are to be in accordance with Sec 12.

In the upper part of the after peak, a non-tight longitu-dinal bulkhead is generally to be fitted in the centreline.

When the bottom in the after zone is of the flat type and raised towards the extreme stern, a centre bottom girder and side bottom girders are to be fitted, as well as transverses with scantlings as per [2.2].

4 Propeller shaft brackets

4.1 Double arm propeller shaft brackets

4.1.1 Double arm propeller shaft brackets consist of two arms arranged at approximately right angles and converging in the propeller shaft bossing.

The scantlings of cast or forged propeller shaft brack-ets having arms of elliptical section are to have a minor axis d_1 and a major axis d_2, in mm, not less than those given by the following formulae:

$d_1 = 0,4\ d_P$

$d_2 = 0,004\ l_B \cdot (d_P / d_l)^3$

where:

l_B : length of the longer arm, measured from the section at the root of the palm to that at the root of the boss, in mm

d_P : propeller shaft diameter, measured inside the liner, if any, in mm.

In the case of arms of other shapes, the moment of inertia of the section about its major axis is to be not less than the value J, in cm^4, given by the following formula:

$J = 0,4\ l_B \cdot d_P^3 \cdot 10^{-7}$

The thickness of the propeller shaft bossing is to be not less than 0,33 d_P.

4.2 Ends of bossed propeller shaft brackets

4.2.1 Bossed propeller shaft brackets consist, in general, of a U-shaped cast steel arm connected to the hull plating by means of a substantial palm and ending in a boss for propeller shaft support. The scantlings of the arm and the boss are subject to approval by Tasneef

As guidance, the above scantlings are normally to be in accordance with the requirements of a), b) and c) below.

a) The section modulus at the root of the arm, calculated about the horizontal neutral axis of the root section, is to be not less than the value Z, in cm^3, calculated by the following formula:

$$Z = 60 \, l_B \cdot d_P^2 \cdot 10^{-7}$$

b) The length of the boss, in mm, is to be between 2,3 d_P and 3 d_P.

c) The thickness of the boss, in mm, is to be not less than 0,33 d_P, in mm.

The symbols l_B and d_P used above have the same meaning as in [4.1].

APPENDIX 1 SIDE DOORS AND STERN DOORS

1 General

1.1 Application

1.1.1 The requirements of this Section apply to the arrangement, strength and securing of side doors, abaft the collision bulkhead, and of stern doors leading to enclosed spaces.

1.2 Arrangement

1.2.1 Side doors and stern doors are to be so fitted as to ensure tightness and structural integrity commensurate with their location and the surrounding structure.

1.2.2 Where the sill of any side door is below the uppermost load line, the arrangement is considered by the Society on a case by case basis.

1.2.3 Doors are preferably to open outwards.

1.3 Definitions

1.3.1 Securing device

A securing device is a device used to keep the door closed by preventing it from rotating about its hinges or about pivoted attachments to the yacht.

1.3.2 Supporting device

A supporting device is a device used to transmit external or internal loads from the door to a securing device and from the securing device to the yacht's structure, or a device other than a securing device, such as a hinge, stopper or other fixed device, which transmits loads from the door to the yacht's structure.

1.3.3 Locking device

A locking device is a device that locks a securing device in the closed position.

2 Design loads

2.1 Side and stern doors

2.1.1 Design forces

The design external forces FE and the design internal forces FI, in kN, to be considered for the scantlings of primary supporting members and securing and supporting devices of side doors and stern doors are to be obtained, in kN, from the formulae in Tab 1.

3 Scantlings of side doors and stern doors

3.1 General

3.1.1 The strength of side doors and stern doors is to be commensurate with that of the surrounding structure.

3.1.2 Side doors and stern doors are to be adequately stiffened and means are to be provided to prevent any lateral or vertical movement of the doors when closed.

Adequate strength is to be provided in the connections of the lifting/manoeuvring arms and hinges to the door structure and to the Yacht's structure.

3.1.3 Shell door openings are to have well rounded corners and adequate compensation is to be arranged with web frames at sides and stringers or equivalent above and below.

3.2 Plating and ordinary stiffeners

3.2.1 Plating

The thickness of the door plating is to be not less than that obtained according to the requirements for side plating, using the door stiffener spacing.

3.2.2 Ordinary stiffeners

The scantling of door ordinary stiffeners is to be not less than that obtained according to the requirements for the side, using the door stiffener spacing.

Consideration is to be given, where necessary, to differences in conditions of fixity between the ends of ordinary stiffeners of doors and those of the side.

Table 1 : Design forces

Structural elements	External force F_E, in kN	Internal force F_I, in kN
Securing and supporting devices of doors opening inwards	$A\ p_E + FP$	$F_0 + 10\ W$
Securing and supporting devices of doors opening outwards	$A\ p_E$	$F_0 + 10\ W + FP$
Primary supporting members **(1)**	$A\ p_E$	$F_0 + 10\ W$

(1) The design force to be considered for the scantlings of the primary supporting members is the greater of F_E and F_I.

Note 1: A : Area, in m^2 to be determined on the basis of the load area taking account of the direction of the pressure

W : Mass of the door, in t

F_P : Total packing force, in kN; the packing line pressure is normally to be taken not less than 5 kN /m

F_0 : the greater of F_C and 5A, in kN

F_C : Accidental force, in kN, due to loose cargoes etc., to be uniformly distributed over the area A.

Such above value is to be assumed considering the failure of the lashing of the objects to be carried in the space behind the doors: in such a case Fc is to be assumed not less than the weight in KN of the most heavy object to be carried in the space behind the doors.

However, the value of FC may be taken as zero, provided an additional structure such as an inner ramp is fitted, which is capable of protecting the door from accidental forces due to loose cargoes.

p_E : Design pressure for the side shell (Ch 1, Sec 5, [5.4]) not to be taken less than 25 kN/m^2

3.3 Primary supporting members

3.3.1 The door ordinary stiffeners are to be supported by primary supporting members constituting the main stiffening of the door.

3.3.2 The primary supporting members and the hull structure in way are to have sufficient stiffness to ensure structural integrity of the boundary of the door.

3.3.3 Scantlings of primary supporting members are generally to be verified through direct calculations on the basis of the design Loads in Table 1 and the strength criteria given in [5].

In general, isolated beam models may be used to calculate the loads and stresses in primary supporting members, which are to be considered as having simply supported end connections.

4 Securing and supporting of doors

4.1 General

4.1.1 Side doors and stern doors are to be fitted with adequate means of securing and supporting so as to be commensurate with the strength and stiffness of the surrounding structure.

4.1.2 The number of securing and supporting devices is generally to be the minimum practical while taking into account the requirements for redundant provision given in [4.2.3] and the available space for adequate support in the hull structure.

4.2 Scantlings

4.2.1 Securing and supporting devices are to be adequately designed so that they can withstand the reaction forces within the allowable stresses defined in [5].

4.2.2 When the securing and supporting devices are equally spaced, the distribution of the forces acting on each device may be obtained by dividing the total design force given in [2.1.1] for the number of the suppoting devices.

For arrangements of securing and supporting devices different from the above, direct calculations may be necessary to asses the distribution of the forces acting on the devices.

Special consideration will be given by Tasneef when the dimension of the opening is significant compared to the depth of the vessel: the distribution of the forces acting on the securing and supporting devices may need to be supported by direct calculations taking into account the flexibility of the hull structure and the actual position of the supports.

4.2.3 The arrangement of securing and supporting devices is to be designed with redundancy so that, in the event of failure of any single securing or supporting device, the remaining devices are capable of withstanding the reaction forces without exceeding by more than 20% the allowable stresses defined in [5].

4.2.4 All load transmitting elements in the design load path, from the door through securing and supporting devices into the ship's structure, including welded connections, are to be of the same strength standard as required for the securing and supporting devices. These elements include pins, supporting brackets and backup brackets.

5 Strength criteria

5.1 Primary supporting members and securing and supporting devices

5.1.1 Plastic reinforced structures

The allowable normal and shear stresses are to be in conformity with the requirements stated in Ch 4, Sec 1, [4].

5.1.2 Steel structures

It is to be checked that the normal stress s, the shear stress t and the equivalent stress σ_{VM}, induced in the primary supporting members and in the securing and supporting devices of doors by the design forces defined in [2.1.1], are in compliance with the following formulae:

$\sigma \leq \sigma_{ALL}$

$\sigma_{VM} = (\sigma^2 + \tau^2)^{0,5} \leq \sigma_{VM,ALL}$

where:

σ_{ALL} : Allowable normal stress, in N/mm²:

$\sigma_{ALL} = 120 / k$

τ_{ALL} : Allowable shear stress, in N/mm²:

$\tau_{ALL} = 80 / k$

$\sigma_{VM,ALL}$: Allowable equivalent stress, in N/mm²:

$\sigma_{VM,ALL} = 150 / k$

k : Material factor, defined in Ch 2, Sec 2, [2.3].

5.1.3 Pins

Pins in securing and supporting devices are to be checked for shear stress τ and normal stress σ due to bending moment using the above criteria.

Where:

$\tau = 10^3 F/(2 n A)$ N/mm²

$\sigma = 5{,}1\ 10^3\ (F\ l / n\ d^3)$ N/mm²

and:

F = design force, in KN, defined in [2.1.1]

n = number of fixed bearings supporting the pin

A = cross sectional area of the pin in mm²

l = distance between two consecutive fixed bearings in mm

d = diameter of the pin in mm

If the radial clearance between pin and bearing and the axial clearance between two consecutive bearings of the pins are small and *l* is nearly equal to *d*, the normal stress due to bending moment can be disregarded.

5.1.4 Bearings

For steel to steel bearings in securing and supporting devices, it is to be checked that the nominal bearing pressure σ_B, in N/mm², is in compliance with the following formula:

$\sigma_B \leq 0{,}8\ R_{eH,B}$

where:

$\sigma_B = 10\ F / A_B$

with:

F : Design force, in KN, defined in [2.1.1]

A_B : Projected bearing area, in cm²

$R_{eH,B}$: Yield stress, in N/mm², of the bearing material.

For other bearing materials, the allowable bearing pressure is to be determined according to the manufacturer's specification.

5.1.5 Bolts

The arrangement of securing and supporting devices is to be such that threaded bolts do not carry support forces.

It is to be checked that the stress σ_T in way of threads of bolts not carrying support forces is in compliance with the following formula:

$\sigma_T \leq \sigma_{T,ALL}$

where:

$\sigma_{T,ALL}$: Allowable tension in way of threads of bolts, in N/mm²

$\sigma_{T,ALL} = 125 / k$

k : Material factor, defined in Ch 2, Sec 2, [2.3].

6 Securing and locking arrangement

6.1 Systems for operation

6.1.1 Securing devices are to be simple to operate and easily accessible.

Securing devices are to be equipped with mechanical locking arrangement (self-locking or separate arrangement), or to be of the gravity type.

The opening and closing systems as well as securing and locking devices are to be interlocked in such a way that they can only operate in the proper sequence.

6.1.2 Doors with a clear opening area equal to or greater than 10 m² are to be provided with closing devices operable from a remote control position above the freeboard deck. This remote control is provided for the**:**

- closing and opening of the doors
- associated securing and locking devices.

For doors which are required to be equipped with a remote control arrangement, indication of the open/closed position of the door and the securing and locking device is to be provided at the remote control stations.

The operating panels for operation of doors are to be inaccessible to unauthorised persons.

A notice plate, giving instructions to the effect that all securing devices are to be closed and locked before leaving harbour, is to be placed at each operating panel and is to be supplemented by warning indicator lights.

6.1.3 Where hydraulic securing devices are applied, the system is to be mechanically lockable in closed position.

This means that, in the event of loss of hydraulic fluid, the securing devices remain locked.

The hydraulic system for securing and locking devices is to be isolated from other hydraulic circuits, when in closed position.

7 Operating and Maintenance Manual

7.1 General

7.1.1 An Operating and Maintenance Manual (OMM) for the side doors and stern doors is to be provided on board and contain necessary information on:

a) special safety precautions

b) service conditions

c) maintenance.

This manual is to be submitted in duplicate to the Society for information.

7.1.2 Documented operating procedures for closing and securing the side and stern doors are to be kept on board and posted at an appropriate place.

APPENDIX 2 CRITERIA FOR DIRECT CALCULATION OF RUDDER LOADS

Symbols

ℓ_{10}, ℓ_{20}, ℓ_{30}, ℓ_{40} : lengths, in m, of the individual girders of the rudder system (see Fig 1, Fig 2 and Fig 3)

ℓ_{50} : llength, in m, of the solepiece (see Fig 2 and Fig 4)

J_{10}, J_{20}, J_{30}, J_{40} : moments of inertia about the x axis, in cm^4, of the individual girders of the rudder system having lengths ℓ_{10}, ℓ_{20}, ℓ_{30}, ℓ_{40} (see Fig 1, Fig 2 and Fig 3). For rudders supported by a solepiece only, J_{20} indicates the moment of inertia of the pintle in the solepiece

J_{50} : moment of inertia about the z axis, in cm^4, of the solepiece (see Fig 2 and Fig 4)

C_R : rudder force, in N, acting on the rudder blade, defined in Sec 1, [2.1.1]

C_{R1}, C_{R2} : rudder forces, in N, defined in Sec 1, [2.2.3].

1 Criteria for direct calculation of the loads acting on the rudder structure

1.1 General

1.1.1 Application

The requirements of this Appendix apply to the following types of rudders:

- spade rudders (see Fig 1),
- 2 bearing rudders with solepiece (see Fig 2),
- 2 bearing semi-spade rudders with rudder horn (see Fig 3).

The requirements of this Appendix provide the criteria for calculating the following loads:

- bending moment M_B in the rudder stock,
- support forces F_A,
- bending moment M_R and shear force Q_R in the rudder body.

1.1.2 Load calculation

The loads in [1.1.1] are to be calculated through direct calculations based on the model specified in Fig 1, Fig 2 and Fig 3, depending on the type of rudder.

They are to be used for the stress analysis required in:

- Sec 1, [4], for the rudder stock,
- Sec 1, [6], for the rudder pintles and the pintle bearings,
- Sec 1, [7] for the rudder blade,
- Sec 1, [8] for the rudder horn and the solepiece.

1.1.3 Specific case of spade rudders

For spade rudders, the results of direct calculations carried out in accordance with [1.1.2] may be expressed in an analytical form. The loads in [1.1.1] may therefore be obtained from the following formulae:

- maximum bending moment in the rudder stock, in N.m:

$$M_B = C_R\left(\ell_{20} + \frac{\ell_{10}(2C_1 + C_2)}{3(C_1 + C_2)}\right)$$

  where C_1 and C_2 are the lengths, in m, defined in Fig 1,

- support forces, in N:

$$F_{A3} = \frac{M_B}{\ell_{30}}$$

$$F_{A1} = C_R + F_{A3}$$

- maximum shear force in the rudder body, in N:

  $Q_R = C_R$

1.2 Data for the direct calculation

1.2.1 Forces per unit length

The following forces per unit length are to be calculated, in N/m, according to [1.3]:

- p_R for spade rudders and rudders with solepiece (see Fig 1 and Fig 2, respectively),
- p_{R10} and p_{R20} for semi-spade rudders with rudder horn (see Fig 3).

1.2.2 Spring constant

The following support spring constants are to be calculated, in N/m, according to [1.4]:

- Z_C for rudders with solepiece (see Fig 2),
- Z_P for semi-spade rudders with rudder horn (see Fig 3).

1.3 Force per unit length on the rudder body

1.3.1 Spade rudders and 2 bearing rudders with solepiece

The force per unit length p_R (see Fig 1 and Fig 2) acting on the rudder body is to be obtained, in N/m, from the following formula:

$$p_R = \frac{C_R}{\ell_{10}}$$

1.3.2 bearing semi-spade rudders with rudder horn

The forces per unit length p_{R10} and p_{R20} (see Fig 3) acting on the rudder body are to be obtained, in N/m, from the following formulae:

$$p_{R10} = \frac{C_{R2}}{\ell_{10}}$$

$$p_{R20} = \frac{C_{R1}}{\ell_{20}}$$

1.4 Support spring constant

1.4.1 Sole piece

The spring constant Z_C for the support in the solepiece (see Fig 2) is to be obtained, in N/m, from the following formula:

$$Z_C = \frac{6180 J_{50}}{\ell_{50}^3}$$

1.4.2 Rudder horn

The spring constant Z_P for the support in the rudder horn (see Fig 3) is to be obtained, in N/m, from the following formula:

$$Z_P = \frac{1}{f_B + f_T}$$

where:

f_B : unit displacement of rudder horn due to a unit force of 1 N acting in the centroid of the rudder horn, to be obtained, in m/N, from the following formula:

$$f_B = 1,3 \frac{d^3}{6180 J_N}$$

d : height, in m, of the rudder horn, defined in Fig 3,

J_N : moment of inertia of the rudder horn about the x axis, in cm^4 (see Fig 5),

f_T : unit displacement due to torsion to be obtained, in m/N, from the following formula:

$$f_T = 10^{-8} \frac{de^2}{3140 F_T^2} \sum_i \frac{u_i}{t_i}$$

d, e : lengths, in m, defined in Fig 3

F_T : mean sectional area of rudder horn, in m^2,

u_i : length, in mm, of the individual plates forming the mean horn sectional area,

t_i : thickness of the individual plates mentioned above, in mm.

Figure 1 : Spade rudders

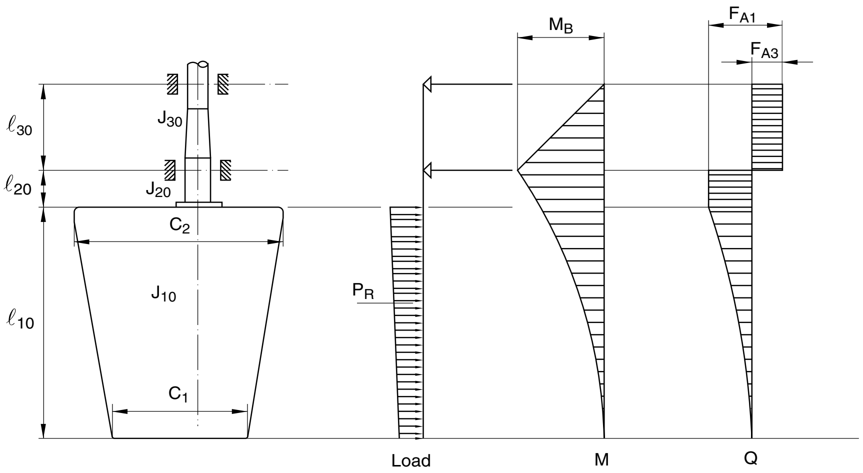


Figure 2 : Two bearing rudders with solepiece

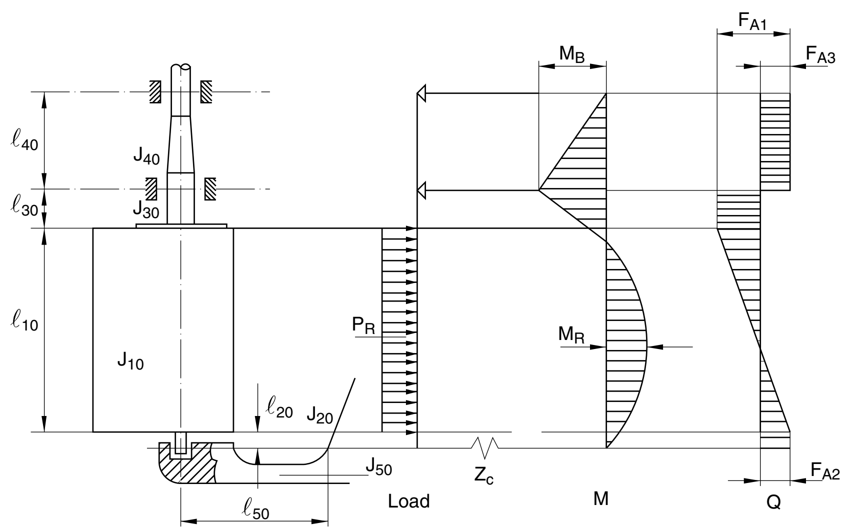


Figure 3 : Two bearing semi-spade rudders with rudder horn

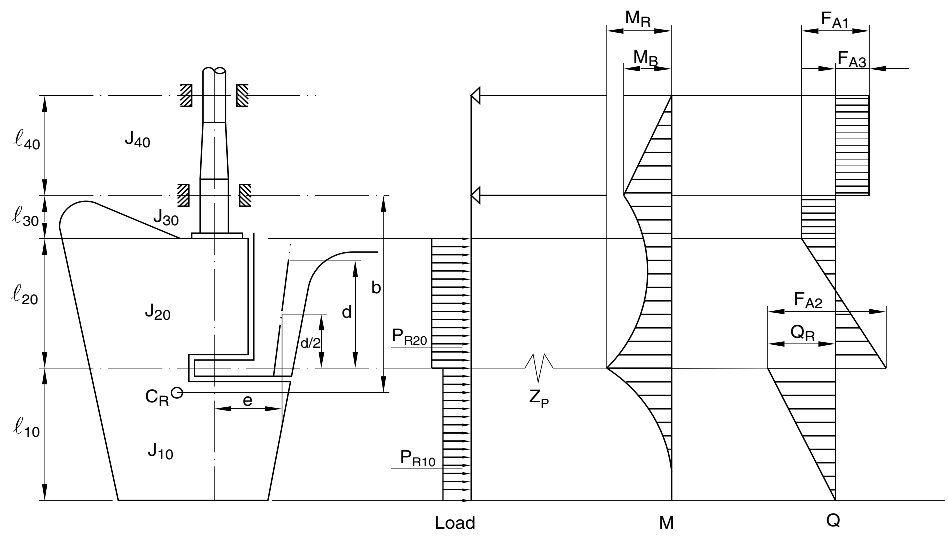


Figure 4 : Solepiece geometry

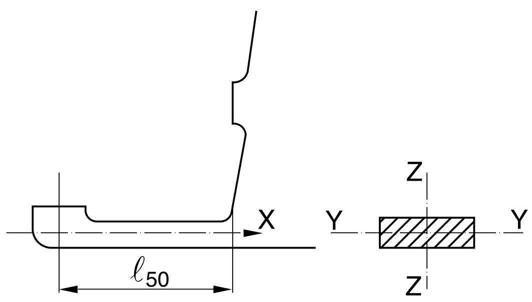
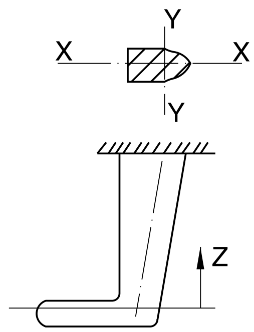


Figure 5 : Rudder horn geometry



Part B
Hull and Stability

Chapter 2
RUDDERS

SECTION 1 GENERAL

1 Symbols and definitions

1.1

1.1.1

V_{AV} : maximum ahead speed in still water, in knots, with the ship on the full load waterline. For the above-mentioned speed, the value V_{MIN}, given by the following formula is to be considered in the calculation:

$$V_{MIN} = 6 \cdot \left(\frac{P}{\Delta^{2/3}}\right)^{1/3}$$

where P is the nominal power, in kW, of the pro-pulsion engine(s)

V_{AD} : maximum astern speed of the ship, in knots; in no case is thesaid speed to be taken less than the value:

$V_{AD} = 0,5\ V_{AV}$

A : total area of rudder blade, in m², bounded by the blade external contour, including the main-piece and the part forward of the centreline of the rudder pintles, if any

A_D : total area of rudder blade, in m², bounded by the blade external contour, including the main-piece and the part forward of the centreline of the rudder pintles, if any

x_G : distance, in m, from the centroid of the area A to the centreline of pintles

k_1 : shape factor, whose value, depending on the ratio Λ defined below, is given by the following formula:

$k_1 = (\Lambda + 2) / 3$

Λ : h^2 / A_T, where h is the mean height of the rudder blade area, in m. In no case is the value of Λ to be taken greater than 2.

