



Guide for the Structural Verification of PCTC

Effective from 1 January 2017

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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 Governments.

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 reinstatement. 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 the 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 part 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 certification 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 seaworthiness,

structural integrity, quality or fitness for a particular purpose or service of any Ship, structure, 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 certification 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, the 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 statutory 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 right 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 class, 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 clients 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 property 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, certificates, 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 to 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.

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1 GENERAL

1.1 Introduction

A PCTC is a ship specifically designed for the transportation of car and trucks. It is a multi-decks ship, generally fitted with single propeller and single rudder.

Due to the high volume/weight ratio of the cargo, this type of ship has several decks generally continuous except for the longitudinal openings necessary for the internal ramps.

The access to cargo areas is generally provided by means of a stern ramp and a side smaller ramp.

In recent years, PCTC differently deck designed so-called "flexible type" were built. As per her own nature, this kind of PCTC (without direct connection between deck primary transverse beams and side structures) experiences higher deformation of the deck structures, and relevant additional structural verification are necessary, as also specified in this document.

Yard is kindly requested to take the highest attention to identify the critical areas raised from "flexible type" design.

This guideline shall be used in combination with Tasneef Rules as mentioned herewith in below paragraphs.

2 Watertight Closing Systems

In recent years, aiming to comply with the current damage stability requirements, more Yards developed PCTC fitted with watertight closing systems within and bounding the ship's hull (e.g. internal ramp cover and/or access ramps). In previous designs the hull was internally protected by means of inner side longitudinal bulkheads (B/5 extension) up to the bulkhead deck.

The water tightness of these closing systems is usually based on a compressed rubber along the edge of the system (e.g. watertight door). The relative compression (or net compression) of the rubber is set by the manufacturer according to the water pressure acting on the closing system. The word "relative" (or "net") is used to highlight that due to the large extension of the opening, also the edge (as part of the ship structures) can be subjected to deformation due to presence of high amount of water. Accordingly, the real rubber compression results from the combined deformation of the door and the edge. In case of small opening, since the edge is relatively more rigid than the system (e.g. watertight door), the rubber compression can be evaluated only on the basis of the door deformation.

For this reason, in case of large openings, due considerations are necessary to get the rubber net compression with a specific structural calculation focused on the (relative) displacements edge-watertight system.

3 Structural Arrangement

The structural design adopted for PCTC is longitudinally framed at decks and bottom. The side area can be longitudinally or transversely framed.

Current PCTC are designed according to probabilistic criteria (or any other that takes into account the flooding of internal spaces) and shall be structurally verified taking into account the flooding water loads. At this purpose, additional documentation is necessary to be produced by Yard (e.g. final damage waterline envelope curves, etc.).

As per her own nature, PCTC are very sensitive to transverse loads experiencing a specific type of displacement called "racking". It is mainly a field of transverse displacements creating a horizontal relative shifting among the decks. As results, structural elements are subjected to extra stresses, with following scenario:

- Transverse elements (ordinary side frames, pillars) are generally subject to an extra bending and shear.
- Rigid structural elements (more rigid than ordinary side frames and pillars) are subjected to unexpected stresses (e.g. trunks, casings).

From above considerations, it is important to carry out a proper calculation focusing on how the racking response stresses are distributed among the structural elements.

For ship designed as "flexible-type", racking becomes an even more a critical field of displacement.

4 Structural Verification

4.1 Cargo Holds Analysis

The FEM analysis (i.e. Cargo Holds Analysis) is to be carried out according to Tasneef Rules Pt B, Ch 7, App 2. Due to the peculiarities of the flexible type (hinged design), the FEM model "s x s" is to be prepared using shells elements. The number of shell elements on the web shall be properly applied. For areas with normal stress levels, the webs shall be meshed by shell elements and their aspect ratio shall be not more than 3.

However, in areas most stressed and where more detailed investigation is deemed necessary, the aspect ratio shall be controlled and in general should be as close as feasible to 1 (the number of elements on the web is to be at least 3 because with less than 3 elements on the web, the beam flexure would not be not at all reliable). In this case, for these areas, meshes finer than sxs shall be made.

