Tasneef

هيئة الإمارات للتصنيف
Emirates Classification Society

Amendments to the "Guide on Complete Ship Model Calculation of Passenger Ships"

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1 INTRODUCTION

1.1 General

From the structural point of view, passenger ships are characterized by several orders of superstructures and deckhouses contributing to the longitudinal strength. According to Pt B, Ch 6, Sec 1, [2.2], the level of contribution of each of these elements is to be obtained through a finite element analysis of the whole ship.
The purpose of the Guide is to detail the procedure for the above analyses, taking into account the general arrangement of the longitudinal elements (side, decks, bulkheads) and the specific characteristics of passenger ships (windows, large openings, recesses, pillaring systems).

1.2 Reference to the Tasneef Rules for the Classification of Ships

In this Guide, reference to the Tasneef Rules for the Classification of Ships is made to the relevant Part, Chapter, Section etc. (e.g. Pt B, Ch 7, App 3, [1.2]).

1.3 Symbols used in this Guide

T1 : draught, in m, as defined in 2.4.2

T2 : draught, in m, as defined in 2.4.3

$M_{SW,H1}$: hogging still water bending moment, in kNm, in loading condition LC 1, refer to 2.4.2

$M_{SW,S2}$: sagging – or minimum hogging - still water bending moment, in kNm, in loading condition LC 2, refer to 2.4.3

$M_{SW,H}$: design still water bending moment, in kNm, in hogging conditions, defined in Pt B, Ch 5, Sec 2, [2.2]

$M_{SW,S}$: design still water bending moment, in kNm, in sagging conditions, defined in Pt B,Ch 5, Sec 2, [2.2]

$M_{WV,H}$: vertical wave bending moment, in kNm, in hogging conditions, defined in Pt B, Ch5, Sec 2, [3.1]

$M_{WV,S}$: vertical wave bending moment, in kNm, in sagging conditions, defined in Pt B, Ch 5, Sec 2, [3.1]

M_{WH} : horizontal wave bending moment, in kNm, defined in Pt B, Ch5, Sec 2, [3.2]

$Q_{SW,H1}$: still water shear force, in kN, in loading condition LC 1, refer to 2.4.2

$Q_{SW,S2}$: still water shear force, in kN, in loading condition LC 2, refer to 2.4.3

Q_{SW} : design still water shear force, in kN, defined in Pt B, Ch 5, Sec 2, [2.3]

$Q_{WV,H}$: vertical wave shear force, in KN, obtained as a derivative of $M_{WV,H}$

$Q_{WV,S}$: vertical wave shear force, in KN, obtained as a derivative of $M_{WV,S}$

Q_{WV} : vertical wave shear force, in kN, defined in Pt B, Ch 5, Sec 2, [3.4]

R_{eH} : Minimum yield stress, in N/mm^2, of the material, defined in Pt B, Ch 4, Sec 1, [2]

k : Material factor, defined in Pt B, Ch 4, Sec 1, [2.3]

R_y : Minimum yield stress, in N/mm^2, of the material, to be taken equal to 235/k, unless otherwise specified.

2 COMPLETE SHIP MODEL

2.1 General

2.1.1 Purpose of the analysis

This analysis aims to assess the contribution of superstructures or deckhouses to the hull girder strength and to evaluate the hull overall strength.
For this purpose, a finite element model of the ship is to be produced and subjected to design still water and wave hull girder loads, in order to obtain the stress level in the various structural elements contributing to the hull girder strength and perform the strength checks required by the Rules.
In the case of structural symmetry with respect to the ship's centreline longitudinal plane, as occurs in most cases, the hull structures may be modelled over half the ship's breadth.
In the case of unusual structural arrangement, for which this symmetry may not be exploited, the structural model is to be extended over the whole breadth.

2.1.2 Information required

The necessary information is listed in Pt B, Ch 7, App 3, [1.2].

2.1.3 Calculation report

A detailed report describing the calculation carried out is to be submitted to the Society for the approval of the ship's structures.
This report is to contain the following information:

- List of drawings used for the creation of the model
- Plots of element types used in the model
- Plots of the geometrical properties of the elements
- Plots of the mechanical properties of the materials used for all elements
- Details of the boundary conditions
- Distributions of the applied loads
- Distributions of the bending moments and shear force applied to the model
- Details of the reaction force in way of constraints
- Plots of the deflections of the model
- Plots of the normal stresses
- Plots of the shear stresses
- Plots of the Von Mises Equivalent Stresses
- Plate and pillar buckling analysis and results

Summary describing the global and local checks carried out and their compliance with the Rule Requirements.

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$$\beta_{Q_y} = \frac{\left(-M_m \sigma_{y-q} + M_q \sigma_{y-m}\right)}{\left(M_q Q_m - M_m Q_q\right)}$$

$$\beta_{Q_{xy}} = \frac{\left(-M_m \tau_{xy-q} + M_q \tau_{xy-m}\right)}{\left(M_q Q_m - M_m Q_q\right)}$$

2.9.4 Global stress correction (factorization)

Where the resultant hull girder shear force and/or bending moment in the FE model is significantly different from required shear force and/or bending moment, the stresses are to be corrected as follows:

$$\sigma_x = \sigma_{x-FEM} + \alpha_{M_x} \Delta M + \beta_{Q_x} \Delta Q$$
$$\sigma_y = \sigma_{y-FEM} + \alpha_{M_y} \Delta M + \beta_{Q_y} \Delta Q$$
$$\tau_{xy} = \tau_{xy-FEM} + \alpha_{M_{xy}} \Delta M + \beta_{Q_{xy}} \Delta Q$$

Where:

$\sigma_x, \sigma_y, \tau_{xy}$: are the factorized direct stresses and shear stress at the element centroid ,

$\sigma_{x-FEM}, \sigma_{y-FEM}, \tau_{xy-FEM}$: are the finite element direct stresses and shear stress at the element centroid*,*

ΔM : is the difference between the required bending moment and the resultant bending moment from the finite element model at the longitudinal position of the element,

ΔQ : is the difference between the required shear force and resultant shear force from the finite element model at the longitudinal position of the element.