The mean height h and mean breadth b of the rudder blade are to be calculated according to Fig 1.

A_T : area, in m², obtained by adding, to the rudder blade area, the area of rudder post or rudder horn, if any, up to the height h

k_2 : factor depending on the rudder profile, whose value is given in [1.1]

k_3 : 0,8, for rudders outside the propeller jet (centre rudders on twin screw ships, or similar cases)

= 1,15, for rudders behind a fixed propeller nozzle

= 1,0 in other cases

D_{TF} : Rule diameter, in mm, of rudder stock subject to combined torque and bending

D_T : Rule diameter, in mm, of rudder stock subject to torque only

C_R : rudder force, in N, i.e. force acting on the rudder blade, as defined in [3.2]

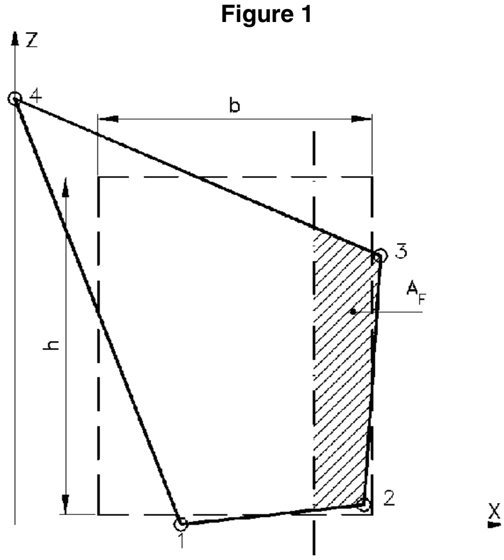
Q_R : rudder torque, in Nm, i.e. torque acting on the rudder stock, as defined in [3.2]

2 Materials

2.1

2.1.1 Rudder stocks, pintles and bolts are to be made of rolled, forged or cast C-Mn steel, in accordance with the relevant requirements of Part D, Ch 2, Sec 3 of the Rules.

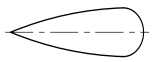
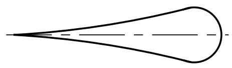
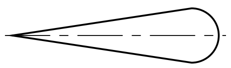
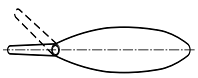
Figure 1



$b = (x_2 + x_3 - x_1)/2$, mean breadth of rudder, in m

$h = (z_3 + z_4 - z_2)/2$, mean heigth of rudder, in m

Table 1

Rudder profile type	k_2 for ahead condition	k_2 for astern condition
NACA-00 - Goettingen profiles 	1,10	1,4
Hollow profiles 	1,10 to 1,35	1,4
Flat side profiles 	1,10	1,4
High lift rudders 	1,7	Special consideration

The material used for rudder stocks, pintles, keys and bolts is to have a minimum yield stress R_{eH} not less than 200 N/mm².

The requirements relevant to the determination of scantlings contained in this Section apply to steels having a minimum yield stress R_{eH} = 235 N/mm².

In the case of the use of steels having a yield stress R_{eH} other than 235 N/mm², the values of diameters and thicknesses calculated with the formulae contained in the following Articles are to be modified, as indicated, depending on the factor K_1 obtained from the following formula:

$$K_1 = \left(\frac{235}{R_{eH}}\right)^y$$

where:

R_{eh} : minimum yield stress of steel employed, in N/mm²; it is not to be taken higher than 0,7 Rm, and in no case is ReH to be taken greater than 450 N/mm²

R_m : minimum ultimate tensile strength of steel employed, in N/mm²

y : 0,75, for R_{eH} > 235 N/mm²

= 1,0, for $R_{eH} \le$ 235 N/mm².

In general, significant reductions in rudder stock Rule diameter for the application of steels having yield stress R_{eH} > 235 N/mm² may be accepted by Tasneef subject to the results of a check calculation of rudder stock deformation.

This, in order to avoid significant rudder stock deformations, so as not to create excessive edge pressures in way of bearings.

Welded parts of rudders are to be made of rolled hull steels of a type approved by Tasneef

3 Conventional rudders

3.1 General

3.1.1 The requirements of this paragraph apply to ordinary profile rudders, without any special arrangement for increasing the rudder force, such as fins or flaps, steering propellers etc. Rudders of unusual form or type will be subject to special consideration by Tasneef

Effective means are to be provided to support the weight of the rudder without excessive bearing pressure (e.g. by means of a rudder carrier attached to the upper part of the rudder stock). The hull structure in way of the rudder carrier is to be suitably strengthened.

Suitable arrangements are to be provided to prevent the rudder from lifting; in addition, structural rudder stops of suitable strength are to be provided, except where the steering gear is provided with its own rudder stopping devices..

In rudder trunks which are open to the external water, a seal or stuffing box is to be fitted above the deepest load waterline, to prevent water from entering the steering gear compartment and the lubricant from being washed away from the rudder carrier.

If the top of the rudder trunk is below the deepest full load waterline, two separate seals or stuffing boxes are to be provided.

3.2 Determination of the force acting on the rudder blade and the torque acting on the rudder stock

3.2.1 Rudder blades without cut-outs

In the case of rudder blades having a rectangular or trapezoidal external contour without cut-outs (see Fig 6 (b) and (c)), the rudder force C_R, in N, is to be calculated by the following formula:

$C_R = 132\ A \cdot V^2 \cdot k_1 \cdot k_2 \cdot k_3$

The rudder torque Q_R, in N . m, is to be calculated for both ahead and astern conditions according to the formula:

$Q_R = C_R \cdot r$

where:

V : V_{AV}, or V_{AD}, depending on the condition under consideration

r : $b(\alpha - k_A)$, in m; for the ahead condition, r is to be taken not less than 0,1 b

b : mean breadth of rudder area, in m, measured in accordance with Figure 1.1

α : 0,33, for ahead condition

0,66, for astern condition

k_A : A_F/A, where A_F is the area, in m², of the rudder blade portion afore the centreline of rudder pintles (see Fig 1).

3.2.2 Rudder blades with cut-outs (semi-spade rudders)

In the case of rudder blades having a rectangular or trapezoidal external contour with cut-outs (see Fig 6 (a), (d) and (e)), the force C_R, in N, acting on the blade is to be calculated in accordance with [3.2.1].

The pressure distribution over the rudder blade area, upon which the determination of rudder torque Q_R is to be based, is to be derived as follows.

The rudder blade area may be divided into two rectangular or trapezoidal parts having areas A_1 and A_2 (see Fig 6 (d) and (e)), so that:

$A = A_1 + A_2$

The levers r_1 and r_2, in m, of the force C_R are given by the following formulae:

$r_1 = b_1\ (\alpha - k_{A1})$ $\qquad$ $r_2 = b_2\ (\alpha - k_{A2})$

where:

- b_1, b_2 : mean breadth of the blade parts having areas A_1 and A_2, determined as appropriate in accordance with Fig 1:

  $k_{A1} = A_{1f} / A_1$

  $k_{A2} = A_{2f} / A_2$

- A_{1f}, A_{2f} : area, in m², of the blade parts indicated in Fig 2
- α : 0,33, for ahead condition

  0,66, for astern condition.

For rudder parts located behind a fixed structure such as a rudder post, the following values apply:

- α : 0,25, for ahead condition

  0,55, for astern condition.

The values C_{R1} and C_{R2} of the resulting force, in N, acting on each part of the rudder blade may be calculated by the following formulae:

$C_{R1} = C_R\ (A_1 / A)$

$C_{R2} = C_R\ (A_2 / A)$

The values Q_{R1} and Q_{R2}, in Nm, of the resulting torque relevant to each part of the rudder blade may be derived from the following formulae:

$Q_{R1} = C_{R1} \cdot r_1$

$Q_{R2} = C_{R2} \cdot r_2$

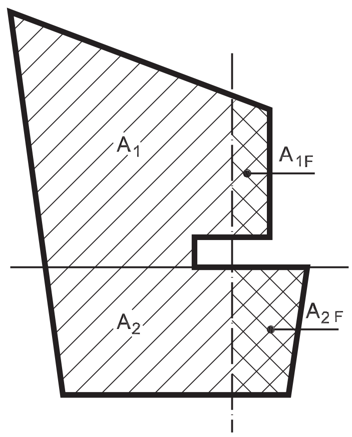
The total torque acting on the rudder stock, Q_R, is to be calculated for both ahead and astern conditions according to the formula:

$Q_R = Q_{R1} + Q_{R2}$

For the ahead condition, Q_R is to be taken not less than the minimum value $Q_{R,MIN}$, in N m, calculated by the following formula:

$Q_{R,MIN} = 0,1\ C_R \cdot [(A_1 \cdot b_1) + (A_2 \cdot b_2) / A\ ]$

Figure 2



3.3 Rudder stock

3.3.1 Column buckling without rotation of the transverse section

a) Rudder stocks subject to torque only (see Fig 6 (e)) are to have scantlings such that the torsional stress, in N/mm², does not exceed the following value:

   $\tau_{T,\ AMM} = 68 / K_1$

   The rudder stock diameter, in mm, is therefore to be not less than the value d_T, in mm, calculated by the following formula:

   $d_T = 4,2\ (Q_R \cdot K_1)^{1/3}$

b) Rudder stocks subject to combined torque and bending (see Fig 6 (b), (c) and (d)) are to have scantlings such that their equivalent stress E, in N/mm², does not exceed the value determined by the formula:

   $\sigma_{E,AMM} = 118 / K_1$

   where σ_E is given by the formula:

$$\sigma_E = \sqrt{\sigma_B^2 + 3\tau_T^2}$$

where:

- σ_B : bending stress component, in N/mm², given by the following formula:

$$\sigma_B = \frac{10,2M}{d_{TF}^3} \cdot 1000$$

- τ_T : torsional stress component, in N/mm², given by the following formula:

The rudder stock diameter, in mm, is to be therefore not less than the value d_{TF}, in mm, calculated according to the following formula:

$$d_{TF} = d_T \cdot \left[1 + \frac{4}{3}\left(\frac{M}{Q_R}\right)^2\right]^{1/6}$$

where:

M : bending moment on rudder stock, in N m, which is given by the following formula:

$M = 0,866 (C_R / A) \cdot H$

where:

$H = A_2 \cdot (H_C + H_2/2)$ for spade rudders (see Fig 6 (b))

$H = A_1 \cdot a_1 \cdot u \cdot H_1$ for rudders with 2 bearings (with solepiece) (see Fig 6 (c))

$H = 0,83\ B$ for semi-spade rudders with 2 bearings (with rudder horn) (see Fig 6 (d)).

A_1, A_2, H_C, H_1 and H_2 are areas, in m², and dimensions, in m, as shown in Fig 6 (b), (c) and (d).

B is the greater of the values (absolute values) obtained from the following formulae:

$B = A_1 \cdot u \cdot H_1 + A_2 \cdot (v \cdot H_1 + w \cdot H_2)$

$B = A_1 \cdot a_2 \cdot H_1 - A_2 \cdot (a_3 \cdot H_1 + 0,5\ H_2)$

The values of the coefficients a_1, a_2, a_3, u, v and w are given in Tab 2 as a function of the ratio c, where:

$c = H_1 / (H_C + H_1)$

Tasneef may accept bending moments, shear forces and support reaction forces determined by a direct calculation to be performed with reference to the static schemes and loading conditions set out in Appendix 1 to this Section.

In the case of rudders having unusual profiles, bending moments, shear forces and support reaction forces are, in any case, to be determined by direct calculation.

In general, the diameter of a rudder stock subject to torque and bending may be gradually tapered above the upper stock bearing so as to reach the value of d_T in way of the quadrant or tiller.

Table 2

c	u	v	w	a_1	a_2	a_3	c_1	c_2	c_3
1,00	0,2490	0,3310	-0,0020	1,000	0,167	0	0,577	0,769	0,298
0,98	0,2370	0,3130	0,0056	1,000	0,181	0,020	0,568	0,797	0,320
0,96	0,2294	0,3006	0,0103	1,000	0,195	0,042	0,563	0,818	0,345
0,94	0,2256	0,2918	0,0131	1,000	0,210	0,064	0,560	0,834	0,366
0,92	0,2242	0,2858	0,0147	1,000	0,225	0,087	0,558	0,847	0,384
0,90	0,2248	0,2817	0,0152	1,000	0,241	0,111	0,557	0,858	0,380
0,88	0,2270	0,2792	0,0149	1,000	0,257	0,136	0,558	0,867	0,414
0,86	0,2303	0,2780	0,0141	1,017	0,276	0,163	0,559	0,874	0,428
0,84	0,2348	0,2780	0,0128	1,064	0,294	0,190	0,560	0,881	0,440
0,82	0,2402	0,2788	0,0110	1,109	0,313	0,220	0,562	0,887	0,452
0,80	0,2464	0,2805	0,0090	1,151	0,334	0,250	0,564	0,892	0,463
0,78	0,2534	0,2830	0,0066	1,191	0,355	0,282	0,567	0,896	0,474
0,76	0,2610	0,2862	0,0041	1,229	0,377	0,316	0,570	0,899	0,485
0,74	0,2694	0,2900	0,0013	1,266	0,401	0,351	0,573	0,903	0,495
0,72	0,2784	0,2945	-0,0016	1,302	0,426	0,389	0,577	0,906	0,505
0,70	0,2881	0,2997	-0,0047	1,336	0,453	0,429	0,580	0,908	0,515
0,68	0,2984	0,3055	-0,0079	1,370	0,481	0,471	0,584	0,911	0,525
0,66	0,3094	0,3120	-0,0112	1,403	0,511	0,515	0,588	0,913	0,535
0,64	0,3212	0,3192	-0,0146	1,435	0,542	0,563	0,592	0,915	0,545
0,62	0,3336	0,3271	-0,0181	1,467	0,576	0,613	0,596	0,916	0,556
0,60	0,3468	0,3358	-0,0217	1,499	0,612	0,666	0,600	0,918	0,565
0,58	0,3608	0,3453	-0,0253	1,531	0,650	0,724	0,604	0,919	0,575
0,56	0,3757	0,3557	-0,0290	1,563	0,691	0,786	0,608	0,920	0,586
0,54	0,3915	0,3670	-0,0328	1,596	0,735	0,852	0,612	0,922	0,596
0,52	0,4084	0,3794	-0,0365	1,629	0,783	0,9232	0,617	0,923	0,607
0,50	0,4264	0,3930	-0,0403	1,662	0,834	1,000	0,621	0,924	0,617

3.4 Rudder plating

3.4.1 Double plating rudders

Double plating rudders consist of a welded plating box, stiffened by horizontal and vertical webs which may or may not incorporate the mainpiece.

The generic horizontal cross-section of the rudder plat-ing is to be such that stress components, in N/mm², do not exceed the following values:

a) rudder of the type shown in Fig 6 (b) and (c)

normal bending stress σ_{FL}: $110 / K_1$

shear stress τ : $50 / K_1$

equivalent stress $\sigma_E = (\sigma_{FL}^2 + 3\tau^2)^{0,5}$: $120 / K_1$

b) rudder of the type shown in Fig 6 (d) and (e):

normal bending stress σ_{FL}: $75 / K_1$

shear stress τ : $50 / K_1$

equivalent stress $\sigma_E = (\sigma_{FL}^2 + 3\tau^2)^{0,5}$: $100 / K_1$

The thickness of each rudder plate panel is to be not less than the value t_F, in mm, calculated by the following formula:

$$t_F = \left[5,5s \cdot \beta \cdot \left(d + \frac{C_R \cdot 10^{-4}}{A}\right)^{0,5} + 2,5\right] \cdot K_1^{0,5}$$

where:

d : draught with the ship on the full load waterline, in m

β : $[1,1 - 0,5\ (s/b_L)^2]^{0,5}$, which need not be taken greater than 1

where:

s : minor side of the plating panel, in m,

b_L : major side of the plating panel, in m.

Vertical webs with spacing greater than twice that of horizontal webs are not acceptable.

Web thickness is to be at least 70% of that required for rudder plating and in no case is it to be less than 8 mm, except for the upper and lower webs. The thickness of any of these webs is to be uniform and not less than that of the web panel having the greatest thickness tF as calculated with the above formula. In any case it is not re-quired that the thickness is increased by more than 20% in respect of normal webs.

When the design of the rudder does not incorporate a mainpiece, this is to be replaced by two vertical webs closely spaced and in general having a thickness not less than 1,5 times that of normal webs. In rudders having an area A smaller than 5 m², one vertical web only may be accepted provided its thickness is in general at least twice that of normal webs. As a rule, the increased thickness of such webs need not exceed 30 mm, unless otherwise required in special cases to be individually considered by Tasneef

The thickness of the side plating between the two ver-tical webs replacing the mainpiece, or in way of the only reinforced web, is to be increased by at least 20%.

The welded connections of blade plating to vertical and horizontal webs are to comply with the requirements of Chapter 1, Section 5.

Where internal access to the rudder is not practicable, connections are to be by means of slots on a supporting flat welded to the webs, to be cut on one side of the rud-der only, in accordance with Chapter 1, Section 5

Rudder nose plates are to have a thickness not less than 1,25 t_F. In general this thickness need not exceed 22 mm, unless otherwise required in special cases to be individually considered by Tasneef

On completion of manufacture, the rudder plating is to be subjected to a leak test using air as required in Chapter 5.

3.5 Rudder pintles

3.5.1

a) rudder pintles are to have a diameter not less than the value d_A, in mm, calculated by the following formula:

$$d_A = \left[\frac{0,38V_{AV}}{V_{AV} + 3} \cdot (F_A \cdot K_1)^{0,5} + f_C\right]$$

where:

F_A : force, in N, acting on the pintle, calculated as specified in the following item (f);

f_C : coefficient depending on corrosion, whose value may generally be obtained as follows: $f_C = 30\ K_1^{0,5}$.

Tasneef may accept lower f_C values based on considerations of ship dimensions and satisfactory service experience, supported by documents, of corrosion control systems adopted.

b) Provision is to be made for a suitable locking device to prevent the accidental loosening of pintles.

The pintle housings are in general to be tapered with the taper ranging:

from 1:12 to 1:8 for pintles with non-hydraulic assembly and disassembly arrangements

from 1:20 to 1:12 for pintles with hydraulic assembly and disassembly arrangements.

c) The housing height is to be not less than:

$0,35\ (F_A \cdot K_1)^{0,5}$

d) The maximum value of the pressure acting on the gudgeons, in N/mm², and in general on the rudder supports, calculated by the following formula:

$p_F = F_A / (d_A \cdot h_A)$

is not to exceed the values given in Tab 3, where h_A is the contact length between pintle and housing, to be taken not greater than 1,2 d_A.

Values in excess of those given in Tab 3 may be accepted by Tasneef on the basis of specific tests.

The thickness of the pintle housing in the gudgeon is to be not less than $0,25d_A$.

e) The manufacturing tolerances on the diameter of metallic supports are to be not less than:

d_A / 1000 +1,0, in mm.

In the case of non-metallic supports, the tolerances are to be carefully evaluated on the basis of the ther-mal and distortion properties of the materials employed; the tolerance on support diameter is in no case to be less than 1,5 mm.

f) Where a direct calculation is used to obtain the rudder stock stress components, the value F_A is also to be derived from the same calculation (see Appendix 1 to this Section).

Otherwise, the value F_A is to be calculated from the following formula:

$F_A = (C_R / A) \cdot A_G$

where:

C_R : force, in N, acting on the rudder blade, determined as specified in [3.2];

A_G : part of the rudder blade area A, in m², supported by the pintle, calculated as specified in items (1) and (2) below.

(1) For rudders (excluding semi-spade rudders) with two bearings, i.e. with sole-piece, (see Fig 6 (c)), A_G is to be not lower than the value obtained from the following formula:

$A_G = A \cdot [(H_C + 0,5\ H_1) / (H_C + H_1)]$

(2) For semi-spade rudders with two or more bearings (with rudder horn) (see Fig 6 (d) and (e)), the area A_G, for the lower pintle, is to be not less than the value A_{G1} calculated by the following formula:

$A_{G1} = C_3 \cdot A_1 + [C_1 \cdot (H_2/(H_C+H_1)) + C_2] \cdot A_2$

In no case is the value of A_{G1} to be greater than A.

For the upper pintle (see Fig 6 (e)), the area A_G is to be not less than the greater of the values A_{G2} obtained from the following formulae:

$A_{G2} = A - A_{G1}$

$A_{G2} = 0,35\ A$

The values of coefficients C_1, C_2 and C_3 are given in Tab 2 as a function of the ratio c, c being as defined in [3.3].

Table 3

Bearing	p_F, in N/mm²
Lignum vitae	2,5
White metal, oil lubrificated	4,5
Synthetic material with hardness between 60 and 70 (1) Shore D	5,5
Steel (2) , bronze and hot-pressed bronze-graphite materials	7,0

(1) Indentation hardness test at 23 ºC and with 50% moisture to be performed according to a recognised standard. The type of synthetic bearing materials is to be approved by Tasneef

(2) Stainless and wear-resistant steel in combination with stock liner approved by Tasneef

3.6 Rudder couplings

3.6.1 Horizontal flange couplings

Horizontal flange couplings are to be connected by fitted bolts in number n_B not less than 6, having a diameter not less than d_B, in mm, given by the following formula:

$$d_B = \frac{0,62\, d_1^{3/2}}{n_B^{0,5}} \cdot \left(\frac{K_{1B}}{K_{1A}}\right)^{0,5} \cdot \frac{1}{e_M^{0,5}}$$

The thickness of the coupling flange is to be not less than the value t_P, in mm, calculated by the following formula:

$$t_P = d_B \cdot \left(\frac{K_{1P}}{K_{1B}}\right)^{0,5}$$

In any case t_P is to be $\geq 0,9\ d_B$, with d_B, calculated for a number of bolts not exceeding 8.