The model construction, extension and boundary conditions should be performed following the provisions in Tasneef Rules Pt B, Ch 7, App 2, [3]. In particular, the extension of the model shall be long enough for correct reading of stresses and displacements on the structural elements.

The loads to be used are those described in Tasneef Rules Pt B, Ch 7, App 2, [4] that makes ample reference to Pt B, Ch 5 provisions. Vertical and

Transverse Accelerations to be used are described in Pt B, Ch 5 as well.

For each structural elements, it will be selected the loading conditions (LC) that raise the most severe stresses level. Loaded cases as upright and inclined shall be considered.

For general reference:

- LC with maximum cargo on lower part of section in upright condition
- LC with maximum cargo on upper part of section in upright condition
- LC Ballast Condition
- LC generating the maximum racking moment
- LC with transversely unsymmetrical deck load
- LC with longitudinally unsymmetrical deck load
- Further LC as selected from the loading manual
- Additional LC identified by Yard as critical

In the above loading conditions, "upper part" is related to decks above the waterline at the maximum draught, and "lower part" is related to those decks below the same waterline.

Regarding the yielding and buckling verification criteria, for the isotropic "s x s" mesh, the acceptability criteria are stated in Pt B, Ch 7, Sec 3, [4.3.1] to [4.3.3]. The buckling criteria are described in Pt B, Ch 7, Sec 1, [5.4].

The load cases (in the sense of Tasneef Rules) are described in Pt B, Ch 5, Sec 4.

Loads are to be applied according to Pt B, Ch 7, App 2, [4]. In particular, the load cases (in the sense of Tasneef Rules) to be applied are "b" and "d".

4.2 Complete Ship FEM Analysis

In the case of flexible type (hinged design), a complete ship FEM model analysis according to Tasneef Rules Pt B, Ch 7, Appendix 3 is to be also prepared and verified.

The load cases (See Pt B, Ch 7, Appendix 3 Table 4) expected to be critical for racking effects are number 5 (Transverse acceleration and roll angle) and 7 (Vertical relative motion at sides in inclined ship condition, at midship section). The case 3 can be also applicable depends by the longitudinal strength shear distribution. Wave Parameters to set up a hydrodynamic calculation can be found in this Table 4. Relevant refined mesh models according to Tasneef Rules Pt B, Ch 7, App 1, [3.4.3] are to be foreseen for the areas as described in App 3, Table 1 for ro-ro cargo ships and in particular:

- Typical reinforced transverse rings
- Typical deck girders
- Areas of structural discontinuity (e.g. ramp areas)
- Collision and engine room bulkheads
- Stairway casings
- Ventilation trunks
- Racking Bulkheads

It is of the utmost importance that the refined meshing follows the requirements above. As a minimum, the webs of primary members are to be modelled with at

least three elements on their height. Higher refining may be necessary depending by the stress variation and in order to correctly read the stiffness and relevant deformation.

The boundary conditions of the model can be either applied as prescribed in Appendix 3, [2.5] or, with the inertia relief if the FEM solver supports it (e.g. with NASTRAN this is possible).

The loading conditions to be considered should be those that are likely to maximize the racking structural response i.e. maximum load on upper part of the section in order to maximize the racking moment (highest racking moment). Other loading conditions should be proposed by Yard in order to maximize other structural responses likely to be critical: for example transversely unsymmetrical deck load can be critical for deck beams and longitudinally unsymmetrical deck load can be critical for longitudinal deck girders.

The FE models shall be prepared as corroded (i.e. net model). The corrosion values shall be applied according to Tasneef Rules Part B, Chapter 4. As alternative, the models can be prepared as gross (not corroded) but applying an increase of the stresses fields.

4.3 General Considerations about PCTC "flexible type"

The following matters are highlighted to Yard that takes the responsibility to carry out the necessary verifications.