The symbols used above have the following meanings:

d_1 : rule diameter d_T or d_{TF} in mm, of the rudder stock, in compliance with the requirements in [3.3];

K_{1B}, K_{1A}, K_{1P}: coefficients depending on the high strength steel used for bolts, rudder stock and coupling flange, respectively, whose values are to be taken as defined in [2.1].

e_M : mean distance, in mm, of the bolt axes from the longitudinal axis through the coupling centre.

The distance from the bolt axes to the external edge of the coupling flange is generally to be not less than 1,2 d_B.

A suitable locking device is to be provided to prevent the accidental loosening of nuts.

Non-fitted bolts may be used provided that, in way of the mating plane of the coupling flanges, a key is fitted having a section of 0,25 d_T x 0,10 d_T, and keyways in both the coupling flanges, and provided that at least two of the coupling bolts are fitted bolts.

3.6.2 Vertical flange couplings

Vertical flange couplings are to be connected by fitted bolts, in number n_B not less than 8, having a diameter d_B, in mm, not less than the value calculated by the following formula:

$$d_B = \frac{0,81\, d_1}{n_B^{0,5}} \cdot \left(\frac{K_{1B}}{K_{1A}}\right)^{0,5}$$

d_1, K_{1B} and K_{1A} are defined in [3.6.1].

The first moment of area of the sectional area of bolts about the vertical axis through the centre of the coupling is to be not less than the value MS, in cm³, calculated by the following formula:

$M_S = 0,43\ d_1^3 \cdot 10^{-6}$

The thickness of the coupling flange is generally to be not less than d_B.

The distance of the bolt axes from the external edge of the coupling flange is generally to be not less than 1,2 d_B.

A suitable locking device is to be provided to prevent the accidental loosening of nuts.

3.6.3 Cone couplings

Cone couplings of the shape shown in Fig 3 (with reference to the symbols indicated in the same Fig-ure) are to have the dimensions indicated in (a) and (b) below:

a) Cone couplings with hydraulic arrangements for assembling and disassembling the coupling:

   Taper: $1/20 \leq (d_1 - d_0)/t_s \leq 1/12$

   $t_S \leq 1,5\ d_1$

   $d_G \geq 0,65\ d_1$

   $t_N \geq 0,60\ d_G$

   $d_N \geq 1,2\ d_0$ and, in any case, $d_N \geq 1,5\ d_G$.

   Between the nut and the rudder gudgeon a washer is to be fitted having a thickness not less than 0,13 d_G and an outer diameter not less than 1,3 d_0 or 1,6 d_G, whichever is the greater.

b) Cone couplings without hydraulic arrangements for assembling and disassembling the coupling:

   Taper: $1/12 \leq (d_1 - d_0)/t_s \leq 1/8$

   $t_S \leq 1,5\ d_1$

   $d_G \geq 0,65\ d_1$

$t_N \geq 0,60\ d_G$

$d_N \geq 1,2\ d_0$ and, in any case, $d_N \geq 1,5\ d_G$.

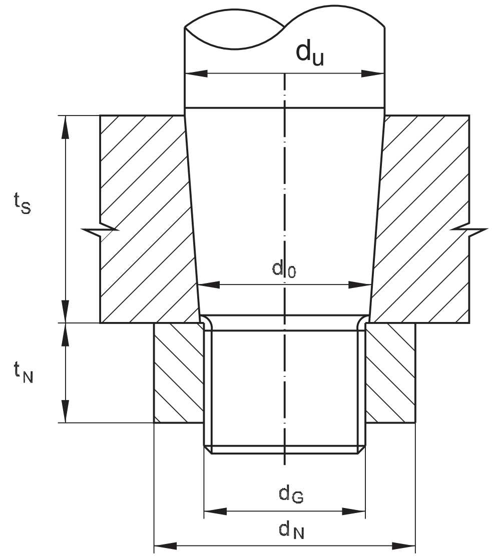
The dimensions of the locking nut, in both (a) and (b) above, are given purely for guidance, the determination of adequate scantlings being left to the responsibility of the Designer.

In cone couplings of type (b) above, a key is to be fit-ted having a cross-section 0,25 d_T x 0,10 d_T and keyways in both the tapered part and the rudder gudgeon.

In cone couplings of type (a) above, the key may be omitted. In this case the Designer is to submit to Tasneef shrinkage calculations supplying all data necessary for the relevant check.

All necessary instructions for hydraulic assembly and disassembly of the nut, including indication of the values of all relevant parameters, are to be available on board.

Figure 3



3.7 Supporting arrangements and rudder stops

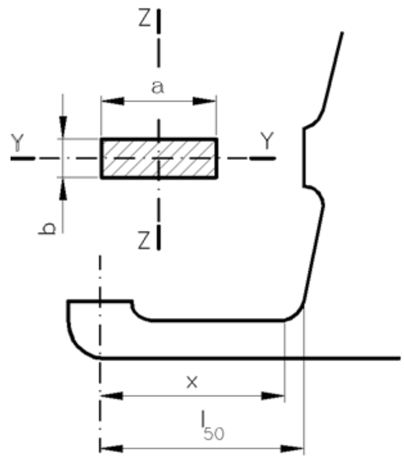
3.7.1 General

The weight of the rudder is normally supported by a carrier bearing inside the rudder trunk.

In the case of unbalanced rudders having more than one pintle, the weight of the rudder may be supported by a suitable disc fitted in the solepiece gudgeon.

Robust and effective structural rudder stops are to be fitted, except where adequate positive stopping arrange-ments are provided in the steering gear.

Figure 4



3.7.2 Solepiece

At no cross-section of the solepiece is the section modulus Z_z, in cm³, about the vertical axis Z (see Fig 4) to be less than:

$Z_z = (M_B \cdot K_1) / 80$

The section modulus Z_y, in cm³, about the horizontal axis Y is to be not less than:

$Z_y = 0,5 \cdot Z_z$

The cross-sectional area A_S, in mm², is to be not less than:

$A_S = (B_1 \cdot K_1) / 48$

In addition to the dimensional limits above, at no sec-tion within the length l_{50} is the equivalent stress σ_E, in N/mm², to exceed the value $115/K_1$, where:

$\sigma_E = (\sigma^2_B + 3\tau^2)^{0,5}$, in N/mm²

$\sigma_B = M_B / Z_z$, in N/mm²

$\tau = B_1 / A_S$, in N/mm²

M_B : $B_1 \cdot x$, $(0 \leq x \leq l_{50})$, bending moment, in N m, at the section considered

B_1 : supporting force, in N, of the solepiece (in general $B_1 = C_R / 2$).

3.7.3 Rudder horn

The stress components (see Fig 5) acting on the generic rudder horn cross-section at a distance z from the horizontal axis are the following:

$M_B = B_1 \cdot z$, bending moment, in N·m

$Q = B_1$, shear force, in N

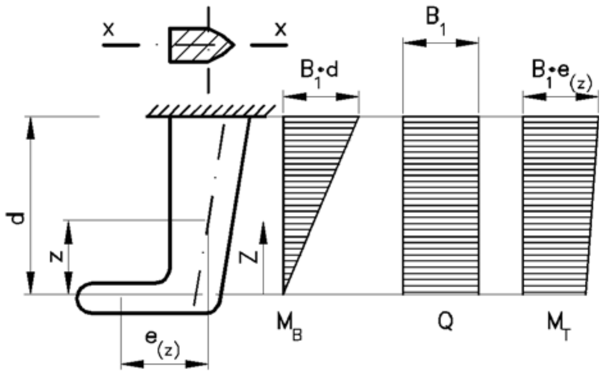
$M_T = B_1 \cdot e$, torque, in N·m

where B_1, in N, is generally given by the formula:

$B_1 = C_R \cdot [b / (l_{20} + l_{30})]$

(For b, l_{20}, and l_{30}, see App 1, Fig 2).

Figure 5



The modulus Z_x, in cm^3, of the section about the horizontal axis is to be not less than:

$Z_x = (M_B \cdot K_1) / 67$

The shearing stress τ, in N/mm^2, due to the shear force is not to exceed the value:

$\tau = 48 / K_1$

At no horizontal section of the rudder horn, for $0 \le z \le d$ is the equivalent stress σ_E, in N/mm^2, to exceed $120/K_1$, where:

$\sigma_E = (\sigma^2_B + 3(\tau^2 + \tau^2_T))^{0,5}$

$\sigma_B = M_B / Z_x$, in N/mm^2

$\tau = B_1 / A_H$, in N/mm^2

$\tau_T = (M_T \cdot 10^3) / (2A_T \cdot t_H)$, in N/mm^2

A_H : effective shear area of the rudder horn in y-direction, in mm^2

A_T : area in the horizontal section enclosed by the rudder horn plating, in mm^2

t_H : plate thickness of rudder horn, in mm.

4 Single plate rudders

4.1

4.1.1 Single plate rudders consist of a mainpiece of circular shape, connected to two or more arms fitted alternately on either side of the rudder blade plate.

The rudder stock diameter is to be calculated according to [3.3].

The mainpiece diameter is to be not less than the rudder stock diameter. For spade rudders, the lower third may taper down to 0,75 times the rudder stock diameter.

The blade thickness t_B, in mm, is to be not less than:

$t_B = (1,5 s \cdot V_{AV} + 2,5) \cdot K_1^{0,5}$

where:

s : spacing of stiffening arms, in m, in no case to be more than 1 m.

The thickness of the arms is to be not less than the blade thickness; the section modulus, in cm^3, of the generic cross-section is to be not less than:

$Z_A = 0,5 s \cdot C_l^2 \cdot V_{AV}^2 \cdot K_1$

where:

C_l : horizontal distance, in m, from the aft edge of the rudder to the cross-section.

5 Steering nozzles

5.1 General

5.1.1 In this Article the requirements for scantlings for steer-ing nozzles are given, applicable to nozzles for which:

$(P \cdot d_M)^{0,5} \le 130$

where:

P : power transmitted to the propeller, in kW

d_M : inside diameter of the nozzle, in m.

Nozzles for which $(P \cdot d_M)^{0,5}$ exceeds the above value will be specially considered in each case by Tasneef

Nozzles normally consist of a double skin cylindrical structure stiffened by ring webs and other longitudinal webs placed perpendicularly to the nozzle.

At least two ring webs are to be fitted, one of which, of greater thickness, is to be placed in way of the axis of rotation of the nozzle.

The number of ring webs is to be increased, as deemed necessary by Tasneef on nozzles with an inner diameter d_M exceeding 3 m.

Care is to be taken in the manufacture of the nozzle to ensure the welded connection between plating and webs.

The internal part of the nozzle is to be adequately protected against corrosion.

Upon completion of manufacture, the nozzle is to be subjected to a leak test using air as required in Chapter 5.

5.2 Nozzle plating and internal diaphragms

5.2.1 The inner plating of the nozzle is to have a thickness tF, in mm, not less than that given by the formulae in (a) or (b) below, as appropriate.

a) For $(P \cdot d_M)^{0,5} \le 78$:

$t_F = [0,085 (P \cdot d_M)^{0,5} + 9,65] \cdot K_1^{0,5}$

b) For $(P \cdot d_M)^{0,5} > 78$:

$t_F = [0,085 (P \cdot d_M)^{0,5} + 11,65] \cdot K_1^{0,5}$

The symbols P and d_M used in (a) and (b) above have the same meanings specified in [5.1].

The thickness t_F is to be extended to a length across the transverse section containing the propeller blade tips equal to 1/3 of the total nozzle length.

Outside the above length, the thickness may be not less than t_F - 7 mm.

The outer plating of the nozzle may have a thickness not less than t_F - 9 mm.

In no case are both of the above thicknesses to be less than 7 mm.

Ring webs and longitudinal webs are to have a thick-ness not less than t_F - 7 mm, or 7 mm, whichever is the greater. However, the ring web, in way of the axis of rotation and connected above to the headbox and below to the pintle support structure, is to have a thickness not less than t_F.

Where stainless steel accepted by Tasneef is used, thicknesses may be reduced, at the discretion of Tasneef in relation to the type of stainless steel concerned.

The requirements for scantlings given in [5] may also be applied to fixed nozzles (nozzle propellers).

5.3 Nozzle stock

5.3.1 The diameter of the nozzle stock is to be not less than the value d_{TF} given in Tab 4.

The diameter d_{TF} of the nozzle stock may be gradually tapered above the upper stock bearing so as to reach the value d_T, given in Tab 4, in way of the tiller or quadrant

5.4 Pintles

5.4.1 Pintles are to have a diameter d_A, in mm, not less than that calculated by the following formula:

$$d_A = \left(\frac{11 V_{AV}}{V_{AV} + 3} S_{AV}^{0,5} + 30\right) \cdot K_1^{0,5}$$

S_{AV} being as indicated in Tab 4.

The net pintle length h_A, in mm, is to be not less than 1,2 d_A.

Smaller values of h_A, but in no case smaller than d_A, may be accepted provided that the pressure on the gud-geon bearing p_F, in N/mm², given by the following formula does not exceed the values given in Tab 3:

$$p_F = \frac{0,6S' \cdot 10^3}{d'_A \cdot h'_A}$$

where:

d'_A : actual pintle diameter, in mm

h'_A : actual bearing length of pintle, in mm

S' : the greater of the values S_{AV} and S_{AD}, in k_N, given in Tab 4.

Table 4

Parameter	Formula for its determination
d_{TF}, in mm	64,23 $(M_T \cdot K_1)^{1/3}$
d_{TF}, in mm	0,73 d_{TF}
M_{AV}, in kN·m	0,3 $S_{AV} \cdot a$
M_{AD}, in kN·m	$S_{AD} \cdot b$
S_{AV} , in kN	0,147 $A \cdot V_{AV}^2$
S_{AD} , in kN	0,196 $A \cdot V_{AD}^2$
A , in m²	1,35 $A_1 + A_2$
A_1 , in m²	$L_M \cdot d_M$
A_2 , in m²	$L_1 \cdot H_1$

Note 1: $M_T = M_{AV}$ or M_{AD}, whichever is the greater;
a, b, L_M, d_M, L_1 and H_1 = nozzle dimensions, in metres, as shown in Fig 6 (f);
V_{AV} and V_{AD} = ahead and astern speed, in knots, as defined in [1.1].

Note 1: $M_T = M_{AV}$ or M_{AD}, whichever is the greater;
a, b, L_M, d_M, L_1 and H_1 = nozzle dimensions, in metres, as shown in Fig 6 (f);
V_{AV} and V_{AD} = ahead and astern speed, in knots, as defined in [1.1].

5.5 Nozzle coupling

5.5.1 In addition to the requirements in [3.6.1] for horizontal flange couplings, coupling bolts are to have a diameter not less than the value d_B, in mm, calculated by the following formula:

$$d_A = 0,23 d_{TF} \cdot \left(\frac{K_{1B}}{K_{1A}}\right)^{0,5}$$

The thickness of the coupling flange is to be not less than the value t_P, in mm, given in the following formula:

$$t_P = 0,23 d_{TF} \cdot \left(\frac{K_{1P}}{K_{1B}}\right)^{0,5}$$

d_{TF} being as shown in Fig 4 and K_{1B}, K_{1A} and K_{1P} being as defined in [3.6.1].

6 Special rudder types

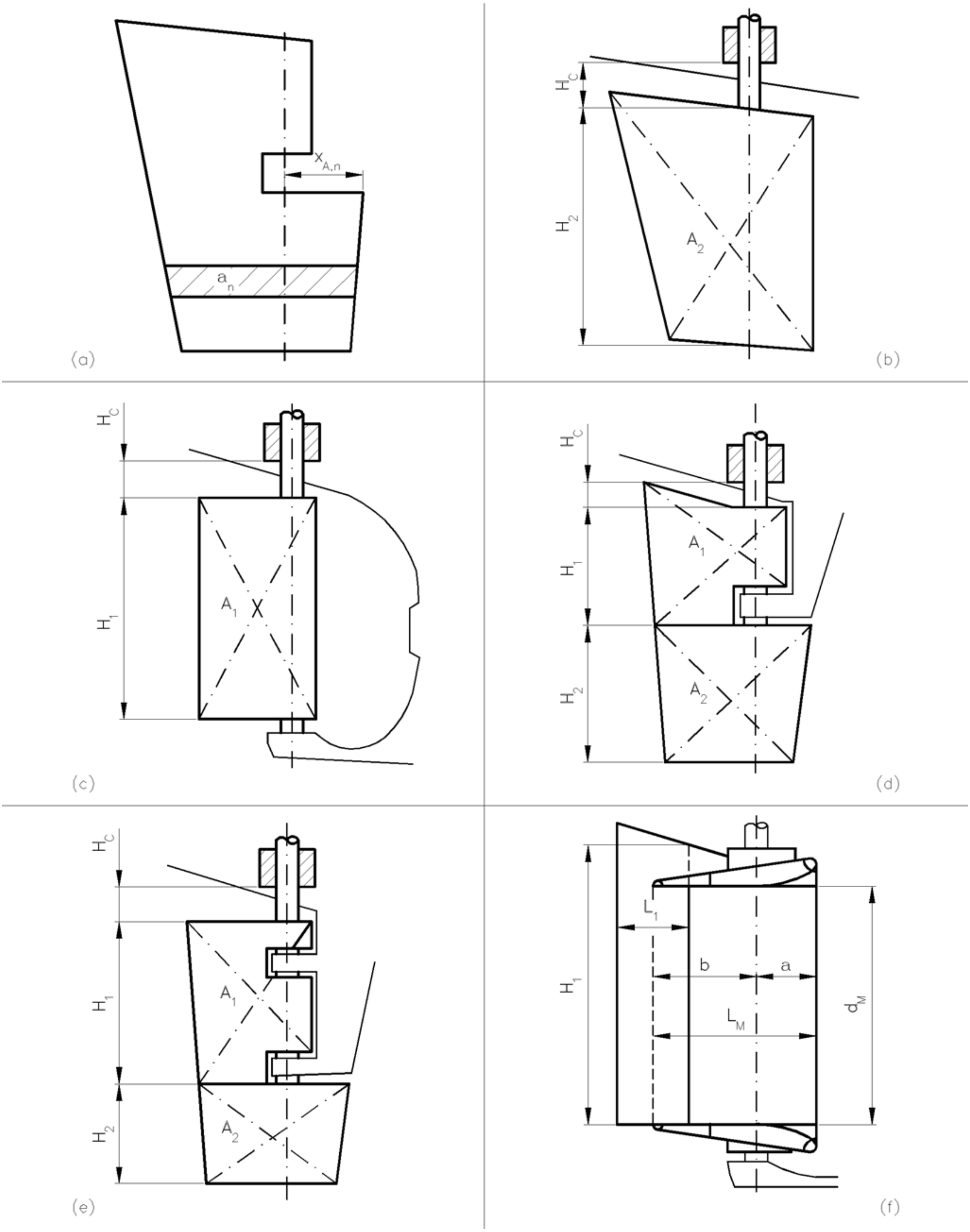
6.1

6.1.1 Special rudder types will be considered by Tasneef on a case-by-case basis.

Assuming the external pressure C_R / A, C_R being the force given in [3.2.1], the equivalent stresses for com-bined torque and bending in the rudder stock are not to exceed 118/K_1 N/mm².

Where the rudder stock is subject to torque only, the torsional stresses are not to exceed 68/K_1 N/mm².

Figure 6 : Rudder types



APPENDIX 1 DIRECT CALCULATION OF SUPPORT FORCES AND STRESS COMPONENTS FOR RUDDER STOCKS

1 General

1.1

1.1.1 With reference to Fig 1, Fig 2 and Fig 3, the following symbols and definitions apply:

l_{10} to l_{50} = length of the individual elements of the rud-der system, in m

J_{10} to J_{50} = moments of inertia of these elements, in cm^4.

For rudders supported by a solepiece only, J_{20} indicates the moment of inertia of the pintle in the solepiece.

For the rudder in Fig 1, the load per unit length P_R, in kN/m, is given by:

$P_R = C_R / (10^3 \cdot l_{10})$

where C_R is defined in

For the rudder in Fig 2, the load per unit length of its various elements, in kN/m, is given by the following formulae:

$P_{R10} = C_{R2} / (10^3 \cdot l_{10})$

$P_{R20} = C_{R1} / (10^3 \cdot l_{20})$

where C_{R1} and C_{R2} are defined in [3.2.2].

The spring constant Z_C, in kN/m, for the solepiece is given by the following formula (see Fig 1):

$Z_C = (6{,}18 \cdot J_{50}) / l^3_{50}$

where:

J_{50} = moment of inertia of the solepiece about the z-axis, in cm^4 (see also in Ch 2, Sec 1, Fig 4)

l_{50} = effective length of the solepiece, in m.

The stiffness Z_P, in kN/m, for the rudder horn is given by the following formula (see Fig 2):

$Z_P = 1/(f_B + f_T)$

where:

f_B = unit displacement of rudder horn due to a unit force of 1 kN acting in the centroid of the rudder horn, in m/kN, which may be expressed, as guidance, by

$f_B = 1{,}3 \cdot (d^3 / 6{,}18\, J_N)$

J_N = moment of inertia of rudder horn about the x-axis, in cm^4 (see also in Chap 2, Sec 1, Fig 5)

f_T = unit displacement due to torsion, in m/kN, which may be expressed as guidance by

$$f_T = \frac{d \cdot e^2 \cdot \Sigma u_i / t_i}{3{,}14 \cdot 10^8 \cdot F^2_T}$$

where:

F_T = mean sectional area of rudder horn, in m^2

u_i =breadth, in mm, of the individual plates forming the mean rudder horn sectional area

t_i = thickness of the individual plates above, in mm

e, d = see Fig 2.

For the rudder in Fig 3, the maximum bending moment M_B, in N · m, and support forces B_3 and B_2, in N, may be determined by the following formulae:

$$M_B = C_R\left[l_{20} + \frac{l_{10} \cdot (2C_1 + C_2)}{3 \cdot (C_1 + C_2)}\right]$$

$B_3 = M_B / l_{30}$ $B_2 = C_R + B_3$

Figure 1

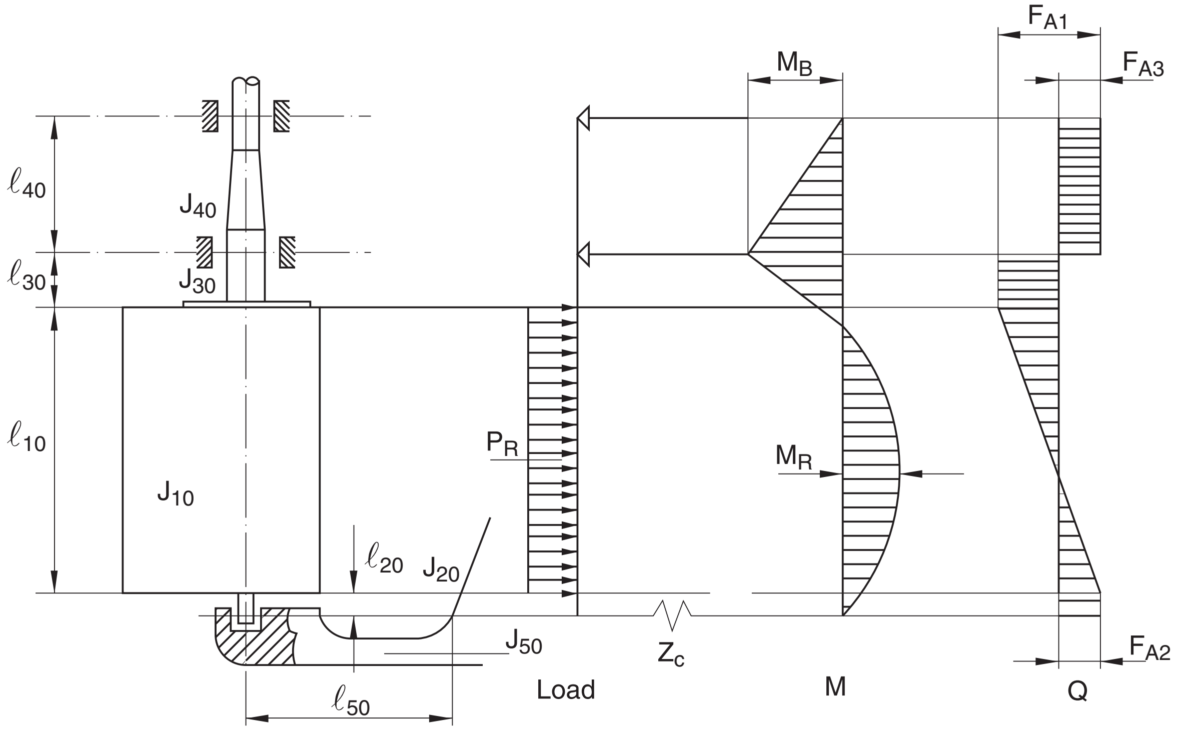


Figure 2

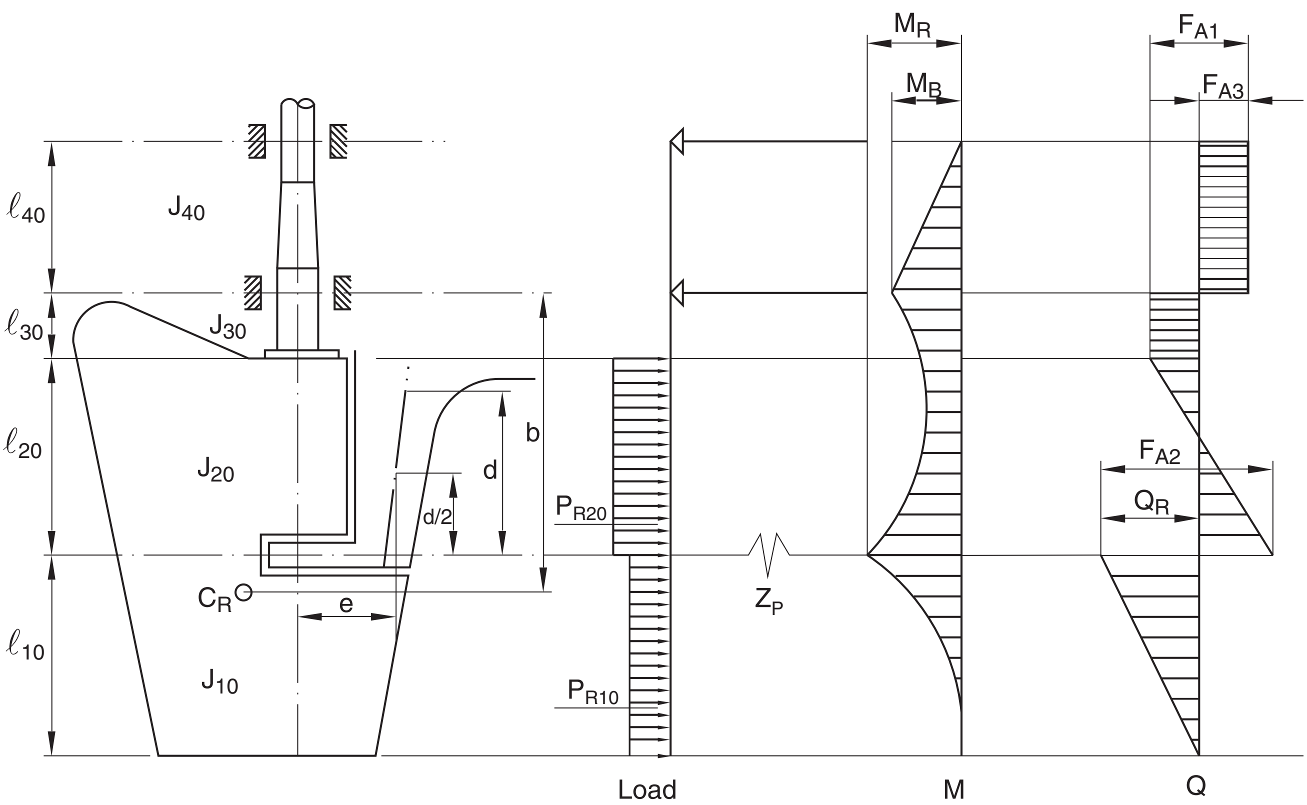
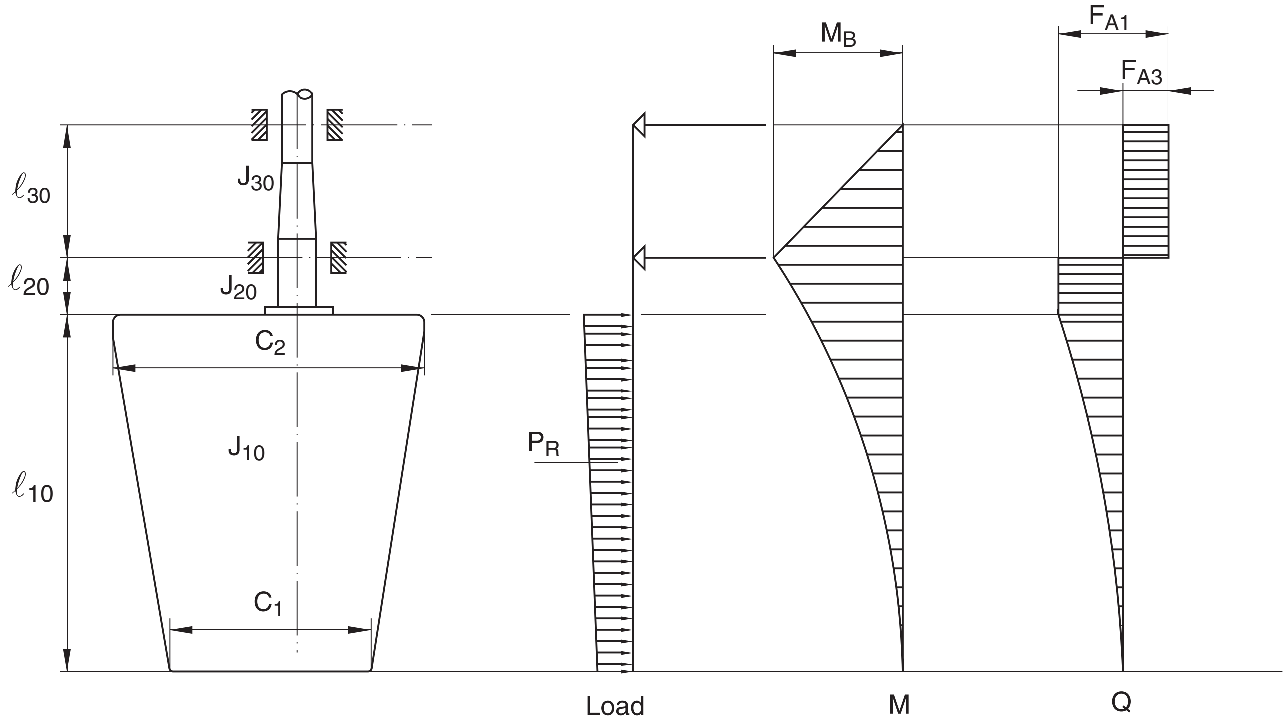


Figure 3



Part B
Hull and Stability

Chapter 3
EQUIPMENT

SECTION 1 EQUIPMENT

SECTION 1 GENERAL

1 General

1.1

1.1.1 All ships are to be provided with anchors, chain cables and ropes based on their Equipment Number EN, as shown in Tab 1, 2 and 3.

At the discretion of Tasneef taking into account the use of the ship and the operating conditions in the service area, the equipment mentioned in the previous tables may be reduced.

In this case, the area of use of the ship is to be indi-cated on the Certificate of Classification.

When the service in which the ship is engaged is considered in "strong current", the anchor mass may be increased at the discretion of Tasneef

It should be borne in mind that some waterways or sections thereof may be subject to special requirements of the relevant Administrations.

2 Equipment number and equipment

2.1

2.1.1 The equipment number EN for all cargo ships engaged in inland waterway service is to be obtained by the formula:

EN = Δ

where:

Δ = displacement, in t, of the ship at deepest draught.

For passenger ships and for ships with a large surface exposed to wind, the equipment number EN is to be obtained by the formula:

EN = Δ + A

where:

A= area, in m², in profile view, of the parts of the hull, superstructures and deckhouses above the deepest draught waterline, which have a breadth greater than B/4.

3 Particulars of anchors, chain cables and ropes

3.1 Anchors

3.1.1 Anchors may be stockless and with articulated flukes. When anchors not exceeding 90 kg in mass are required, four-fluke grapnel anchors may be used.

When stocked anchors are used, their mass, excluding the stock, is to be equal to 80% of the mass indicated in Tab 1.

When use is made of "high holding power" anchors, the anchor mass may be reduced by 25%.

Ships are to be fitted, in general, with two bower an-chors. At the discretion of Tasneef depending on the area of use of ships, one bower anchor only may be accepted.

When two anchors are fitted, it is recommended that both have the same mass.

In no case is the mass of the lighter anchor to be less than 45% of the total mass indicated in Tab 1.

3.2 Chain cables and wire ropes for anchors

3.2.1 Chain cables

Bower anchors are to be used in association with stud link or studless chain cables.

The breaking load of chain cables is to be not less than 35 times the mass of the anchor to which they are connected.

When "high holding power" anchors are used, the breaking load of chain cables is to be not less than 47 times the mass of the actual anchor.

In this case, grade U2 steel chain cables are to be used.

The diameter of stud link or studless chain-cables may be obtained from Table 1.2 depending on the breaking load.

If bower anchors of different mass are used, it is recommended that the same chain cable diameter is adopted based on the greater mass.

The length, in m, of bower anchor chain cables is to be not less than (L + 10), or 40 m, whichever is the greater.

However, in no case is a length greater than 60 m re-quired.

The length of the chain cable for the stern anchor is to be not less than 40 m.

Ships which are to be capable of stopping along the stream are to be equipped with a stern anchor chain cable length not less than 60 m.

At the discretion of Tasneef the anchor chain cable may be replaced by a steel wire rope having the same break-ing load as required for the chain cable. The steel wire rope length is to be increased by 20 m in respect of the length required in the previous provisions.

3.2.2 Chain lockers

Chain lockers are to have sufficient capacity so as to easily contain the whole chain cable.

Each anchoring line (either chain cable or wire rope) is to be adequately connected to a reinforced structure of the chain locker, or of the hull, and is to be fitted with a release device if possible.

3.2.3 Ropes

Towlines, as well as warping and mooring lines, may be of steel wire, natural or synthetic fibre or a mixture of steel wire and fibre.

The breaking loads given in Tab 3 refer to steel wires or natural fibre ropes.

Ropes are to be of the flexible type, preferably having not less than:

- 144 threads in 6 strands with 7 fibre cores, for towlines and mooring lines;
- 222 threads in 6 strands with one fibre core for warping lines.

When synthetic fibre ropes are adopted, their size will be determined taking into account the type of material used and the manufacturing characteristics of the rope, as well as the different properties of such ropes in comparison with natural fibre ropes.

The equivalence between synthetic fibre ropes and natural fibre ropes may be assessed by the following formula:

$CR_S = 7{,}4\ \delta \cdot CR_M^{8/9}$

where:

δ = elongation to breaking of the synthetic fibre rope, to be assumed not less than 0,3 (i.e. 30 per cent elongation);

CR_S = breaking load of the synthetic fibre rope, in kN;

CR_M = breaking load of the natural fibre rope, in kN, given by Tab 3.

Where fibre ropes are adopted, rope diameters under 20 mm are not allowed, even where, for the required breaking load, a smaller diameter could be adopted.

4 Equipment

4.1 General

4.1.1 Manoeuvring appliances are to be adequately connected to the hull.

It is to be possible for personnel in charge to easily and safely manoeuvre such appliances.

Fittings and their connections to the hull are to have sufficient strength so as to withstand a tensile force at least equal to the breaking load of the chain cables or ropes for which they are intended.

4.2 Manoeuvring of bower anchors

4.2.1 If the bower anchors are of the type intended to be housed in hawse pipes, the ship is to be fitted with such hawse pipes, which are to be well faired and of adequate strength.

The stern anchor is preferably to be housed in a hawse pipe or arranged on a special slipway so as to be always ready for use.

Grapnel anchors and stocked anchors are to have adequate arrangements on deck so as to enable them to be easily dropped and recovered.

Chain cables are to be kept in appropriate lockers lo-cated inside the hull.

For anchors having a mass exceeding 50 kg, a wind-lass is to be provided, which is to be proportionate to the size of chains, and is to be power operated or manually operated depending on the mass of anchors.

Windlasses designed to be either power operated or manually operated are to be so conceived such that the control of power operation cannot activate manual opera-tion.

Bollards, fairleads and winches are to be provided and suitably distributed for mooring and warping.

4.3 Manoeuvring of stern anchors

4.3.1 The helmsman is to be capable of dropping the stern anchor or anchors from his position. This does not apply to pushed or coupled convoys not less than 86 m in length.

Table 1 : Anchors

Equipment number EN	Bower anchor Total mass kg	Self-propelled ship		Non-self-propelled ships Passenger ships	
		Stern anchor		Stern anchor	
		Number	Mass of each anchor kg	Number	Total mass kg
50	90	-		-	
100	180	-		-	
150	270	-		-	
200	360	-			
250	450		110	-	110
300	540		140		140
400	670		170		170
500	790		200		200
600	920	1	230	1	280
700	1040		260		310
800	1170		290		350
900	1280		320		380
			350		420
1000	1390				
1100	1490		370		520
1200	1580		400		550
1300	1670		420		580
1400	1750		440		610
150	1820		460		640

(1) For self-propelled ships having L_{FT} > 86 m, two stern anchors are required.
For self-propelled ships equipped for pushing other ships, two stern anchors are required.
Instead of the two stern anchors, one anchor only may be fitted, provided its mass is equal to the sum of the masses of the two anchors.

Equipment number EN	Bower anchor Total mass kg	Self-propelled ship		Non-self-propelled ships Passenger ships	
		Stern anchor		Stern anchor	
		Number	Mass of each anchor kg	Number	Total mass kg
1600	1870		470		940
1700	1930		480		970
1800	1990		500		990
1900	2050		510		1020
2000	2110	1 or 2	530		1050
2200	2200		550		1100
2400	2290		570		1150
2600	2380		600		1190
2800	2470		620		1240
3000	2560		640		1280
3200	2650		660		1330
3400	2740		690		1370
3600	2830		710		1420
3800	2920		730		1460
4000	3010		750		1510
4200	3100		780		1550
4400	3190		800		1600
4600	3280		820		1640
4800	3370		840		1690
5000	3460		870	1 or 2	1730
5200	3550	2 (1)	890		1780
5400	3640		910		1820
5600	3730		930		1870
5800	3820		960		1910
6000	3910		980		1960
7000	4360		1090		2180
8000	4810		1200		2400
9000	5260		1320		2630
10000	5710		1430		2860
11000	6160		1540		3080
12000	6610		1650		3300

(1) For self-propelled ships having $L_{FT} > 86$ m, two stern anchors are required.
For self-propelled ships equipped for pushing other ships, two stern anchors are required.
Instead of the two stern anchors, one anchor only may be fitted, provided its mass is equal to the sum of the masses of the two anchors.

Table 2 : Chain cables for anchors

Stud link chain cables			Studless chain cables		
Chain cable diameter mm	Steel grade U1 Nominal breaking strength kN	Steel grade U2 Nominal breaking strength kN	Chain cable diameter mm	Steel grade U1 Nominal breaking strength kN	Steel grade U2 Nominal breaking strength kN
12,5	66	92	8	25	32
14	82	116	10	40	50
16	107	150	13	63	85
17,5	127	179	16	100	125
19	150	211	18	125	160
20,5	175	244	20	160	200
22	200	280	23	200	265
24	237	332	26	250	340
26	278	389	28	300	400
28	321	449	30	340	450
30	368	514	33	400	530
32	417	583	36	500	630
34	468	655	39	560	750
36	523	732	42	680	900
38	581	812			
40	640	896			
42	703	981			
44	769	1080			
46	837	1170			
48	908	1270			

Table 3 : Ropes

Equipment Number EN	1st towline		2st towline		Mooring lines			Warping lines		
	Length m	Breaking strength kN	Length m	Breaking strength kN	Quantity	Length m	Breaking strength kN	Quantity	Length m	Breaking strength kN
50	110	35	80	30	2	50	15	2	70	10
100	110	60	85	50	2	55	30	2	75	12
150	120	80	90	65	2	60	40	2	80	15
200	130	100	95	80	2	65	50	2	85	20
300	150	125	105	105	2	75	70	2	95	25
400	160	150	110	125	2	80	85	2	100	30
600	180	185	120	160	2	90	110	2	110	45
800	200	215	130	185	2	100	130	2	120	55
1000	200	235	140	200	3	100	150	3	120	65
1500	200	275	150	235	4	100	170	4	120	85
2000	200	305	150	260	4	100	185	4	120	100
3000	200	330	150	285	4	100	200	4	120	115
4000	200	355	150	305	4	100	210	4	120	125
5000	200	380	150	330	4	100	220	4	120	135
6000	200	400	150	350	4	100	230	4	120	145

Part B
Hull and Stability

Chapter 4

CLOSING ARRANGEMENTS, SCUPPERS AND OVERBOARD DISCHARGES

SECTION 1 CLOSING ARRANGEMENTS FOR SIDE SHELL, DECK AND SUPERSTRUCTURE OPENINGS - SCUPPERS AND OVERBOARD DISCHARGES

SECTION 1 CLOSING ARRANGEMENTS FOR SIDE SHELL, DECK AND SUPERSTRUCTURE OPENINGS - SCUPPERS AND OVERBOARD DISCHARGES

1 General

1.1

1.1.1 This Section contains the requirements for the closing arrangements for hull and superstructure openings.

Tasneef may consider the possibility of accepting hatch-ways on exposed decks not provided with closing ar-rangements. In this case the acceptance conditions are to be laid down in each case depending on the type of cargo carried and the areas of operation.

2 Closing arrangements for openings in superstructure bulkheads and machinery casings

2.1

2.1.1 All access openings in bulkheads at the ends and sides of enclosed 1st tier superstructures are to be fitted with doors of steel or other material judged suitable by Tasneef permanently and strongly attached to the bulk-heads.

The doors are to be weathertight and arranged so that they can be operated from both sides of the bulkhead and generally open outwards.

For the sill heights of these openings, reference is to be made to [9].

2.2

2.2.1 Machinery casing doors are to be of steel, hinged, ca-pable of being operated from both sides and of strength adequate to that of the casing bulkheads on which they are fitted.

3 Hatch coamings

3.1 Height

3.1.1 The height of hatch coamings closed by portable covers is to be not less than 300 mm.

Unless otherwise required by the flag Administration, the height of hatch coamings closed by steel covers pro-vided with gaskets and securing devices may be reduced with respect to the above value or the coamings may be omitted entirely; in such cases the scantlings of the covers, their gasketing and securing arrangements and the drainage of recesses will be subject to special considera-tion by Tasneef

3.2 Scantlings

3.2.1 Longitudinal coamings are to be extended at least to the lower edge of deck beams.

The plate thickness of coamings is to be not less than the thickness of the deck on the sides of hatchways.

In ships intended to carry liquid cargoes, the coaming thickness is to be not less than that required for oil tankers.

Hatch coamings which are 600 mm or more in height are to be stiffened by a substantial rolled section fitted 250 mm below their upper edges where the hatchways are closed by wooden covers and tarpaulins, and on their upper edges where weathertight steel covers are fitted.

Additional support is to be provided by fitting vertical brackets from the rolled section above to the deck below at intervals generally not exceeding 3 m.

Hatch coamings less than 600 mm in height are to be stiffened at their upper edge by a substantial rolled sec-tion and suitably spaced vertical brackets.

The scantlings of continuous side coamings will be specially considered in each case by Tasneef

4 Hatch covers

4.1 General

4.1.1 Hatch covers on exposed decks are to be weathertight and may be of the following types:

a) steel hatch covers, made of plate panels stiffened by webs or other stiffeners and secured to the hull by clamping devices; weathertightness is obtained by means of gaskets;

b) steel pontoon hatch covers, made of plate panels, suitably stiffened with welded webs extending for the full width of the hatchway; weathertightness is ob-tained by means of tarpaulins;

c) hatch covers of steel or wood (portable covers), supported by portable beams; weathertightness is ob-tained by means of tarpaulins.

Hatch covers in closed superstructures may be of any of the three types (a), (b) or (c) but need not be watertight.

However, where they are fitted in way of ballast tanks, fuel oil tanks or other tanks, hatch covers are to be of type (a) and tight.

Tank hatch covers in tankers of closed box type con-struction are to be provided with effective means of gas freeing.

The formulae for scantlings given in the following paragraphs are applicable to steel hatch covers.

The use of materials other than steel will be specially considered by Tasneef which will verify that criteria adopted for scantlings are such as to ensure strength and stiffness equivalent to those of steel covers.

Materials used for the construction of steel hatch cov-ers are to comply with the applicable requirements of Chapter 1, Section 3.

The formulae are applicable to rectangular hatch cov-ers with primary webs or stiffeners arranged in one direc-tion and subjected to a uniformly distributed load.

In the case of covers with primary stiffeners of the same height arranged in a grillage formation or covers carrying point loads, the scantlings are to be verified by direct calculations (see [4.4.3]).