-Vertical side frames deform as a cantilever beams supported at the lowest solid deck and are only able to carry a reduced portion of the racking displacement field. Therefore bow and stern regions are than contributing as racking constraining structure together with other main structure such as engine-stair casings and strengthened ventilation trunks.

-Since on this particular design, vertical side frames are not in line with the deck transverse girder, longitudinal flexible hinges should have low torsional stiffness (i.e. flat bar is preferred) and the distance between the flexible hinge and the face plate of the side girder should be made as small as possible.

-Pillars connecting two decks have to be designed to withstand the transverse relative deflection between the decks.

-Fixed ramps between two decks have to be designed to withstand the transverse relative deflection between the decks.

-Local reinforcements for integration of equipment-outfitting on decks (e.g. ramp winches) shall be designed in compliance with the "flexible" concept.

4.4 Fatigue Verification

As first verification step, the fatigue check shall be carried out on the basis of the Cargo Holds Analysis taking into account the hot spots according to Pt B, Ch

7, App 1, [6.2]. Yard shall prepare a hot spot map depending by the number of highly stresses areas. The fatigue analysis using FEM is described in Tasneef ITPA-13-2-22. This is only a simplification of the general fatigue procedure described in Pt B, Ch 7, Sec 4. According to the procedure ITPA-13-2-22 above, the load cases to be analyzed are the “b” and “d” ones. This is consistent with the Rules provisions in Pt B, Ch 7, App 2, [4.1.2].

As second verification step, the outcome of the global FEM for yielding and buckling and relevant sub meshes is to be taken into account. If highly stresses areas are present in the fore/aft parts and the critical areas mentioned above (e.g. racking frames, collision and engine room bulkheads, stairway casings etc.) then a spectral fatigue analysis on a global FEM is required.

Annex 1 - Fatigue assessment for RO-RO structural detail - Detail 1: ends of superstructures

INPUT DATA	Explanation
Parameter	
Ship's length	ship's length according to Tasneef Rules Pt.B, Ch.1, Sec.2
Ship's design life	ship's design life (to be not less than 20 years)
Yield stress	Minimum Yield stress of the material as defined in Tasneef Rules Pt.B, Ch.7
Net thickness	Net thickness as defined in "Tasneef Procedure on fatigue calculation of details subjected mainly to longitudinal hull girder stresses" ,(1.3)
Teta	Coefficient defined in "Tasneef Procedure on fatigue calculation of details subjected mainly to longitudinal hull girder stresses"
Lambda	Mean weld toe angle as defined in "Tasneef Procedure on fatigue calculation of details subjected mainly to longitudinal hull girder stresses"
Gross section modulus	Hull girder section modulus calculated considering the gross thickness as defined in Tasneef Rules Pt.B, Ch.4, Sec.2
Net section modulus	Hull girder section modulus calculated considering the net thickness in Tasneef Rules Pt.B, Ch.4, Sec.2
Wave hogging bending moment (rule)	Wave hogging bending moment as defined in "Tasneef Procedure on fatigue calculation of details subjected mainly to longitudinal hull girder stresses", (1.1)
Wave sagging bending moment (rule)	Wave sagging bending moment as defined in "Tasneef Procedure on fatigue calculation of details subjected mainly to longitudinal hull girder stresses", (1.1)
Wave hogging bending moment (FEM)	Wave hogging bending moment applied to FEM model
Wave sagging bending moment (FEM)	Wave sagging bending moment applied to FEM model
Hot_spot_stress_hogging_ (FEM result)	Hot spot stress fro hogging condition obtained from FEM model
Hot_spot_stress_sagging_ (FEM result)	Hot spot stress fro sagging condition obtained from FEM model
OUTPUT DATA	
Hot_spot_stress_hogging	Hot spot stress hogging according to "Tasneef Procedure on fatigue calculation of details subjected mainly to longitudinal hull girder stresses" ,(1.1)
Hot_spot_stress_sagging	Hot spot stress hogging according to "Tasneef Procedure on fatigue calculation of details subjected mainly to longitudinal hull girder stresses" ,(1.1)
Delta_sigma Dss	Hot spot stress range according to "Tasneef Procedure on fatigue calculation of details subjected mainly to longitudinal hull girder stresses" ,(1.1)
Fatigue life	Fatigue life obtained according to "Tasneef Procedure on fatigue calculation of details subjected mainly to longitudinal hull girder stresses"