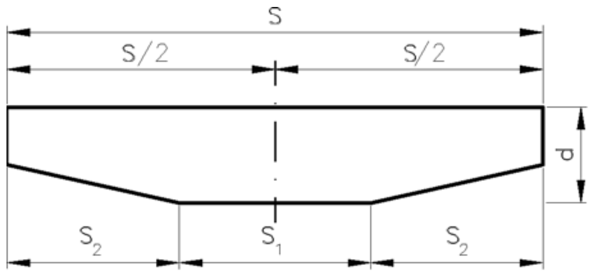
4.2 Definitions and symbols

4.2.1

- s : spacing of stiffening members supporting the cover, in m
- S : span of members, measured between end supports, in m (see Fig 1)
- S_1 : length of middle part of beam at constant height, in m (see Fig 1)
- S_2 : $(S - S_1)/2$,in m (see Fig 1)
- Z_0, J_0 : section modulus and moment of inertia of the transverse section of supporting member under consideration, at mid-span, in cm^3 and cm^4, respectively
- Z_1, J_1 : section modulus and moment of inertia of the transverse section of supporting member under consideration, at the ends, in cm^3 and cm4, respectively
- α : S_2 / S
- β : J_1 / J_0
- δ : Z_1 / Z_0
- C_0 : $1 + [(3{,}2\alpha - \delta - 0{,}8) / (7\delta + 0{,}4)]$, when $3{,}2\alpha > \delta + 0{,}8$
  = 1, in all other cases
- C_1 : $1 + 8\,\alpha^3 \cdot [(1 - \beta) / (0{,}2 + 3\beta^{0{,}5})]$

The values of the coefficients C_0 and C_1 are given for beams which do not present sharp section variations.

Figure 1



4.3 Loads for scantlings

4.3.1 The conventional load q, in kN/m², to be taken for scantlings of hatch covers on exposed decks irrespective of position, is given by the following formula:

$q = 11 \cdot |2 - D_H|$

where:

- D_H : distance of the hatch cover from the full load wa-terline, in m.

The load q is not to be taken as less than 10 kN/m².

Where the actual value of the load per surface unit acting on the hatch cover is greater than the value of q determined as above, such actual value is to be taken for q.

4.3.2 The scantlings of hatch covers supporting loads on closed decks are to be verified taking the value q, in kN/m², given by the following formula:

$q = 7{,}54\ \gamma_C \cdot h_{TD}$

where:

- h_{TD} : 'tweendeck height in way of the cover, in m
- γ_C : mass density of the load stowed on the cover, to be taken, as a rule, not less than 0,7 m³.
  Specific cases of loads with $\gamma_C < 0{,}7$ t/m³ will be considered individually by Tasneef

4.3.3 The scantlings of hatch covers in way of cargo tanks are also to be verified with the load q, in kN/m², corresponding to the head defined in Chapter 1, Section 5.

4.4 Steel covers

4.4.1 Plating

The plating thickness t of weathertight steel covers is to be not less than the greater of the following values t_1 and t_2, in mm:

$t_1 = 2{,}3\ s \cdot (q \cdot K)^{0{,}5}$ $\quad t_2 = 5\ s$

where s is the spacing of stiffeners, in m.

The plating thickness is, however, to be not less than the following values:

- 3 mm, for dry cargo hold hatch covers
- 4 mm, for cargo tank hatch covers.

The above-mentioned minimum values may be reduced where a suitable corrosion protection system is adopted (for example stainless or galvanised steel).

4.4.2 Webs and stiffeners

Webs and stiffeners, associated with a cover plating portion having a width equal to the spacing of the same webs and stiffeners, are to have a section modulus Z_0, in cm³, not less than the value given by the following for-mula:

$Z_0 = 1,29\ q \cdot s \cdot S_2 \cdot C_0 \cdot K \cdot f$

where:

- in the case of webs and stiffeners simply supported at both ends or with one support at one end and a clamp joint at the other:

  $f = f_1 = 1$

- in the case of webs and stiffeners clamped at both ends:

  $f = 2/3$ and $f_1 = 0,2$

4.4.3 Direct calculations

In the case of hatch covers of special construction or arrangement (e.g. hatch covers stiffened by a grillage forma-tion of stiffening members having the same height, hatch covers made of multiple panels supporting each other etc) or in the case of hatch covers carrying special cargoes (e.g. containers etc), the scantlings are to be checked by direct calculations.

Among the loading conditions to be assumed for cal-cula-tions, those corresponding to the loads given in [4.3] are to be included.

For calculations carried out according to conventional beam theory, the values of the permissible stresses amm and amm, in N/mm², are 127 and 70, respectively.

4.4.4 Gaskets and securing arrangements of hatch covers

The material used for gaskets is to be able to with-stand the action of the elements and, in the case of cargo tank hatch covers, the liquid cargo as well; the gaskets are to be effec-tively fitted along the edges of the hatch covers so as to ensure weathertightness.

Coamings and steel parts of hatch covers in contact with gaskets are not to have sharp edges.

The forces due to the weight of the hatch covers and the cargoes stowed on them are to be transferred to the coam-ings or the deck by direct contact obtained by means of suitable devices capable of withstanding such forces, while the weathertightness is to be achieved by a suitable and suf-ficiently soft gasket.

Metallic contact is required for an earthing connection between the hatch cover and the hull; if necessary, this is to be achieved by means of a special connection for the pur-pose.

The gasket and the securing and stopping arrange-ments are to maintain their efficiency also when subjected to the rela-tive movements between the cover and the coaming; if nec-essary, suitable devices are to be fitted to limit such movements.

The securing and stop arrangements are to be ar-ranged so as to ensure sufficient compression on gaskets between hatch covers and coamings and between adja-cent hatch covers.

The securing and stop arrangements are to be fitted using appropriate means which cannot be easily removed.

When hydraulically operated arrangements are used, they are to remain mechanically locked in a closed posi-tion in the event of failure of the hydraulic system.

The net cross-sectional area A, in cm², of each secur-ing arrangement is to be not less than that given by the follow-ing formula:

$A = 1,1\ a_S$

a_S being the spacing, in m, of the securing arrangements.

In the case of securing arrangements which are par-ticu-larly stressed due to the unusual width of the hatch-way, the net cross-sectional area A of the above securing arrange-ments is to be adequately increased.

The distribution and spacing of the securing arrange-ments are to be established in relation to the type and di-mensions of the hatch covers, the loads acting, the stiff-ness of the cover edges and taking account of the possi-bility of achiev-ing weathertightness.

In the case of securing arrangements made of high strength steel, the net cross-sectional area A may be de-termined taking account of the mechanical properties of the steel employed.

For end panels, securing arrangements fitted as close as possible to the hatchway edges are to be provided.

Hatch covers provided with special sealing devices, insu-lated hatch covers, flush hatch covers and those hav-ing coamings of a height reduced in respect of the Rule height will be considered by Tasneef in each case.

Securing arrangements with reduced scantlings may be accepted provided it can be demonstrated that the possibil-ity of water reaching the deck is negligible.

4.5 Corrugated metal covers

4.5.1 Hatch covers built of corrugated plates are to have a thickness not less than 1,5 mm if made of galvanised steel.

Their strength is to be equivalent to that of steel cov-ers cal-culated using the formulae in [4.4], taking for s the spacing of the corrugation for the calculation of the sec-tion modu-lus, and the larger side of the corrugation for the calculation of the thickness.

4.6 Portable hatch beams, portable covers and tarpaulins

4.6.1 Portable hatch beams

Portable hatch beams, whose spacing s does not generally exceed 1,50 m, are to have a section modulus Z_0, in cm³, and moment of inertia J0, in cm4, not less than those calcu-lated with the following formulae:

$Z_0 = 1,52\ q \cdot s \cdot S_2 \cdot C_0 \cdot K$

$J_0 = 2,87\ q \cdot s \cdot S_3 \cdot C_1$

Portable hatch beams are generally in the form of built girders having a web plate stiffened by continuous flat bars at its upper and lower edges; the minimum thickness of the web plate is to be not less than 3 mm.

Alternatively, direct calculations may be submitted for approval to Tasneef provided that the requirements of [4.4.4] are complied with.

A vertical 50 mm flat bar is to be welded onto the up-per face plate of beams which carry the ends of wood or steel portable covers.

The upper face plate of the beams is to be such that the width of bearing surface for hatch covers is not less than 65 mm.

The ends of the web plates of beams are to have in-creased thickness and their depth, as a rule, is to be not less than 150 mm for at least 180 mm of their length, so as to fit in the end supports; the latter are normally in the form of fork lug carriers, and are to have a minimum width of bearing surface of 75 mm and a thickness of at least 12,5 mm.

Portable hatch beams are to be adequately locked in the supports in order to prevent vertical movements.

4.6.2 Portable hatch beams

Portable covers, normally made of pine or fir wood, are to have a thickness of not less than 1/25 of the un-supported span, subject to a minimum of 30 mm. Where portable covers of material other than wood are used, their scantlings are to be such as to afford an equivalent strength.

Where the clear height for cargo above the hatchway in 'tweendeck cargo spaces exceeds 2,60 m, the thickness of the wood covers is to be increased at the rate of 1 mm for every 0,10 m in excess of the above-mentioned clear height.

The ends of wooden covers are to be protected by en-circling galvanised steel bands, 3,5 mm thick and 65 mm wide, efficiently secured by screws.

4.6.3 Tarpaulins

The weathertighness of hatch covers on exposed decks is to be ensured by fitting at least two layers of tarpaulin.

Tarpaulins are to be free from jute and waterproof and are to have adequate characteristics of strength and resis-tance to atmospheric agents and high and low temperatures.

In addition to tarpaulins made of vegetable fibres, those of synthetic fabrics or plastic laminates may be accepted by Tasneef provided their qualities, as regards strength, waterproofing and resistance to high and low temperatures, are suitable.

4.6.4 Cleats

The arrangements for securing tarpaulins to hatch coamings are to incorporate cleats of a suitable pattern giving support to battens and wedges and with edges so rounded as to minimise the risk of damage to the wedges. Cleats are to be spaced not more than 600 mm from cen-tre to centre and are to be not more than 150 mm from the hatch corners. The thickness of cleats is to be not less than 9,5 mm for angle cleats or 11 mm for forged cleats. In both cases cleats are to be suitably stiffened.

4.6.5 Wedges, battens and locking bars

Wedges are to be of tough wood, generally not more than 200 mm in length and 50 mm in width.

As a rule, they are to have a taper of not more than 1:6 and thickness not less than 13 mm.

For all hatchways in exposed positions, battens or transverse bars in steel or other equivalent means are to be provided in order to efficiently secure the portable cov-ers after the tarpaulins are battened down.

Portable covers of more than 1,5 m in length are to be secured by at least two such securing appliances.

5 Small hatchways

5.1

5.1.1 The number and size of small hatchways for trimming and access openings to tanks or other enclosed spaces are to be kept to the minimum consistent with the satisfactory operation of the ship. The height of coamings is generally to be not less than that indicated in Appendix 5 "Conditions for the assignment of freeboard".

Unless otherwise specified by the flag Administration, where the closing appliances are in the form of hinged steel covers secured weathertight by gaskets and swing bolts, the height of the coamings may be reduced or the coamings may be omitted altogether.

The coaming plate thickness is to be not less than the Rule minimum thickness required for decks.

The scantlings of the stiffeners of the coaming are to be appropriate to its length and height.The formulae for scantlings given in the following paragraphs are applicable to steel hatch covers.

5.2

5.2.1 Small hatch covers are to have a strength equivalent to that required for main hatchways and are to be of steel, weathertight and generally hinged. Securing arrange-ments are to be such that weathertightness can be main-tained in any sea condition.

At least one securing device is to be fitted at each side; circular hole hinges are considered equivalent to se-curing devices.

5.3

5.3.1 Escape hatches are to be capable of being opened from either side.

5.4

5.4.1 Hatchways of special design will be specially consid-ered.

6 Engine room skylights

6.1

6.1.1 Engine room skylights are to be of substantial construction and securely attached to the deck and, where fitted with opening-type covers providing light and air, the height of the coaming is generally to be not less than 450 mm.

7 Ventilation intakes and oulets - air pipes

7.1

7.1.1 The requirements of Appendix 1 "Conditions for the assignment of freeboard" apply.

The height of air pipes above the upper surface of decks is to be not less than 450 mm, and air pipes are to be fitted with non-return valves so that their operation is ensured even if they are installed in a position exposed to the weather.

8 Scuppers and discharges

8.1

8.1.1 All exposed decks are to be fitted with scuppers in such number and with such dimensions as to ensure wa-ter discharge overboard.

All enclosed spaces and sanitary discharges are to discharge into special drainage tanks provided with suc-tion systems.

If scuppers and discharge pipes discharging over-board pass through cargo holds, their thickness is to be equal to the outer shell thickness in way of ship ends, but need not be greater than 8 mm.

9 Doors, openings and associated coamings

9.1 Doors

9.1.1 All outside doors of superstructures, deckhouses and companionways situated on the freeboard deck are to be weathertight.

All access openings in exposed bulkheads and walls of superstructures, deckhouses and companionways which give access to spaces below the freeboard deck are to be fitted with weathertight closures.

9.2 Openings and associated coamings

9.2.1 The coamings of hatchways, companionways and ac-cess openings to superstructures are to be not less than 300 mm high.

If the coamings are less than 300 mm high, the difference between 300 mm and their actual height is to be added to the minimum freeboard.

Coamings of outside access openings of super-structures, deckhouses and companionways, other than cargo hatches, may be less than 300 mm high without any increase of the freeboard required, provided that the clos-ing devices of the openings are watertight.

Cargo hatchways and other openings situated in exposed positions on the freeboard deck of ships of type A are to be fitted with weathertight closures.

Access ports, companionways and other open-ings on sunk forecastles or raised quarterdecks are to be fitted with weathertight closures and coamings not less than 150 mm high.

The coamings of ventilators and air pipes on the exposed parts of the freeboard deck are to be not less than 600 mm high, and their openings are to be provided with efficient closures.

Pipe outlets in the ship sides below the freeboard deck are to be fitted with efficient and accessible devices to prevent water from entering the ship.

Sidescuttles below the freeboard deck are to be watertight and be provided with permanently attached deadlights. Windows in superstructures, deckhouses and companionways and windows in skylights situated on the freeboard deck, however, need only be weathertight. The distance between sidescuttles in the shell and the maxi-mum draught level is to be not less than 300 mm.

The scuppers and freeing ports in bulwarks are to be of sufficient size to drain the decks of shipped water.

10 Safety clearance, freeboard and draught marks

10.1

10.1.1 *(1/3/2019)*

For such requirements, reference is to be made to Ch.4 ES TRIN 2017/1.

Additional requirements, if any, are to be considered on the basis of the provisions stated in Part B, Ch 6 of these Rules.

Part B
Hull and Stability

Chapter 5
TESTS

SECTION 1 TESTS

SECTION 1 TESTS

1 Pressure tests

1.1 General

1.1.1 Tanks intended to carry liquids, double bottoms and cofferdams are to be hydraulically tested according to the proce-dure given in [1.1.2].

As an alternative to the hydraulic test, the above compartments may be subjected to a leak test using air, according to the procedure given in [1.1.3], when, in the opinion of Tasneef the latter is considered significant also in relation to the con-struction techniques and the welding procedure adopted. In such cases Tasneef may require some of the tanks, double bottoms or cofferdams to be subjected to a hydraulic test. Cargo tanks of tankers and similar may also be subjected to a leak test using air, apart from cargo tanks intended for dangerous chemicals, which are always to be subjected to a hydraulic test for all tanks, and cargo tanks intended for liquefied gases, to which the special requirements of Section I apply. In all cases bulkheads separating cargo tanks from cofferdams, pump rooms, machinery spaces or segregated ballast tanks are to be subjected to a hydraulic test.

Peak tank bulkheads not forming boundaries of tanks are to be tested by filling the peak tanks with water to the level of the full load waterline.

The chain locker, where arranged aft of the collision bulkhead, is to be filled with water for testing.

Pressure tests are to be carried out before cement is applied and after air vents, sounding pipes etc are fitted.

A "Pressure test plan" giving indications relating to test procedures for the various compartments is to be submitted to Tasneef for approval.

1.1.2 Hydraulic test

The value of the test head is to be the highest of the values stated in (a), (b) and (c):

a) the value corresponding to the top of the overflow pipe;

b) the value corresponding to a point located at a height h, in m, above the tank top, h being the higher of the values ob-tained by the following formulae:

   $h = 1 + 0,05(L - 50) \cdot r'$

   $h = 100\ p_{PV}$

   where L is to be taken not less than 50 m and not exceeding 80 m, p_{PV} is as defined in Chapter 1, Section 5, and r' either as in Chapter 1, Section 5 or equal to 1,44, whichever is the lesser;

c) (c)the value corresponding to r metres above the top of the trunk or the hatchway coaming, for tanks with trunks or deep tanks also intended for the carriage of liquids, respectively.

However, in the case of deep tanks intended for water ballast only, the test head may be limited to the upper edge of the hatch coaming and the weathertightness of the hatch cover, in way of the gasket, may be verified by means of hose testing as specified in [1.2.1].

The test head of tanks independent of the hull structure is to be taken equal to that corresponding to the top of the overflow pipe, but is, in any case, to be not less than 1 m.

Hydraulic testing is in general required to be carried out before any type of protective coating is applied to the structures. Tasneef may, however, allow the testing to take place after the application of the coating, subject to the compartment passing a careful inspection of all welded connections.

Whenever possible, hydraulic testing is to be carried out on the building berth or dock.

1.1.3 Leak test using air

Weathertightness is to be verified by applying a soapy water solution to the connections.

It is recommended that the air pressure in the tank is initially raised, with due care, to 0,02 N/mm² and then lowered to 0,015 N/mm², prior to inspection.

The test pressure is to be verified by means of two master pressure gauges and a U-tube; the latter is to have a cross-section larger than that of the pipe supplying air such as to act as a relief valve.

The leak test using air normally takes place before any preservative coating is applied. However, at Tasneef discretion and subject to careful visual inspection, permission may be granted for the test to be carried out after the application of the coating, in particular in way of welds made by automatic welding processes.

In this case, as a rule, specific non-destructive tests will be required with procedures to be defined in the individual cases.

2 Hose tests

2.1 Weathertight and watertight closing appliances

2.1.1 All weathertight and watertight closing appliances which are not hydrostatically tested are to be hose tested at a pres-sure not less than 0,2 N/mm² at the bore of the nozzle, the latter being held at about 2 m from the point to be tested.

2.2 Subdivision watertight bulkheads, shaft tunnels and recesses

2.2.1 Subdivision watertight bulkheads, shaft tunnels and recesses, if any, including any watertight doors, are to be tested on completion by a jet of water having a pressure of not less than 0,2 N/mm² at the bore of the nozzle, the latter being held at about 2 m from the point to be tested.

2.3 Shell and deck plating

2.3.1 Shell and deck plating riveted seams, if any, for which watertightness is required and which are not hydrostatically tested are to be tested by a jet of water having a pressure of not less than 0,2 N/mm² at the bore of the nozzle, the latter being held about 2 m from the point to be tested.

3 Testing of watertight doors

3.1 General

3.1.1 In general, before installation on board, watertight doors of subdivision bulkheads are to be hydraulically tested ashore with a head corresponding to the maximum head to which they may be subjected. In exceptional cases Tasneef may allow the test to be carried out after installation on board, by a procedure to be established in each individual case.

Part B
Hull and Stability

Chapter 6
STABILITY

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 All ships equal to or greater than 24 m in length may be assigned class only after it has been demonstrated that their intact stability is adequate for the service intended. Adequate intact stability means compliance with standards laid down by the relevant Administration or with the requirements specified in this Chapter taking into account the ship's size and type. In any case, the level of intact stability is not to be less than that pro-vided by the Rules.

1.1.2 Ships less than 24 m in length

The Rules also apply to ships less than 24 m in length. In this case, the requirements concerned may be partially omitted subject to the agreement of the Society.

1.1.3 Approval of the Administration

When the Administration of the State whose flag the ship is entitled to fly has issued specific rules covering stability, the Society may accept such rules for classification purposes in lieu of those given in this Chapter.

Evidence of approval of the stability by the Administration concerned may be accepted for the purpose of classification. In cases of application of the above requirements an appropriate entry is made in the classifica-tion files of the ship.

2 Examination procedure

2.1 Documents to be submitted

2.1.1 List of documents

For the purpose of the examination of the stability, the following plans and documents are to be submitted to the Society for information:

- general arrangement
- lines plan
- hydrostatic curves
- lightweight distribution.

The stability documentation to be submitted for approval, as indicated above, is as follows:

a) Inclining test report for the ship, as required in [2.2] or:

   - where the stability data is based on a sister ship, the inclining test report of that sister ship along with the light-ship measurement report for the ship in question;

   or

   - where lightship particulars are determined by methods other than inclining of the ship or its sister, the
   - lightship measurement report of the ship along with a summary of the method used to determine those particulars as indicated in [2.2.4].

b) trim and stability booklet, as required in Sec 2, [1.1.1]

2.1.2 Provisional documentation

The Society reserves the right to accept or demand the submission of provisional stability documentation for examination. Provisional stability documentation includes loading conditions based on estimated lightship values.

2.1.3 Final documentation

Final stability documentation based on the results of the inclining test or the lightweight check is to be submitted for examination.

When provisional stability documentation has already been submitted and the difference between the es-timated values of the lightship and those obtained after completion of the test is less than:

- 2% for the displacement, and,
- 1% of the length between perpendiculars for the longitudinal position of the centre of gravity, and the determined vertical position of the centre of gravity is not greater than the estimated vertical position of the centre of gravity, the provisional stability documentation may be accepted as the final stability documentation.

2.2 Inclining test/lightweight check

2.2.1 Definitions

a) Lightship

   The lightship is a ship complete in all respects, but without consumables, stores, cargo, and crew and effects, and without any liquids on board except for machinery and piping fluids, such as lubricants and hydrau-lics, which are at operating levels.

b) Inclining test

   The inclining test is a procedure which involves moving a series of known weights, normally in the trans-verse direction, and then measuring the resulting change in the equilibrium heel angle of the ship. By using this information and applying basic naval architecture principles, the ship's vertical centre of gravity (VCG or KG) is determined.

c) Lightweight check

   The lightweight check is a procedure which involves auditing all items which are to be added, deducted or relocated on the ship at the time of the inclining test so that the observed condition of the ship can be adjusted to the lightship condition. The weight and longitudinal, transverse and vertical location of each item are to be accurately determined and recorded. The lightship displacement and longitudinal centre of gravity (LCG) can be obtained using this information, as well as the static waterline of the ship at the time of the inclining test as determined by measuring the freeboard or verified draught marks of the ship, the ship's hydrostatic data and the sea water density.

2.2.2 General

Any ship for which a stability investigation is requested in order to comply with class requirements is to be ini-tially subjected to an inclining test permitting the evaluation of the position of the lightship centre of gravity, or a lightweight check of the lightship displacement, so that the stability data can be determined. Cases for which the inclining test is required and those for which the lightweight check is accepted in its place are listed in [2.2.4] and [2.2.5].

The inclining test or lightweight check is to be attended by a Surveyor of the Society. The Society may ac-cept inclining tests or lightweight checks attended by a member of the flag Administration.

The inclining test is adaptable to ships less than 24 m in length, provided that precautions are taken, on a case-by-case basis, to ensure the accuracy of the test procedure.

For cargo ships having length less than 20 metres, irrespective of their navigation, at the discretion of the Society, instead of the inclining test, one or more practical stability test(s) relevant to the most severe condi-tions foreseen in real service may be carried out.