Annex 1 - Fatigue assessment for RO-RO structural detail - Detail 1: ends of superstructures

Fatigue assessment for RO-RO structural detail			
Detail 1: ends of superstructures			
INPUT DATA (IN RED)			
Parameter	Unit	Value	Remark
Ship's length	m	264,58	
Ship's design life	years	20	
Yield stress	N/mm ²	245	
Net thickness	mm	16	to be taken not less than 16mm
Teta	deg	30	=30° for butt joints, =45° for T-joints
Lambda		2,5	According to Table 7
Gross section modulus (See Note 1)	m ³	15	
Net section modulus	m ³	14	
Wave hogging bending moment (rule)	kNm	1000000	
Wave sagging bending moment (rule)	kNm	1000000	
Wave hogging bending moment (FEM)	kNm	500000	
Wave sagging bending moment (FEM)	kNm	480000	
Hot_spot_stress_hogging_(FEM result)	N/mm ²	55,0	
Hot_spot_stress_sagging_(FEM result)	N/mm ²	-55,0	
OUTPUT DATA (IN BLU)			
Hot_spot_stress_hogging	N/mm ²	73,7	
Hot_spot_stress_sagging	N/mm ²	-76,7	
Delta_sigma Δσ _s	N/mm ²	157,9	
Fatigue life =			check
years	46,7		OK

Figure 1 : Nominal, hot spot and notch stresses

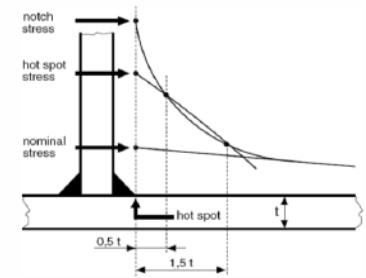


Table 7 : Weld coefficient λ

Weld configuration	Coefficient λ	
	Grind welds	Other cases
Butt joints:		
• Stresses parallel to weld axis		
- full penetration	1,85	2,10
- partial penetration	1,85	2,10
• Stresses perpendicular to weld axis		
- full penetration	2,10	2,40
- partial penetration	3,95	4,50
T joints:		
• Stresses parallel to weld axis; fillet weld and partial penetration	1,60	1,80
• Stresses perpendicular to weld axis and in plane of continuous element (T); fillet weld and partial penetration	1,90	2,15
• Stresses perpendicular to weld axis and in plane of welded element; fillet weld and partial penetration	3,95	4,50
Cruciform joints:		
• Full penetration	1,85	2,10
• Partial penetration	2,05	2,35
(1)	This case includes the hot spots indicated in the sheets of special structural details in Ch 12, Sec 2, relevant to the connections of longitudinal ordinary stiffeners with transverse primary supporting members.	

Note 1 : if the fem model has been made using net thickness the value of gross section modulus is to be input equal to net section modulus

Annex 2 - Fatigue assessment for RO-RO structural detail - Detail 2: attachment of transverse web to deck below garage