For passenger ships having length less than 20 m, at the discretion of the Society, instead of the inclin-ing test, a practical stability test relevant to the most severe conditions foreseen in real service and a practi-cal passenger crowding test may be carried out.

In such cases a report is to be prepared relevant to the tested loading conditions containing restrictions in the loading conditions and/or in ballasting, if any, which, duly approved by the Society, is to replace the pre-scribed stability booklet.

2.2.3 Inclining test

The inclining test is required in the following cases:

- any new ship, after its completion, except for the cases specified in [2.2.4]
- any ship, if deemed necessary by the Society, where any alterations are made so as to materially affect the sta-bility.

2.2.4 Lightweight check

Tasneef may allow a lightweight check to be carried out in lieu of an inclining test in the case of:

a) an individual ship, provided basic stability data are available from the inclining test of a sister ship and a lightweight check is performed in order to prove that the sister ship corresponds to the prototype ship. The lightweight check is to be carried out upon completion of the ship. The final stability data to be considered for the sister ship in terms of displacement and position of the centre of gravity are those of the prototype. Whenever, in comparison with the data derived from the prototype, a deviation from the lightship displacement exceeding 1% for ships of 160 m or more in length, or 2% for ships of 50 m or less in length, or as determined by linear interpolation for intermediate lengths, or a deviation from the lightship longitudinal centre of gravity exceeding 0,5% of Ls is found, the ship is to be inclined.

b) special types of ships, such as pontoons, provided that the vertical centre of gravity is considered at the level of the deck.

c) special types of ships, such as catamarans, provided that:
   - a detailed list of weights and the positions of their centres of gravity is submitted
   - a lightweight check is carried out, showing accordance between the estimated values and those determined
   - adequate stability is demonstrated in all the loading conditions reported in the trim and stability booklet.

2.2.5 Detailed procedure

A detailed procedure for conducting an inclining test is included in App 1.

3 Definitions

3.1

3.1.1 The following definitions shall be considerd in this Chapter :

- plane of maximum draught: the water plane corresponding to the maximum draught at which the craft is authorized to navigate;
- safety clearance: the distance between the plane of maximum draught and the parallel plane passing through the lowest point above which the craft is no longer deemed to be watertight;
- residual safety clearance: the vertical clearance available, in the event of the vessel heeling over, between the water level and the lowest point of the immersed side, beyond which the vessel is no longer regarded as watertight;
- freeboard (f): the distance between the plane of maximum draught and a parallel plane passing through the lowest point of the gunwale or, in the absence of a gunwale, the lowest point of the upper edge of the ship's side;
- residual freeboard: the vertical clearance available, in the event of the vessel heeling over, between the water level and the upper surface of the deck at the lowest point of the immersed side or, if there is no deck, the lowest point of the upper surface of the fixed ship's side;
- margin line: an imaginary line drawn on the side plating not less than 10 cm below the bulkhead deck and not less than 10 cm below the lowest non-watertight point of the side plating. If there is no bulkhead deck, a line

drawn not less than 10 cm below the lowest line up to which the outer plating is watertight shall be used;

- water displacement( ): the immersed volume of the vessel, in m3;
- displacement: the total weight of the vessel, inclusive of cargo, in t;
- block coefficient (CB): the ratio between the water displacement and the product of length LWL, breadth BWL and draughtT;
- lateral plane above water (AV): lateral plane of the vessel above the waterline in m^2;

SECTION 2 INTACT STABILITY

1 General

1.1 Information for the Master

1.1.1 Stability booklet

Each ship is to be provided with a stability booklet, approved by the Society, which contains sufficient information to enable the Master to operate the ship in compliance with the applicable requirements contained in this Section.

Where any alterations are made to a ship so as to materially affect the stability information supplied to the Master, amended stability information is to be provided. If necessary the ship is to be re-inclined.

Stability data and associated plans are to be drawn up in the official language or languages of the issuing country. If the languages used are neither English nor French, the text is to include a translation into one of these languages.

The format of the trim and stability booklet and the information included are specified in App 2.

1.1.2 Loading instrument

As a supplement to the approved stability booklet, a loading instrument, approved by the Society, may be used to facilitate the stability calculations mentioned in App 2.

A simple and straightforward instruction manual is to be provided. In order to validate the proper function-ing of the computer hardware and software, pre-defined loading conditions are to be run in the loading in-strument periodically, at least at every periodical class survey, and the print-out is to be maintained on board as check conditions for future reference in addition to the approved test conditions booklet.

1.1.3 Operating booklets for certain ships

Ships with innovative design are to be provided with additional information in the stability booklet such as design limitations, maximum speed, worst intended weather conditions or other information regarding the han-dling of the craft that the Master needs to operate the ship.

1.2 Permanent ballast

1.2.1 If used, permanent ballast is to be located in accordance with a plan approved by the Society and in a manner that prevents shifting of position. Permanent ballast is not to be removed from the ship or relocated within the ship without the approval of the Society. Permanent ballast particulars are to be noted in the ship's stability booklet.Where any alterations are made to a ship so as to materially affect the stability information supplied to the Master, amended stability information is to be provided. If necessary the ship is to be re-inclined.

1.2.2 Permanent solid ballast is to be installed under the supervision of the Society.

2 Design criteria

2.1 General intact stability criteria

2.1.1 General

The intact stability criteria are generally to be complied with for the loading conditions mentioned in App 2, [1.2].

However, the lightship condition not being an operational loading case, the Society may accept that part of the above-mentioned criteria are not fulfilled.

These criteria set minimum values, but no maximum values are recommended. It is advisable to avoid ex-cessive values of metacentric height, since these might lead to acceleration forces which could be prejudicial to the ship, its equipment and safe carriage of the cargo.

2.1.2

For ships having length not more than 24 m, it may be accepted that it is only verified that the initial metacentric height GMo is not less than 0,35 m, except in the lightship condition for which a positive value can be accepted.

For ships greater than 24 m, the intact stability is to be verified according to the criteria given from [2.1.3] to [2.1.5].

In addition, for each service notation the requirements given in [3] are also to be complied with.

2.1.3 GZ curve area

The area under the righting lever curve (GZ curve) is to be not less than 0,055 m.rad up to = 30° angle of heel and not less than 0,09 m.rad up to f = 40° or the angle of down flooding J f if this angle is less than 40°. Additionally, the area under the righting lever curve (GZ curve) between the angles of heel of 30° and 40° or between 30°and J, if this angle is less than 40°, is to be not less than 0,03 m.rad.

Note 1: J is an angle of heel at which openings in the hull, superstructures or deckhouses which cannot be closed weathertight submerge. In applying this criterion, small openings through which progressive flooding cannot take place need not be considered as open.

2.1.4 Minimum righting lever

The righting lever GZ is to be at least 0,20 m at an angle of heel equal to or greater than 30°.

When the righting lever curve has a shape with two maximums, the first is to be located at a heel angle not less than 25°.

In cases of ships with a particular design, the Society may accept an angle of heel Jmax less than 25° but in no case less than 15°, provided that the area "A" below the righting lever curve is not less than the value ob-tained, in m.rad, from the following formula:

$A = 0,055 + 0,001 (30° - \theta_{max})$

where θ_{max} is the angle of heel in degrees at which the righting lever curve reaches its maximum.

2.1.5 Initial metacentric height

The initial metacentric height GM_0 is not to be less than 0,15 m.

2.1.6 Passenger ships of not more than 24 m in length and carrying not more than 150 passengers

The intact stability check of passenger ships having a length not more than 24 m and carrying not more than 150 passengers is to be carried out in conformity with [2.1.2]. For such vessels the requirements listed from item a) to g) are also to be satisfied.

a) Standard requirements

The requirements in [2.1.2] to [2.1.5] are to be complied with for the loading conditions defined in App 2.

b) Crowding of passengers

The angle of heel on account of crowding of passengers to one side as defined may not exceed 10° and in any event the freeboard deck is not to be immersed.

For ships less than 20 m in length, the angle of heel is not to be greater than the angle corresponding to a freeboard of 0,1 m before the deck's immersion, or 12° if this is less.

c) Maximum turning angle

The angle of heel on account of turning may not exceed 10° when calculated using the following formula:

$$M_R = 0,02 \frac{V_0^2}{L_s} \Delta \left(KG - \frac{T_1}{2} \right)$$

where:

M_R : Heeling moment, in t

V_0 : Service speed, in m/s

T_1 : Mean draught, in m

KG : Height of centre of gravity above keel, in m.

d) Where anti-rolling devices are installed in a ship, the Society is to be satisfied that the above criteria can be maintained when the devices are in operation.

e) Stability criteria

1) Loading conditions

In addition to the loading conditions considered in App 2, the loading condition at arrival, without cargo, with necessary water ballast, with all passengers, on all decks assigned to them, crowded on the same side of the ship, is also to be considered. If in any real loading condition the stability of the ship is less favourable than in the requested conditions, the stability requirements are also to be checked in such real condition.

In elaborating the stability booklet, the following is to be assumed:

- weight of each person equal to 75 kg;
- centre of gravity of each person, both standing and sitting, equal to 0,90 m above the upper surface of the relevant deck;
- maximum allowable number of persons equal to the number of sitting places plus two passengers/m^2 in the areas available for passengers, clear from the persons seated.

A higher number of standing persons may be assumed provided that the competent authority agrees.

In calculating the area in which the passengers are crowded among the benches, the distance between two of them may be reduced by 0,3 m x l (length of the bench) to exclude the area obstructed by sitting pas-sengers.

2) Stability requirements in all required loading conditions

The following stability requirements are to be complied with:

- (r-a) to be not less than 0,35 m.

  To this end passengers are to be considered accommodated taking all the sitting places and areas assigned to them with 4 passengers/m2, starting from the highest deck and proceeding to lower decks until the maximum allowable number of passengers is exceeded;
- Distance between the upper surface of the main deck, at side, from the waterline in the final equilibrium status of heeled ship (residual minimum freeboard) to be not less than 0,20 m. For this purpose, passengers are to be considered accommodated on one side of the ship only, from the ship's centreline, taking all the sitting places and areas assigned to them with 4 passengers/m^2, starting from the highest deck and proceeding to lower decks until the maximum allowable number of passengers is exceeded.

  If the number of all the passengers on one side of the ship does not reach the maximum allowable number, the surplus of passengers is to be ignored in calculating the transverse heeling of the ship.
- The maximum allowable number of passengers is to be the lower of 1 and 2 above. Such number may be further reduced taking into account the following:
  - if the value calculated according to 1 leads to a value of (r-a) less than 0,30 m and this cannot be avoided by the use of ballast of the ship, or by other suitable operations, such number is to be decreased in the calculation by unloading a suitable number of passengers, starting from the lower deck, until (r-a) not less than 0,30 m is reached. Therefore, the resulting reduced number of passengers is to replace the one resulting from 1

- if the residual freeboard, calculated through the passenger distribution according to 2, is less than 0,20 m and it cannot be increased by ballasting the ship, or by other suitable operations, the number of passengers calculated according to 2 is to be decreased in the calculation by unloading a suitable number of passengers, starting from those standing closest to the midship plane on the lower deck. Obviously, in such operation an upper deck is not affected by unloading of passengers as far as first all those standing, and then those sitting, in the lower deck are unloaded.

  The resulting reduced number of passengers is to replace the one resulting from 2.
- In the case of longitudinal obstructions, such as seats, railings or nets, fitted to prevent passengers from crowding on one side of the ship, the Society may, at its discretion, relax the above-mentioned requirements, reducing the level of crowding of standing persons. Such longitudinal obstructions may be partially movable for the purpose of ensuring a suitable distribution of embarking passengers; nevertheless, the crew undertakes to put the longitudinal obstructions temporarily removed back in place, before the voyage starts.
- To facilitate the calculations, it is permissible not to take into account both the shear and the camber of the ship, but to evaluate the vertical positions of all the centres of gravity referring to the section at ½ L.
- Any opening sidescuttles located below the upper deck which, because of the transverse heeling of the ship, may have their lowest point less than 0,20 m above the final waterline, are to be fitted with efficient devices such that they can be effectively closed and secured, under the Master's responsibility, while the passengers are on board. Such condition is to be noted in the ship's logbook. It is allowable in the calculations that such sidescuttles are partially or fully submerged at the end of the heeling.
- In the case of decked ships of length less than 20 m, item b) applies except that the required residual freeboard on the side of passenger crowding, to be not less than 0,20 m, is to correspond to a heeling angle not more than 15°. In the case of ships without decks, the residual freeboard after heeling due to the crowding of passengers on one side of the ship is to be not less than 0,30 m with an angle of heel not greater than 15°.

f) Elements affecting stability

A number of influences, such as beam wind on ships with a large windage area, icing of topsides, water trapped on deck, rolling characteristics, following seas etc, which adversely affect stability are to be taken into account.

g) Elements reducing stability

Provisions are to be made for a safe margin of stability at all stages of the voyage, regard being given to ad-ditions of weight, such as those due to absorption of water and icing (details regarding ice accretion are given in [6]) and to losses of weight such as those due to consumption of fuel and stores.

3 Stability criteria according to the type of ship

3.1 Passenger ships

3.1.1 Standard loading conditions

The requirements of this paragraph apply to passenger ships other than those indicated in [2.1.2].

The intact stability is to be proven for the following standard load conditions:

a) at the start of the voyage:

100% passengers, 98% fuel and fresh water, 10% waste water;

b) during the voyage:

100% passengers, 50% fuel and fresh water, 50% waste water;

c) at the end of the voyage:

100% passengers, 10% fuel and fresh water, 98% waste water;

d) unladen vessel:

no passengers, 10% fuel and fresh water, no waste water.

For all standard load conditions, the ballast tanks are to be considered as either empty or full in accor-dance with normal operational conditions.

As a precondition for changing the ballast whilst underway, the requirements of [3.1.3] to [3.1.5] are to be proved for the following load condition:

100% passengers, 50% fuel and fresh water, 50% waste water, all other liquid (including ballast) tanks are considered filled to 50%.

3.1.2 GZ curve area

The area under the righting lever curve (GZ curve) is to be not less than 0,055 m.rad up to J = 30° angle of heel and not less than 0,09 m.rad up to J = 40° or the angle of down flooding Jf if this angle is less than 40°. Additionally, the area under the righting lever curve (GZ curve) between the angles of heel of 30° and 40°, or between 30° and J_f, if this angle is less than 40°, is to be not less than 0,03 m.rad.

Note 1: J_f is an angle of heel at which openings in the hull, superstructures or deckhouses which cannot be closed weathertight submerge. In applying this criterion, small openings through which progressive flooding cannot take place need not be considered as open.

3.1.3 Minimum righting lever

The righting lever GZ is to be at least 0,20 m at an angle of heel equal to or greater than 30°.

3.1.4 Angle of maximum righting lever

The maximum righting arm is to occur at an angle of heel preferably exceeding 30° but not less than 25°.

When the righting lever curve has a shape with two maximums, the first is to be located at a heel angle not less than 25°.

In cases of ships with a particular design, the Society may accept an angle of heel Jfmax less than 25° but in no case less than 15°, provided that the area "A" below the righting lever curve is not less than the value obtained, in m.rad, from the following formula:

$A = 0{,}055 + 0{,}001\ (30° - q_{max})$

where J_{fmax} is the angle of heel in degrees at which the righting lever curve reaches its maximum.

3.1.5 Initial metacentric height

The initial metacentric height GM0 is not to be less than 0,15 m.

3.1.6 Elements affecting stability

A number of influences, such as beam wind on ships with a large windage area, icing of topsides, water trapped on deck, rolling characteristics, following seas etc, which adversely affect stability are to be taken into account.

3.1.7 Elements reducing stability

Provisions are to be made for a safe margin of stability at all stages of the voyage, regard being given to ad-ditions of weight, such as those due to absorption of water and icing (details regarding ice accretion are given in [5]) and to losses of weight, such as those due to consumption of fuel and stores.

3.1.8 Moment due to crowding of passengers *(1/1/2017)*

The heeling moment due to one-sided accumulation of persons is to be calculated according to the following formula:

$Mp = g \cdot P \cdot y = g \cdot \Sigma\ Pi \cdot yi$ (kNm)

where:

- P : total mass of persons on board in (t), calculated by adding up the maximum permitted number of passengers and the maximum number of shipboard personnel and crew under normal operating conditions, assuming an average mass per person of 0,075 t ;
- y : lateral distance of centre of gravity of total mass of persons P from centreline in (m);
- g : acceleration of gravity ($g = 9{,}81\ m/s^2$);
- P : mass of persons accumulated on area Ai in (t)
- P_i : $n_i \cdot 0{,}075 \cdot A_i$ (t)

  where:

  - A_i : area occupied by persons in (m^2)
  - n_i : number of persons per square metre
  - n_i : 3,75 for free deck areas and deck areas with movable furniture; for deck areas with fixed seating furniture such as benches, n_i is to be calculated by assuming an area of 0,5 m in width and 0,75 m in seat depth per person
- y_i : lateral distance of geometric centre of area Ai from centreline in (m).

The calculation is to be carried out for an accumulation of persons both to starboard and to port.

The distribution of persons is to correspond to the most unfavourable one from the point of view of stability.

Cabins are to be assumed unoccupied for the calculation of the persons' moment.

For the calculation of the loading cases, the centre of gravity of a person is to be taken as 1 m above the lowest point of the deck at 0,5 LWL, ignoring any deck curvature and assuming a mass of 0,075 t per person.

A detailed calculation of deck areas which are occupied by persons may be dispensed with if the following values are used:

$P = 1{,}1 \cdot F_{max} \cdot 0{,}075$ for day trip vessels

$1{,}5 \cdot F_{max} \cdot 0{,}075$ for cabin vessels

where:

F_{max} = maximum permitted number of passengers on board

y = B/2 in (m).

day trip vessel = a passenger vessel without overnight passenger cabins;

cabin vessel = a passenger vessel with overnight passenger cabins.

3.1.9 Moment due to lateral wind pressure *(1/1/2017)*

The moment due to wind pressure (Mw) is to be calculated as follows:

$Mw = pw \cdot Aw \cdot (lw+T/2)$ (kNm)

where:

pw = the specific wind pressure, in kN/m^2, defined in Tab 1;

Table 1 : Specific wind pressure

Range of navigation	Pw, in kN/m^2
IN (1,2), IN (2)	0,25
IN (0), IN (0,6)	0,15

Aw = lateral plane of the vessel above the plane of draught according to the considered loading condition in m^2; in calculating the lateral plane, account shall be taken of the intended enclosure of the deck by awnings and similar mobile installations.

lw = distance of the centre of gravity of the lateral plane AW from the plane of draught according to the considered loading condition in m.

3.1.10 Turning circle moment

The moment due to centrifugal force (Mdr), caused by the turning of the vessel, is to be calculated as follows:

$Mdr = cdr \cdot CB \cdot v^2 \cdot D/LWL \cdot (KG - T/2)$ (kNm)

where:

cdr = a coefficient of 0,45;

CB = block coefficient (if not known, taken as 1,0);

v = maximum speed of the vessel in m/s;

KG = distance between the centre of gravity and the keel line in m;

D = displacement of the vessel (t)

For passenger vessels with propulsion systems (rudder propeller, water jet, cycloidal propeller and bow thruster) Mdr is to be derived from fullscale or model tests or else from corresponding calculations.

3.1.11 Maximum list angle and minimum freeboard height

a) Under the action of the above heeling moment acting not simultaneously the heeling angle shall be not more than of 12°.

b) For a heeling moment resulting from moments due to passengers, wind and turning according to [3.1.8], [3.1.9] and [3.1.10] the residual freeboard shall be not less than 200 mm.

c) For vessels with windows or other openings in the hull located below the bulkhead decks and not closed watertight, the residual safety clearance is to be at least 100 mm on the application of the three heeling moments resulting from subparagraph (b).

3.1.12 Safety clearance and freeboard

a) The safety clearance is to be at least equal to the sum of:

   1) the additional lateral immersion, which, measured on the outside plating, is produced by the permissible heeling angle according to [3.1.11] a), and

   2) the residual safety clearance according to [3.1.11] c).

   For vessels without a bulkhead deck, the safety clearance is to be at least 500 mm.

b) The freeboard is to be at least equal to the sum of:

   1) the additional lateral immersion, which, measured on the outside plating, is produced by the heeling angle according toaccording to [3.1.11] a), and

   2) the residual freeboard according to [3.1.11] b).

   However, the freeboard is to be at least 300 mm.

c) The plane of maximum draught is to be set so as to

   ensure compliance with the safety clearance according to [3.1.12]a) and the freeboard according to [3.1.12]b).

3.2 Intact stability criteria applicable to floating equipment

3.2.1 Definition and documentation to be submitted

Floating equipment is to be intended as a floating installation carrying working gear such as cranes, dredging equipment, pile drivers or elevators.

Stability confirmation is to include the following data and documents:

a) scale drawings of floats and working gear and the detailed data relating to these that are needed to confirm stability, such as content of the tanks, openings providing access to the inside of the vessel etc;

b) hydrostatic data or curves;

c) curves for the static stability lever curve;

d) description of the operating conditions together with the corresponding data concerning weight and centre of gravity, including the equipment's unladen state and the situation as regards transport;

e) calculation of the heeling, trimming and righting moments, with specification of the trim and heeling angles and the corresponding residual freeboard and residual safety clearances;

f) compilation of the results of the calculation with specification of the limits for operation and the maximum loads.

3.2.2 Load assumptions

Confirmation of stability is to be based on at least the following load assumptions:

a) specific mass of the dredging products for dredgers:
   - sands and gravels: 1,5 t/m^3,
   - very wet sands: 2,0 t/m^3,
   - soil, on average: 1,8 t/m^3,
   - mixture of sand and water in the ducts: 1,3 t/m^3;

b) for clamshell dredgers, the values given under point (a) are to be increased by 15%;

c) for hydraulic dredgers the maximum lifting power is to be considered.

3.2.3 Stability confirmation

Confirmation of stability is to take account of the moments resulting from:

a) load;

b) asymmetrical structure;

c) wind pressure;

d) turning whilst underway of self-propelled floating equipment;

e) cross-current, if necessary;

f) ballast and provisions;

g) deck loads and, where appropriate, cargo;

h) free surfaces of liquids;

i) inertia forces;

j) other mechanical equipment.

The moments which may act simultaneously are to be added up.

3.2.4 Stability Requirements

It is to be verified that, taking into account the loads applied during the use and operation of the working gear, and the residual safety clearance and the residual freeboard are not less than:

a) residual safety clearance:
   - 0,30 m for watertight and weathertight aperture;
   - 0,40 m for non-weathertight openings;

b) residual freeboard
   - The residual freeboard value is to be not less than 0,30 m.
   - The sum of the list and trim angles is not to exceed 10° and the base of the hull is not to emerge.

3.2.5 Stability assessment

The stability assessment is to be carried out considering the heeling moments defined in [3.2.6] to [3.12].

The moments which may act simultaneously are to be added up.

3.2.6 Load-induced moment

The above moment will be given by the Designer.

3.2.7 Asymmetrical structure induced moment

The above moment will be given by the Designer.

3.2.8 Moment due to wind pressure

The moment caused by the wind pressure is to be calculated in accordance with the following formula:

$$M_w = c \cdot p_w \cdot A\left(l_w + \frac{T}{2}\right)[kNm]$$

where:

c = shape-dependent coefficient of resistance

- for frameworks c = 1,2
- for solid-section beams c = 1,6
- both values take account of gusts of wind.

The whole area encompassed by the contour line of the framework is to be taken to be the surface area exposed to the wind.

pw = specific wind pressure; this is to be taken to be in conformity with Tab 2;

Table 2 : Specific wind pressure

Range of navigation	Pw, in kN/m^2
IN (1,2), IN (2)	0,25
IN (0), IN (0,6)	0,15

A = lateral plane above the plane of maximum draught in m^2;

lw = distance from the centre of area of the lateral plane A from the plane of maximum draught, in m.

3.2.9 Turning circle induced moment

For self-propelled vessels the moments due to turning whilst underway may be derived from the following formula.

Mdr = cdr · CB · v^2 · D/LWL · (KG - T/2) (kNm)

where:

cdr = a coefficient of 0,45;

CB = block coefficient (if not known, taken as 1,0);

v = maximum speed of the vessel in m/s;

KG = distance between the centre of gravity and the keel line in m.

D = displacement of the vessel (t)

3.2.10 Cross-current moment

The moment resulting from cross-current is to be taken into account only for floating equipment which is anchored or moored across the current while operating.

3.2.11 Ballast and supplies induced moment

The least favourable extent of tank filling from the point of view of stability is to be determined and the cor-responding moment introduced into the calculation when determining the moments resulting from liquid bal-last and liquid provisions.

3.2.12 Moment due to inertia forces

The moment resulting from inertia forces according to paragraph 3.2.3 (i) is to be given due consideration if the movements of the load and the working gear are likely to affect stability.

3.2.13 Moment due to clear surfaces occupied by liquid

The moment due to clear surfaces occupied by liquid is to be calculated in accordance with [4].

3.2.14 Moment due to other mechanical equipment

The above moment will be given by the Designer.

3.2.15 The righting moments for floats with vertical side walls may be calculated using the following formula:

Ma = 10 · D · GM sinφ (kNm)

where:

GM = metacentric height, in m;

φ = heeling angle in degrees;

D = displacement of the vessel (t).

This formula is to apply up to heeling angles of 10° or up to a heeling angle corresponding to immersion of the edge of the deck or emergence of the edge of the bottom; the smallest angle is to be decisive. The formula may be applied to slanting side walls up to heeling angles of 5°.

If the particular shape of the float(s) does not permit such simplification, the righting lever curves according to paragraph 4.7 are required.

3.2.16 Intact stability in the case of reduced residual freeboard

a) after correction for the free surfaces of liquids, the metacentric height is not less than 0,15 m;

b) for heeling angles between 0 and 30°, there is a righting lever of at least

   h = 0,30 - 0,28 · φ_n (m)

   φ_n being the heeling angle from which the righting lever curve displays negative values (range of stability); it is to be not less than 20° or 0,35 rad and is not to be introduced into the formula for more than 30° or 0,52 rad, taking the radian (rad) (1° = 0,01745 rad) for the unit of φ°;

c) the sum of the trim and heeling angles does not exceed 10°;

d) the residual safety clearance is at least:

- 0,30 m for watertight and weathertight openings
- 0,40 m for non-watertight openings

e) there is a residual freeboard of at least 0,05 m;

f) for heeling angles between 0° and 30°, a residual righting lever of at least

$h = 0,20 - 0,23 \cdot \varphi_n$ (m)

remains, where φ_n is the heeling angle from which the righting lever curve displays negative values; it is not to be introduced into the formula for more than 30° or 0,52 rad.

Residual righting lever means the maximum difference existing between 0° and 30° of heel between the right-ing lever curve and the heeling lever curve. If an opening towards the inside of the vessel is reached by the water at a heeling angle less than that corresponding to the maximum difference between the lever curves, the lever corresponding to that heeling angle is to be taken into account.

3.2.17 Floating installation without confirmation of stability

The following floating equipment may be dispensed from the application of requirements from [3.2.4] to [3.2.16]:

a) equipment whose working gear can in no way alter its heel or trim, and

b) where any displacement of the centre of gravity can be reasonably excluded.

However:

a) at maximum load the safety clearance is to be at least 0,30 m and the freeboard at least 0,15 m;

b) for apertures which cannot be closed spray-proof and weathertight the safety clearance is to be at least 0,50 m.

3.2.18 Intact stability criteria applicable to worksite craft

a) Worksite craft means a vessel, appropriately built and equipped for use at worksites, such as a reclamation barge, hopper or pontoon barge, pontoon or stone-dumping vessel;

b) Worksite craft designated as such may navigate outside worksites only when unladen. That restriction shall be entered on the relevant certificate.

c) If a worksite craft is used as a reclamation barge or a hopper barge the safety clearance outside the hold area shall be at least 300 mm and the freeboard at least 150 mm. Tasneef may permit a smaller freeboard if proof by calculation is provided that stability is sufficient for a cargo having a specific mass of 1,5t/m³ and that no side of the deck reaches the water. The effect of liquefied cargo shall be taken into account.

3.3 Vessel carrying containers

3.3.1 The provisions of paragraphs 3.3 and 3.4 apply to vessels carrying containers.

Stability documents are to provide the Master with comprehensible information on vessel stability for each loading condition.

Stability documents are to include at least the following:

a) information on the permissible stability coefficients, the permissible KG values or the permissible heights for the centre of gravity of the cargo;

b) data concerning spaces that can be filled with ballast water;

c) forms for checking stability;

d) instructions or an example of a calculation for use by the Master.

For vessels where it is optional whether containers are carried non-secured or secured, separate calculation methods are to be provided for confirmation of stability for transport of both non-secured and secured cargoes of containers.

A cargo of containers is only to be considered secured if each individual container is firmly attached to the hull of the vessel by means of container guides or securing equipment and its position cannot alter during the voyage.

3.3.2 Intact stability of ships carrying non-secured containers

All methods of calculating vessel stability in the case of non-secured containers are to meet the following limit conditions:

a) Metacentric height GM is to be not less than 1,00 m;

b) Under the joint action of the centrifugal force resulting from the vessel's turning, wind pressure and the free surfaces of liquids, the heeling angle is not to exceed 5° and the edge of the deck is not to be immersed;

c) The heeling lever resulting from the centrifugal force caused by the vessel's turning is to be determined in accordance with the following formula:

$$h_{kz} = c_{kz} \cdot \frac{v^2}{L_{WL}} \cdot \left(\overline{KG} - \frac{T'}{2}\right) \quad [m]$$

where:

c_{KZ}	:	parameter (c_{KZ} = 0,04) (s²/m);
v	:	the maximum speed of the vessel in relation to the water (m/s);
KG	:	height of centre of gravity of the laden vessel above its base (m);
T′	:	draught of the laden vessel (m).

d) The heeling lever resulting from the wind pressure is to be determined in accordance with the following formula:

$$h_{KW} = \frac{P_W}{9,81} \cdot \frac{A'}{D'} \cdot \left(l_W + \frac{T'}{2}\right) \quad [m]$$

where:

P_W	:	specific wind pressure, in kN/m², to be assumed in conformity with Table 3;

Table 3 : Specific wind pressure

Range of navigation	Pw, in kN/m²
IN (1,2), IN (2)	0,25
IN (0), IN (0,6)	0,15

A' : lateral plane above the respective plane of draught with the vessel laden (m²);

D' : displacement of the laden vessel (t);

l_w : height of the centre of gravity of the lateral plane A' above the respective plane of draught (m);

T' : draught of the laden vessel (m).

e) The heeling lever resulting from the free surfaces of rain-water and residual water within the hold or the double bottom is to be determined in accordance with the following formula:

$$h_{Kfo} = \frac{c_{Kfo}}{D'} \cdot \Sigma \cdot b \cdot l \cdot (b - (0,55\sqrt{b})) \quad [m]$$

where:

c_{Kfo} : parameter (c_{KfO} = 0,015) (t/m²)

b : width of hold or section of the hold in question (m); (see Note 1)

l : length of hold or section of the hold in question (m); (see Note 1)

D' : displacement of the laden vessel (t);

f) Half of the fuel and fresh water supply is to be taken into account for each load condition.

Note 1: The hold sections providing free surfaces that are exposed to water arise from the longitudinal and/or transverse watertight compartmentalisation that forms independent sections.

3.3.3 The stability of a vessel carrying non-secured containers is to be considered sufficient if the effective KG does not exceed the KG_{zul} resulting from the following formulae. The KG_{zul} is to be calculated for various displacements covering the entire range of draughts.

a)

$$\overline{KG}_{zul} = \frac{\overline{KM} + \frac{B_{WL}}{2F} \cdot \left(Z \cdot \frac{T_m}{2} - h_{KW} - h_{Kfo}\right)}{\frac{B_{WL}}{2F} \cdot Z + 1} \quad [m]$$

No value less than 11,5 (11,5 = 1/tan5°) is to be taken for BWL/2F

b) $\overline{KG}_{zul} = \overline{KM}$ - 1,00 (m)

The lowest value of $\overline{KG}_{zul}$ in accordance with formula (a) or (b) is to be decisive.

Within the formulae:

$\overline{KG}_{zul}$: maximum permissible height of the laden vessel's centre of gravity above its base (m);

$\overline{KM}$: height of the metacentre above the base (m) in accordance with the approximation formula in paragraph 3;

F : respective effective freeboard at 1/2 L (m);

Z : parameter for the centrifugal force resulting from turning

$$Z = \frac{(0,7 \cdot v)^2}{9,81 \cdot 1,25 \cdot L_{WL}} = 0,04 \cdot \frac{v^2}{L_{WL}} \quad [-]$$

v : maximum speed of the vessel in relation to the water (m/s);

t_m : respective average draught (m);

h_{KW} : heeling lever resulting from lateral wind pressure according to [3.3.2] d) 1(d) (m);

h_{Kfo} : sum of the heeling levers resulting from the free surfaces of liquids according to [3.3.2] e) (m).

3.3.4 Approximation formula for KM

Where no sheet of hydrostatic curves is available, the value KM may be determined by the following approximation formulae:

a) for vessels in the shape of a pontoon:

$$\overline{KM} = \frac{B^2_{WL}}{\left(12,5 - \frac{T_m}{H}\right) \cdot T_m} + \frac{T_m}{2} \quad [m]$$

b) for other vessels:

$$\overline{KM} = \frac{B^2_{WL}}{\left(12,7 - 1,2 \cdot \frac{T_m}{H}\right) \cdot T_m} + \frac{T_m}{2} \quad [m]$$

3.4 Intact stability of ships carrying secured containers

3.4.1 All methods of calculating vessel stability in the case of secured containers are to meet the following limit conditions:

a) metacentric height GM is to be not less than 0,50 m;

b) no hull opening is to be immersed by the joint action of the centrifugal force resulting from the turning of the vessel, the wind pressure and the free surfaces of liquids;

c) the heeling levers resulting from the centrifugal force due to the vessel's turning, the wind pressure and the free surfaces of liquids are to be determined in accordance with the formulae referred to in (3.3.1) (c) to (e);

d) half of the fuel and fresh water supply is to be taken into account for each load condition.

3.4.2 The stability of a vessel carrying secured containers is to be considered sufficient if the effective KG does not exceed the KG_{zul} resulting from the following formulae that has been calculated for various displacements covering the entire range of draughts.

a)

$$\overline{KG}_{zul} = \frac{\overline{KM} + \frac{l - i}{2\forall} \cdot \left(1 - 1,5 \cdot \frac{F}{F'}\right) + 0,75\frac{B_{WL}}{F} \cdot \left(Z \cdot \frac{T_m}{2} - h_{KW} - h_{KfO}\right)}{0,75 \cdot \frac{B_{WL}}{F} \cdot Z + 1} \quad [m]$$

No value less than 6,6 is to be taken for B_{WL}/F' and no value less than 0 for

$$\frac{I-i}{2\forall} \cdot \left(1 - 1,5 \cdot \frac{F}{F'}\right)$$

b) $\overline{KG}_{zul} = \overline{KM} - 0,50$ (m)

The lowest value for $\overline{KG}_{zul}$ in accordance with formula (a) or (b) is to be decisive.

Within these formulae, apart from the terms defined previously:

I : transverse moment of inertia of the waterline area at T_m (m^4) (for the approximation formula see paragraph 3);

i : transverse moment of inertia of the waterline area parallel to the base, at height

$$T_m + \frac{2}{3}F' \qquad [m^4]$$

$\forall$: water displacement of the vessel at T_m (m^3);

F' : ideal freeboard F' = H' - T_m (m) or

$$F' = \frac{a \cdot B_{WL}}{2 \cdot b} \ [m]$$, the lowest value is to be decisive

a : the vertical distance between the lower edge of the opening that is first immersed in the event of heeling and the waterline in the vessel's upright position (m);

b : distance from that same opening from the centre of the vessel (m);

H' : ideal side height

$$H' = H + \frac{q}{0,9 \cdot B_{WL} \cdot L} \ [m]$$

q : sum of the volumes of the deckhouses, hatches, trunk decks and other superstructures up to a maximum height of 1,0 m above H or up to the lowest aperture in the volume under consideration, the lowest value being decisive. Parts of volumes located within a range of 0,05 L from the extremities of the vessel are not to be taken into account (m^3).

3.4.3 Approximation formula for I

Where there is no sheet of hydrostatic curves available the value for the transverse moment of inertia I of the waterline area may be calculated by the following approximation formulae:

a) metacentric height GM is to be not less than 0,50 m:

$$I = \frac{B^2_{WL} \cdot \forall}{\left(12,5 - \frac{T_m}{H}\right) \cdot T_m} \ [m^4]$$

b) for other vessels:

$$I = \frac{B^2_{WL} \cdot \forall}{\left(12,7 + 1,2 \cdot \frac{T_m}{H}\right) \cdot T_m} \ [m^4]$$

3.5 Ships carrying bulk dry cargo

3.5.1 The requirementsof this paragraph are to be applied to ships carrying dry bulk cargo.

3.5.2 Heeling moments

a) Moment due to wind pressure

The moment caused by the wind pressure is to be calculated in accordance with the following formula:

$$M_w = c \cdot p_w \cdot A\left(l_w + \frac{T}{2}\right)[kNm]$$

where:

c = shape-dependent coefficient of resistance

- for frameworks c = 1,2
- for solid-section beams c = 1,6
- both values take account of gusts of wind.

pw = specific wind pressure; this is to be taken to be in conformity with Tab 4;

Table 4 : Specific wind pressure

Range of navigation	Pw, in kN/m^2
IN (1,2), IN (2)	0,25
IN (0), IN (0,6)	0,15

A = lateral plane above the plane of maximum draught in m^2;

l_w = distance from the centre of area of the lateral plane A from the plane of maximum draught, in m.

b) Turning circle induced moment

For self-propelled vessels the moments due to turning whilst underway may be derived from the following formula.

Mdr = cdr · CB · v^2 · D/L_{WL} · (KG - T/2) (kNm)

where:

cdr = a coefficient of 0,45;

CB = block coefficient (if not known, taken as 1,0);

v = maximum speed of the vessel in m/s;

KG = distance between the centre of gravity and the keel line in m.

D = displacement of the vessel (t)

c) Cargo shift induced moment

For cargo ships carrying goods such as grain or cement, where the vessel lists to an inclination greater than its angle of repose, the cargo shifting induced moment is to be taken into account.

Such moment may be calculated according to Pt E, Ch 4, Sec 4, App 1 of the Tasneef Rules for the Classification of Ships.

In any case such moment is to be calculated assuming an angle of the resulting cargo surface after shifting of 12°.

3.5.3 Intact stability requirements

At any time during the voyage the following requirements are to be met:

a) the angle of heel φ_1 is to be not greater than 12°;

b) from the lever arm curve it is to be verified that the residual area between the heeling arm curve and the righting arm curve up to an angle of heel φ_2 is not less than 0,0065 m.rad in all conditions of loading,

where:

φ_1 : is the heeling angle due to the cargo shift heeling moment

φ_2 : is the angle of heel of maximum difference between the ordinates of the heeling arm curve and the righting arm curve, or 27°, or the angle of flooding, whichever is the least.

When ships may list to an angle greater than their angle of repose, such as is the case with vessels carrying grain or cement, the following requirements are to be satisfied:

a) all necessary and reasonable trimming is to be performed to level all free cargo surfaces and minimise the effect of cargo shifting,

b) the surface of the bulk cargo in any partially filled compartment is to be secured so as prevent a cargo shift by overstowing,

c) the longitudinal subdivision in the holds or compartments is to minimise the possibility of shift of cargo.

3.6 Tankers

3.6.1 Intact stability requirements

Stability is to be assessed according to the requirements stated from [2.1.3] to [2.1.5].

For ships with cargo tanks of more than 0,70 B in width, the following intact stability requirements are to be satisfied:

a) a minimum righting lever GZ value of 0,10 m is to be reached within the range of positive stability, limited by the angle at which unprotected openings become submerged

b) the area below the GZ curve within the range of positive stability, limited by the angle at which unprotected openings become submerged or 27°, whichever is the lesser, is to be not less than 0,024 m.rad

c) the initial metacentric height GMo value is to be at least 0,10 m

In any case, the effects of free surfaces of liquids in tanks are to be considered according to [4.0].

3.6.2 Intact Stability for Tankers carrying dangerous Good

a) The basic values for the stability calculation - the vessel's lightweight and location of the centre of gravity - shall be determined either by means of an inclining experiment or by detailed mass and moment calcu-lation. In the latter case the lightweight of the vessel shall be checked by means of a lightweight test with a tolerance limit of ± 5% between the mass determined by calculation and the displacement determined by the draught readings.

b) Proof of sufficient intact stability shall be furnished for all stages of loading and unloading and for the final loading condition.

c) Stability (intact)

Stability is to be assessed according to the requirements stated from [2.1.3] to [2.1.5].

1) The requirements for intact stability resulting from the damage stability calculation shall be fully complied with.

2) For vessels with cargo tanks of more than 0,70 B in width, additional proof shall be furnished that, at an angle of 5° or, when this angle is less, at a heeling angle at which an opening becomes immersed, the right-ing arm is 0,10 m. The stability-reducing free surface effect in the case of cargo tanks filled to less than 95% of their capacity shall be taken into account.

3) The most stringent requirement of items [3.6.1]c) 1) and [3.6.1]c) 2) is applicable to the vessel.

3.6.3 Intact Stability for Tankers carrying dangerous liquefied gasses

a) The basic values for the stability calculation - the vessel's lightweight and location of the centre of gravity - shall be determined either by means of an inclining experiment or by detailed mass and moment calcu-lation. In the latter case the lightweight of the vessel shall be checked by means of a lightweight test with a tolerance limit of ± 5% between the mass determined by calculation and the displacement determined by the draught readings.

b) Proof of sufficient intact stability shall be furnished for all stages of loading and unloading and for the final loading condition.

c) Stability (intact)

1) Stability is to be assessed according to the requirements stated from [2.1.3] to [2.1.5].

2) The requirements for intact stability resulting from the damaged stability calculations shall be fully complied with.

3.7 Intact Stability for cargo ships carrying dry dangerous goods

3.7.1

a) The basic values for the stability calculation - the vessel's lightweight and location of the centre of gravity - shall be determined either by means of an inclining experiment or by detailed mass and moment calcu-lation. In the latter case the lightweight of the vessel shall be checked by means of a lightweight test with a tolerance limit of ± 5% between the mass determined by calculation and the displacement determined by the draught readings.

b) Proof of sufficient intact stability shall be furnished for all stages of loading and unloading and for the final loading condition.

c) Stability (intact)

1) Stability is to be assessed according to the requirements stated from [2.1.3] to [2.1.5] and [3.5] as applicable.

2) The requirements for intact stability resulting from the damaged stability calculations shall be fully complied with.

3) For the carriage of containers, proof of sufficient stability shall also be furnished in accordance with the provision of national regulations.

4) In addition for the carriage of containers also the requirements given in [3.3] and [3.4] are to be applied.

3.8 Tugs and pushers

3.8.1 Intact stability requirements

a) Proof of adequate intact stability is to be verified according to the general criteria given in [2.1].

In addition the following checks are to be carried out:

b) Thrust action

Thrust is to be taken into account on the basis of the maximum permissible heeling moment Madm as indicated in c).

c) The stability of tugs is considered to be sufficient if the maximum permissible heeling moment Madm of the ship is not less than the sum of the heeling moments resulting from the dynamic effect of wind Mdv as in d) and from the dynamic effect of the lateral component of the bollard pull force Mt specified below, i.e. if:

$M_{adm} \geq M_{dv} + M_t$

The heeling moment, in kN.m, resulting from the dynamic effect of the lateral component of the bollard pull force is given by the formula:

$M_t = 1{,}1\ T \cdot (Z_t - d)$

where:

Z_t : height of the point of application of the bollard pull force above the base line, in m

T : maximum bollard pull force measured on checking at moorings, in kN.

Where the force T is not known, the following values are to be assumed for calculation purposes:

- for $\Delta \leq 30$ t:

  $T = 0{,}13\ N_e$, for tugs without propeller nozzles;

  $T = 0{,}20\ N_e$, for tugs with propeller nozzles;

- for $\Delta > 30$ t:

  $T = 0{,}16\ N_e$, for tugs without propeller nozzles;

  $T = 0{,}20\ N_e$, for tugs with propeller nozzles;

where N_e is the total power of the main machinery, in kW.

In addition, the stability of each tug is to be such that the angle of heel resulting from the combined effect of the dynamic wind pressure moment M_{dv} and the moment M_{fc} of the centrifugal force on turning does not exceed the critical angle, and , in any case, is less than 15°.

d) Moment due to wind pressure

The moment caused by the wind pressure is to be calculated in accordance with the following formula:

$$M_{dv} = c \cdot p_w \cdot A\left(l_w + \frac{T}{2}\right)[\text{kNm}]$$

where:

c = shape-dependent coefficient of resistance

- for frameworks c = 1,2
- for solid-section beams c = 1,6
- both values take account of gusts of wind.

The whole area encompassed by the contour line of the framework is to be taken to be the surface area exposed to the wind.

pw = specific wind pressure; this is to be taken to be in conformity with Tab 5;

Table 5 : Specific wind pressure

Range of navigation	Pw, in kN/m^2
IN (1,2), IN (2)	0,25
IN (0), IN (0,6)	0,15

A = lateral plane above the plane of maximum draught in m^2;

l_w = distance from the centre of area of the lateral plane A from the plane of maximum draught, in m.

4 Effects of free surfaces of liquids in tanks

4.1 General

4.1.1 For all loading conditions, the initial metacentric height and the righting lever curve are to be corrected for the effect of free surfaces of liquids in tanks.