INPUT DATA	Explanation
Parameter	
Ship's length	ship's length according to Tasneef Rules Pt.B, Ch.1, Sec.2
Ship's design life	ship's design life (to be not less than 20 years)
Yield stress	Minimum Yield stress of the material as defined in Tasneef Rules Pt.B, Ch.7
Net thickness	Net thickness as defined in "Tasneef Procedure on fatigue calculation of details subjected to wheeled loads where hull girder stresses may be disregarded", (1.3)
Teta	Coefficient defined in "Tasneef Procedure on fatigue calculation of details subjected to wheeled loads where hull girder stresses may be disregarded"
Lambda	Mean weld toe angle as defined in "Tasneef Procedure on fatigue calculation of details subjected to wheeled loads where hull girder stresses may be disregarded"
Case "b"	
Hot_spot_stress_case_b	Stress obtained from FEM as defined in "Tasneef Procedure on fatigue calculation of details subjected to wheeled loads where hull girder stresses may be disregarded", (1.1.1)
Vertical acceleration az1	Vertical acceleration as defined in "Tasneef Procedure on fatigue calculation of details subjected to wheeled loads where hull girder stresses may be disregarded", (1.1.1)
Case "d"	
Hot_spot_stress_d_port racking	Stress obtained from FEM as defined in "Tasneef Procedure on fatigue calculation of details subjected to wheeled loads where hull girder stresses may be disregarded", (1.1.2)
Hot_spot_stress_d_stbd racking	Stress obtained from FEM as defined in "Tasneef Procedure on fatigue calculation of details subjected to wheeled loads where hull girder stresses may be disregarded", (1.1.2)
OUTPUT DATA	
Delta_sigma_case b $\Delta\sigma_s$	Hot spot stress range as defined in "Tasneef Procedure on fatigue calculation of details subjected to wheeled loads where hull girder stresses may be disregarded", (1.1)
Delta_sigma_case d $\Delta\sigma_s$	Hot spot stress range as defined in "Tasneef Procedure on fatigue calculation of details subjected to wheeled loads where hull girder stresses may be disregarded", (1.1)
Fatigue life	Fatigue life obtained according to "Tasneef Procedure on fatigue calculation of details subjected to wheeled loads where hull girder stresses may be disregarded"

Annex 2 - Fatigue assessment for RO-RO structural detail - Detail 2: attachment of transverse web to deck below garage

Fatigue assessment for RO-RO structural detail			
Detail 2: attachment of transverse web to deck below garage			
INPUT DATA			
Parameter	Unit	Value	Remark
Ship's length	m	205	
Ship's design life	years	30	
Yield stress	N/mm ²	326	
Net thickness	mm	25	to be taken not less than 16mm
Teta	deg	30	(30° for butt joints, 45° for T-joints)
Lambda		2.35	According to Table 7
Case "b"			
Hot_spot_stress_case_b	N/mm ²	300	(includes static+dynamic)
Vertical acceleration az1	m/s ²	4.45	at current x co-ordinate
Case "d"			
Hot_spot_stress_d_port racking	N/mm ²	123.4	
Hot_spot_stress_d_stbd racking	N/mm ²	-100	
OUTPUT			
Delta_sigma_case b $\Delta\sigma_s$	N/mm ²	199.7	
Delta_sigma_case d $\Delta\sigma_s$	N/mm ²	223.4	
Fatigue life =		years 9.5	check NOT OK

Figure 1 : Nominal, hot spot and notch stresses

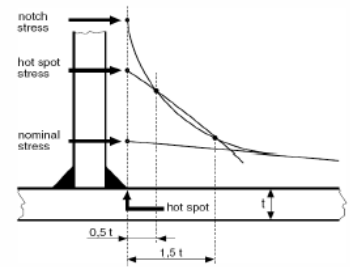


Table 7 : Weld coefficient λ

Weld configuration	Coefficient λ	
	Grind welds	Other cases
Butt joints:		
• Stresses parallel to weld axis		
- full penetration	1,85	2,10
- partial penetration	1,85	2,10
• Stresses perpendicular to weld axis		
- full penetration	2,10	2,40
- partial penetration	3,95	4,50
T joints:		
• Stresses parallel to weld axis: fillet weld and partial penetration	1,60	1,80
• Stresses perpendicular to weld axis and in plane of continuous element (T): fillet weld and partial penetration	1,90	2,15
• Stresses perpendicular to weld axis and in plane of welded element: fillet weld and partial penetration	3,95	4,50
Cruciform joints:		
• Full penetration	1,85	2,10
• Partial penetration	2,05	2,35
(1) This case includes the hot spots indicated in the sheets of special structural details in Ch 12, Sec 2, relevant to the connections of longitudinal ordinary stiffeners with transverse primary supporting members.		