4.2 Consideration of free surface effects

4.2.1 Free surface effects are to be considered whenever the filling level in a tank is less than 98% of full condition.

Free surface effects need not be considered where a tank is nominally full, i.e. filling level is 98% or above. Free surface effects for small tanks may be ignored under the condition in [4.9.1].

4.2.2 For ships having cargo tanks with a breadth greater than 60% of the ship's maximum beam, the free surface effects when the tanks are filled at 98% or above may not be neglected.

4.3 Categories of tanks

4.3.1 Tanks which are taken into consideration when determining the free surface correction may be in one of two categories:

- Tanks with fixed filling level (e.g. liquid cargo, water ballast).

  The free surface correction is to be defined for the actual filling level to be used in each tank.

- Tanks with variable filling level (e.g. consumable liquids such as fuel oil, diesel oil and fresh water, and also liquid cargo and water ballast during liquid transfer operations).

  Except as permitted in [4.5.1] and [4.6.1], the free surface correction is to be the maximum value attainableamong the filling limits envisaged for each tank, consistent with any operating instructions.

4.4 Consumable liquids

4.4.1 In calculating the free surface effect in tanks containing consumable liquids, it is to be assumed that for each type of liquid at least one transverse pair or a single centreline tank has a free surface and the tank or combination of tanks taken into account is to be that where the effect of free surface is the greatest.

4.5 Water ballast tanks

4.5.1 Where water ballast tanks, including anti-rolling tanks and anti-heeling tanks, are to be filled or discharged during the course of a voyage, the free surface effect is to be calculated to take account of the most onerous transitory stage relating to such operations.

4.6 Liquid transfer operations

4.6.1 For ships engaged in liquid transfer operations, the free surface corrections at any stage of the liquid transfer operations may be determined in accordance with the filling level in each tank at the stage of the transfer operation.

4.7 GM0 and GZ curve corrections

4.7.1 The corrections to the initial metacentric height and to the righting lever curve are to be addressed separately as indicated in [4.7.2] and [4.7.3].

4.7.2 In determining the correction to the initial metacentric height, the transverse moments of inertia of the tanks are to be calculated at 0 degrees angle of heel according to the categories indicated in [4.3.1].

4.7.3 The righting lever curve may be corrected by any of the following methods:

- Correction based on the actual moment of fluid transfer for each angle of heel calculated; corrections may be calculated according to the categories indicated in [4.3.1]
- Correction based on the moment of inertia, calculated at 0 degrees angle of heel, modified at each angle of heel calculated; corrections may be calculated according to the categories indicated in [4.3.1]
- Correction based on the summation of M_{fs} values for all tanks taken into consideration, as specified in [4.8.1].

4.7.4 Whichever method is selected for correcting the righting lever curve, only that method is to be presented in the ship's trim and stability booklet. However, where an alternative method is described for use in manually calculated loading conditions, an explanation of the differences which may be found in the results, as well as an example correction for each alternative, are to be included.

4.8 Free surface moment

4.8.1 The values for the free surface moment at any inclination in m.t for each tank may be derived from the formula:

$$M_{fs} = v b p k \sqrt{\delta}$$

where:

v : Tank total capacity, in m^3

b : Tank maximum breadth, in m

P : Mass density of liquid in the tank, in t/m^3

k : Dimensionless coefficient to be determined from Tab 6according to the ratio b/h. The intermediate values are determined by interpolation.

δ : Tank block coefficient, equal to:

$$\delta = \frac{v}{blh}$$

l : Tank maximum length, in m

h : Tank maximum height, in m.

4.9 Small tanks

4.9.1 Small tanks which satisfy the following condition using the values of k corresponding to an angle of inclination of 30° need not be included in the correction:

$$\frac{M_{fs}}{\Delta_{min}} < 0,01\,m$$

where:

Δ_{min} : Minimum ship displacement, in t, calculated at dmin

dmin : Minimum mean service draught, in m, of ship without cargo, with 10% stores and minimum water ballast, if required.

4.10 Remainder of liquid

4.10.1 The usual remainder of liquids in the empty tanks need not to be taken into account in calculating the corrections, providing the total of such residual liquids does not constitute a significant free surface effect.

Table 6 : Value of coefficient k for calculating free surface corrections

$$k = \frac{\sin\theta}{12} \cdot \left(1 + \frac{(\tan\theta)^2}{2}\right) \cdot \frac{b}{h}, \quad \text{where} \quad \cot\theta \geq \frac{b}{h}$$

$$k = \frac{\cos\theta}{8} \cdot \left(1 + \frac{\tan\theta}{b/h}\right) - \frac{\cos\theta}{12 \cdot (b/h)^2} \cdot \left(1 + \frac{(\cot\theta)^2}{2}\right), \quad \text{where} \quad \cot\theta < \frac{b}{h}$$

θ b/h	5°	10°	15°	20°	30°	40°	45°	50°	60°	70°	75°	80°	85°	θ b/h
20	0,11	0,12	0,12	0,12	0,11	0,10	0,09	0,09	0,09	0,05	0,04	0,03	0,02	20
10	0,07	0,11	0,12	0,12	0,11	0,10	0,10	0,09	0,07	0,05	0,04	0,03	0,02	10
5,0	0,04	0,07	0,10	0,11	0,11	0,11	0,10	0,10	0,08	0,07	0,06	0,05	0,04	5,0
2,0	0,01	0,03	0,04	0,06	0,09	0,11	0,11	0,11	0,10	0,09	0,09	0,08	0,07	2,0
1,5	0,01	0,02	0,03	0,05	0,07	0,10	0,11	0,11	0,11	0,11	0,10	0,10	0,09	1,5
1,0	0,01	0,01	0,02	0,03	0,05	0,07	0,09	0,10	0,12	0,13	0,13	0,13	0,13	1,0
0,75	0,01	0,01	0,01	0,02	0,02	0,04	0,04	0,05	0,09	0,16	0,18	0,21	0,16	0,75
0,5	0,00	0,01	0,01	0,02	0,02	0,04	0,04	0,05	0,09	0,16	0,18	0,21	0,23	0,5
0,3	0,00	0,00	0,01	0,01	0,01	0,02	0,03	0,03	0,05	0,11	0,19	0,27	0,34	0,3
0,2	0,00	0,00	0,00	0,01	0,01	0,01	0,02	0,02	0,04	0,07	0,13	0,27	0,45	0,2
0,1	0,00	0,00	0,00	0,00	0,00	0,01	0,01	0,01	0,02	0,04	0,06	0,14	0,53	0,1

5 Icing

5.1 General

5.1.1 Ice formation is a complicated process which depends upon meteorological conditions, condition of loading and behaviour of the ship in stormy weather as well as on the size and location of superstructures and rigging. The most common cause of ice formation is the deposit of water droplets on the ship's structure. These droplets come from spray driven from wave crests and from ship-generated spray.

5.1.2 Ice formation may also occur in conditions of snowfall, sea fog including arctic sea smoke, a drastic fall in ambient temperature, as well as from the freezing of drops of rain on impact with the ship's structure.

5.1.3 Ice formation may sometimes be caused or accentuated by water shipped on board and retained on deck.

5.1.4 Intensive ice formation generally occurs on stem, bulwark and bulwark rail, front walls of superstructures and deckhouses, hawse holes, anchors, deck gear, forecastle deck and upper deck, freeing ports, aerials, stays, shrouds, masts and spars.

5.1.5 The most dangerous areas as far as ice formation is concerned are the sub-Arctic regions.

5.1.6 The most intensive ice formation takes place when wind and sea come from ahead. In beam and quartering winds, ice accumulates quicker on the windward side of the ship, thus leading to a constant list which can be extremely dangerous.

5.1.7 Listed below are meteorological conditions causing the most common type of ice formation due to spraying of a ship.

a) Slow accumulations of ice take place:
   - at ambient temperature from -1°C to -3°C and any wind force
   - at ambient temperature -4°C and lower and wind force from 0 to 9 m/s
   - under the conditions of precipitation, fog or sea mist followed by a drastic fall of the ambient temperature.

b) At ambient temperature of -4°C to -8°C and wind force 10-15 m/s, rapid accumulation of ice takes place.

   Under these conditions the intensity of ice accumulation can reach three times the amount normally accumulated in a).

c) Very fast accumulation of ice takes place:
   - at ambient temperature of -4°C and lower and wind forces of 16 m/s and over
   - at ambient temperature -9°C and lower and wind force 10 to 15 m/s.

5.2 Icing accumulation consequences

5.2.1 Ice formation adversely affects the seaworthiness of the ship as ice formation leads to:

- an increase in the weight of the ship due to accumulation of ice on the ship's surfaces, which may cause the reduction of freeboard and buoyancy
- a rise of the ship's centre of gravity due to the high location of ice on the ship structures with corresponding reduction in the level of stability
- an increase of windage area due to ice formation on the upper parts of the ship and hence an increase in the heeling moment due to the action of the wind
- the development of a constant list due to uneven distribution of ice across the breadth of the ship

- impairment of the manoeuvrability and reduction of the speed of the ship.

5.3 Application

5.3.1 For any ship operating in areas where ice accretion is likely to occur, adversely affecting a ship's stability, icing allowances are to be included in the analysis of conditions of loading.

5.3.2 The Society is concerned to take icing into account and may apply national standards where environmental conditions warrant higher standards than those specified in the following regulations.

APPENDIX 1 INCLINING TEST AND LIGHTWEIGHT CHECK

1 General

1.1 General conditions of the ship

1.1.1 Prior to the test, Society's Surveyor is to be satisfied of the following:

a) the weather conditions are to be favourable;

b) the ship is to be moored in a quiet, sheltered area free from extraneous forces, such as to allow unrestricted heeling. The ship is to be positioned in order to minimise the effects of possible wind, stream and tide;

c) the ship is to be transversely upright and the trim is to be taken not more than 1% of the length between perpendiculars. If this condition is not satisfied, hydrostatic data and sounding tables are to be available for the actual trim;

d) cranes, derrick, lifeboats and liferafts capable of inducing oscillations are to be secured;

e) main and auxiliary boilers, pipes and any other system containing liquids are to be filled;

f) the bilge and the decks are to be thoroughly dried;

g) preferably, all tanks are to be empty and clean, or completely full. The number of tanks containing liquids is to be reduced to a minimum taking into account the above-mentioned trim.

   The shape of the tank is to be such that the free surface effect can be accurately determined and remains almost constant during the test. All cross connections are to be closed;

h) the weights necessary for the inclination are to be already on board, located in the correct place;

i) all work on board is to be suspended and crew or personnel not directly involved in the inclining test are to leave the ship;

j) the ship is to be as complete as possible at the time of the test. The number of weights to be removed, added or shifted is to be limited to a minimum. Temporary material, tool boxes, staging, sand, debris, etc on board are to be reduced to an absolute minimum.

2 Inclining weights

2.1

2.1.1 The total weight used is preferably to be sufficient to provide a minimum inclination of one degree and a maximum of four degrees of heel to each side. Tasneef may, however, accept a smaller inclination angle for large ships provided that the requirement on pendulum deflection or U-tube difference in height specified in [3] is complied with. Test weights are to be compact and of such a configuration that the VCG (vertical centre of gravity) of the weights can be accurately determined. Each weight is to be marked with an identification number and its weight. Recertification of the test weights is to be carried out prior to the incline. A crane of sufficient capacity and reach, or some other means, is to be available during the inclining test to shift weights on the deck in an expeditious and safe manner. Water ballast and people are generally not acceptable as inclining weight.

2.1.2 Where the use of solid weights to produce the inclining moment is demonstrated to be impracticable, the movement of ballast water may be permitted as an alternative method. This acceptance would be granted for a specific test only, and approval of the test procedure by Tasneef is required. The following conditions are to be met:

a) inclining tanks are to be wall-sided and free of large stringers or other internal members that create air pockets;

b) tanks are to be directly opposite to maintain the ship's trim;

c) specific gravity of ballast water is to be measured and recorded;

d) pipelines to inclining tanks are to be full. If the ship's piping layout is unsuitable for internal transfer, portable pumps and pipes/hoses may be used;

e) blanks are to be inserted in transverse manifolds to prevent the possibility of liquids being "leaked" during transfer. Continuous valve control is to be maintained during the test;

f) all inclining tanks are to be manually sounded before and after each shift;

g) vertical, longitudinal and transverse centres are to be calculated for each movement;

h) accurate sounding/ullage tables are to be provided. The ship's initial heel angle is to be established prior to the incline in order to produce accurate values for volumes and transverse and vertical centres of gravity for the inclining tanks at every angle of heel. The draught marks amidships (port and starboard) are to be used when establishing the initial heel angle;

i) verification of the quantity shifted may be achieved by a flowmeter or similar device;

j) the time to conduct the inclining is to be evaluated. If time requirements for transfer of liquids are considered too long, water may be unacceptable because of the possibility of wind shifts over long periods of time.

3 Pendulums

3.1

3.1.1 The use of three pendulums is recommended but a minimum of two are to be used to allow identification of bad readings at any one pendulum station. However, for ships of a length equal to or less than 30 m, only one pendulum may be accepted. They are each to be located in an area protected from the wind. The pendulums are to be long enough to give a measured deflection, to each side of upright, of at least 10 cm. To ensure that recordings from individual instruments are kept separate, it is suggested that the pendulums should be physically located as far apart as practical.

The use of an inclinometer or U-tube is to be considered in each separate case. It is recommended that inclinometers or other measuring devices should only be used in conjunction with at least one pendulum.

4 Means of communication

4.1

4.1.1 Efficient two-way communications are to be provided between central control and the weight handlers and between central control and each pendulum station. One person at a central control station is to have complete control over all personnel involved in the test.

5 Documentation

5.1

5.1.1 The person in charge of the inclining test is to have available a copy of the following plans at the time of the test:

a) hydrostatic curves or hydrostatic data;

b) general arrangement plan of decks, holds, inner bottoms;

c) capacity plan showing capacities and vertical and longitudinal centres of gravity of cargo spaces and tanks. When water ballast is used as inclining weights, the transverse and vertical centres of gravity for the applicable tanks are to be available for each angle of inclination;

d) tank sounding tables;

e) draught mark locations;

f) docking drawing with keel profile and draught mark corrections, if available.

6 Calculation of the displacement

6.1

6.1.1 The following operations are to be carried out for the calculation of the displacement:

a) draught mark readings are to be taken at aft, midship and forward, at starboard and port sides;

b) the mean draught (average of port and starboard reading) is to be calculated for each of the locations where draught readings are taken and plotted on the ship's lines drawing or outboard profile to ensure that all readings are consistent and together define the correct waterline. The resulting plot is to yield either a straight line or a waterline which is either hogged or sagged. If inconsistent readings are obtained, the freeboards/draughts are to be taken again;

c) the specific gravity of the sea water is to be determined. Samples are to be taken from a sufficient depth of the water to ensure a true representation of the sea water and not merely surface water, which could contain fresh water from run-off of rain. A hydrometer is to be placed in a water sample and the specific gravity read and recorded. For large ships, it is recommended that samples of the sea water are taken forward, midship and aft, and the readings averaged. For small ships, one sample taken from midship is sufficient. The temperature of the water is to be taken and the measured specific gravity corrected for deviation from the standard, if necessary;

d) A correction to water specific gravity is not necessary if the specific gravity is determined at the inclining experiment site. Correction is necessary if specific gravity is measured when the sample temperature differs from the temperature at the time of the inclining test. Where the value of the average calculated specific gravity is different from that reported in the hydrostatic curves, adequate corrections are to be made to the displacement curve;

e) all double bottoms, as well as all tanks and compartments which can contain liquids, are to be checked, paying particular attention to air pockets which may accumulate due to the ship's trim and the position of air pipes;

f) it is to be checked that the bilge is dry, and an evaluation of the liquids which cannot be pumped, remaining in the pipes, boilers, condenser, etc., is to be carried out;

g) the entire ship is to be surveyed in order to identify all items which need to be added, removed or relocated to bring the yacht to the lightship condition. Each item is to be clearly identified by weight and location of the center of gravity;

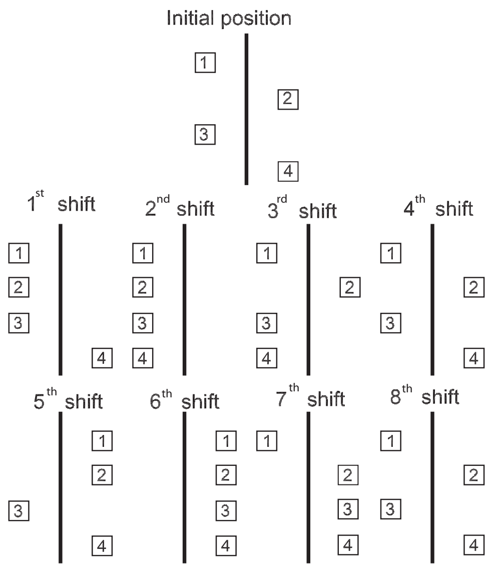
h) the possible solid permanent ballast is to be clearly identified and listed in the report.

7 Inclining procedure

7.1

7.1.1 The standard test generally employs eight distinct weight movements as shown in Fig 1.

Figure 1 : Weight shift procedure



The weights are to be transversely shifted, so as not to modify the ship's trim and vertical position of the centre of gravity.

After each weight shifting, the new position of the transverse centre of gravity of the weights is to be accurately determined.

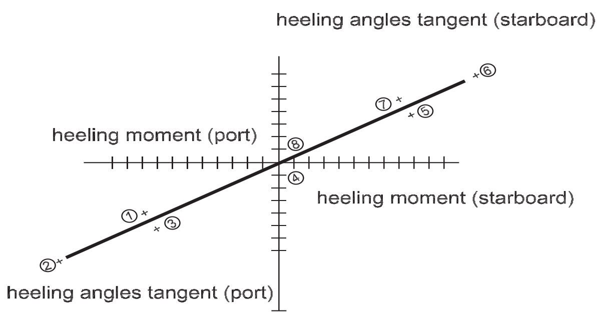
After each weight movement, the distance the weight was moved (centre to centre) is to be measured and the heeling moment calculated by multiplying the distance by the amount of weight moved. The tangent is calculated for each pendulum by dividing the deflection by the length of the pendulum. The resultant tangents are plotted on the graph as shown in Fig 2.

The pendulum deflection is to be read when the ship has reached a final position after each weight shifting.

During the reading, no movements of personnel are allowed.

For ships with a length equal to or less than 30 m, six distinct weight movements may be accepted.

Figure 2



APPENDIX 2 TRIM AND STABILITY BOOKLET

1 Information to be included

1.1 General

1.1.1 A trim and stability booklet is a stability manual, to be approved by Tasneef which is to contain sufficient information to enable the Master to operate the ship in compliance with the applicable requirements contained in these Rules.

The format of the stability booklet and the information included vary depending on the ship type and operation.

1.2 List of information

1.2.1 The following information is to be included in the trim and stability booklet:

a) a general description of the ship, including:
   - the ship's name and Tasneef classification number
   - the ship type and service notation
   - the class notations
   - the yard, the hull number and the year of delivery
   - the flag, the port of registry, the international call sign
   - the moulded dimensions
   - the design draft
   - the displacement corresponding to the above-mentioned draughts;

b) clear instructions on the use of the booklet;

c) general arrangement and capacity plans indicating the assigned use of compartments and spaces (stores, accommodation, etc.);

d) a sketch indicating the position of the draught marks referred to the ship's perpendiculars;

e) hydrostatic curves or tables corresponding to the design trim, and, if significant trim angles are foreseen during the normal operation of the yacht, curves or tables corresponding to such range of trim. A clear reference relevant to the sea density, in t/m^3, is to be included as well as the draught measure (from keel or underkeel);

f) cross-curves (or tables) of stability calculated on a free trimming basis, for the ranges of displacement and trim anticipated in normal operating conditions, with indication of the volumes which have been considered in the computation of these curves;

g) tank sounding tables or curves showing capacities, centre of gravity, and free surface data for each tank;

h) lightship data from the inclining test, including lightship displacement, centre of gravity co-ordinates, place and date of the inclining test, as well as Tasneef approval details specified in the inclining test report. It is recommended that a copy of the approved test report be enclosed with the stability information booklet. Where the above-mentioned information is derived from a sister ship, the reference to this sister ship is to be clearly indicated, and a copy of the approved inclining test report relevant to this sister ship is to be included;

i) standard loading conditions and examples for developing other acceptable loading conditions using the information contained in the booklet;

j) intact stability results (total displacement and its centre of gravity co-ordinates, draughts at perpendiculars, GM, GM corrected for free surface effect, GZ values and curve when applicable, reporting a comparison between the actual and the required values), which are to be available for each of the above-mentioned operating conditions;

k) information on loading restrictions when applicable;

l) information about openings (location, tightness, means of closure), pipes or other progressive flooding sources;

m) information concerning the use of any special cross-flooding fittings with descriptions of damage conditions which may require cross-flooding, when applicable;

n) any other necessary guidance for the safe operation of the ship;

o) a table of contents and index for each booklet.

2 Loading conditions

2.1

2.1.1 The standard loading conditions to be included in the trim and stability booklet are:

a) ship in the fully loaded departure condition, with full stores and fuel and the full number of guests;

b) lightship condition;

c) ship in the fully loaded arrival condition, with only 10% stores and fuel remaining and the full number of guests.

Such loading cases are considered as a minimum requirement and additional loading cases may be included as deemed necessary or useful.

3 Stability curve calculation

3.1 General

3.1.1 Hydrostatic and stability curves are normally prepared on a designed trim basis. However, where the operating trim or the form and arrangement of the ship are such that change in trim has an appreciable effect on righting arms, such change in trim is to be taken into account.

The calculations are to take into account the volume to the upper surface of the deck sheathing.

3.2 Superstructures and deckhouses which may be taken into account

3.2.1 Enclosed superstructures complying with the international or national recognised regulations may be taken into account.

The second tier of similarly enclosed superstructures may also be taken into account. Deckhouses on the freeboard deck may be taken into account, provided that they comply with the conditions for enclosed superstructures above mentioned.

Where deckhouses comply with the above conditions, except that no additional exit is provided to a deck above, such deckhouses are not to be taken into account; however, any deck openings inside such deckhouses are to be considered as closed even where no means of closure are provided.

Superstructures and deckhouses not regarded as enclosed may, however, be taken into account in stability calculations up to the angle at which their openings are flooded (at this angle, the static stability curve is to show one or more steps, and in subsequent computations the flooded space is to be considered non-existent).

Trunks may be taken into account. Hatchways may also be taken into account having regard to the effectiveness of their closures.

3.3 Angle of flooding

3.3.1 In cases where the ship would sink due to flooding through any openings, the stability curve is to be cut short at the corresponding angle of flooding and the yacht is to be considered to have entirely lost its stability.

Small openings such as those for passing wires or chains, tackle and anchors, and also holes of scuppers, as well as of discharge and sanitary pipes are not to be considered as open if they submerge at an angle of inclination more than 30°. If they submerge at an angle of 30° or less, these openings are to be assumed open if Tasneef considers this to be a source of significant progressive flooding; therefore, such openings are to be considered on a case-by-case basis.