2.9.5 Alternative means of stress correction

Alternative means for the procedure of stress correction will be specially considered by the Society.

3 REFINED LOCAL ANALYSES

3.1 General

As specified in Pt B, Ch 7, App 3, [2.3], some areas characterized by structural discontinuities are to be assessed by means local analyses with more refined models than the one described in the previous chapter.
Therefore, these analyses aim at evaluating the stress concentrations in way of the structural discontinuities, to be compared with the allowable values as per the Tasneef Rule criteria.

In addition to the general criteria detailed in Pt B, Ch 7, App 3, the following articles provide more specific criteria for the local analyses of typical structural details of passenger ships.

3.2 Areas to be analysed by means of refined local models

In general, the following areas are to be assessed by means of refined local analyses:

- large deck openings (stairs, lifts),
- side and longitudinal bulkhead's openings in areas of significant hull girder shear force,
- in way of structural discontinuities at the uppermost decks,
- ends of superstructures or large screens/bulwarks.

Furthermore, the areas that the complete ship model analysis has indicated to be highly stressed are generally to be further analysed.

3.3 Modelling criteria

The structural elements in the above areas are to be modeled adopting a fine mesh, as specified in Pt B, Ch 7, App 3, [2.4.3], see Fig 5.
In the close vicinity of the opening corners a more refined mesh (very fine mesh) is to be adopted in order to properly represent the structural detail as required by Pt B, Ch 7, App 3, [2.4.4], see Fig 6 ~~Fig 2~~.
The element mesh size used in the way of openings corners should be such that to ensure at least 12 elements in a 90 degree arc of the edge of the plate.
The element size should not be greater than 50x50mm with at least two rows of elements surrounding the opening corner as much as regular as possible, avoiding triangular elements and with an aspect ratio close to 1.
The model is to be made using the gross scantlings.
In general, it may be convenient to carry out separate analyses of the areas concerned, where the boundary conditions are constituted by the nodal displacements and rotations obtained from the complete ship model analysis. In these cases, is recommended that nodal displacements and rotations to be assigned to very fine mesh models are based on finely mesh modelled parts, in such a way to better represent the local hull stiffness.
However, it is also acceptable localised refined mesh models being incorporated in the complete ship models and assessed at same time. In these cases, transition zones should be properly arranged avoiding too rapid element refinements.

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1, Sec 2, [4] considering the members contributing to the longitudinal strength up to $\overline{z_s}$.

$\overline{z_s}$: Z co-ordinate in the midship section, in m, of the uppermost continuous fully effective deck, with respect to the reference co-ordinate system defined in Pt B, Ch 1, Sec 2, [4].

$\overline{z_{NA}}$: Z co-ordinate, in m, of the neutral axis of the hull transverse section as considered above, with respect to the reference co-ordinate system defined in Pt B, Ch 1, Sec 2, [4].
B: moulded breadth, in m, defined in Pt B, Ch 1, Sec 2, [3.4].

Alternative methods for the derivation of hot spot stress ranges in the inclined cases will be specially considered by the Society.

3.6.2.2 Elementary notch stress range

The elementary notch stress range, in N/mm², is given by:

$$\Delta\sigma_{N,i} = 0{,}7 K_F K_C \Delta\sigma_{S,i}$$

$$\Delta\sigma_{N,i} = 0{,}7 K_F K_C f_{material} \Delta\sigma_{S,i}$$

Where *i* denotes the load cases “a”, “b,” “c” or “d” and K_F is the fatigue notch factor (reference to Pt B, Ch 7, Sec 4 [3.3.1]) equal to the following formula $K_F = \lambda\sqrt{\frac{\theta}{30}}$ for welded joints in the different configurations, using the values in Table 7 and Table 8.
For free edges, K_F is to be taken as prescribed in Table 9

Table 7: weld coefficient λ

	Grinded	Not grinded
Stresses parallel to weld axis	1,39	1,8
Stresses perpendicular to weld axis	1,66	2,15

Table 8: mean weld toe angle θ

Grinded	Not grinded
Only full/partial penetration (no fillet weld allowed)	Either full/partial penetration or fillet weld
45°	30° or 45° according to the welding geometry

Table 9: K_F for free edges

	Grinded	Not grinded
Free edges plasma or laser cut	1,4	1,57

The value of K_C (reference to Pt B, Ch 7, Sec 4 [3.3.1]) can be calculated using the following formula:

$$K_C = \frac{0{,}4 R_y}{\Delta\sigma_S} + 0{,}6 \quad \text{with} \quad 0{,}8 \le K_C \le 1$$

$f_{material}$ is the material factor to be taken as follows:

$f_{material} = 1$ for welded joints

$f_{material} = 1200/(965 + R_{eH})$ for free edges

3.6.2.3 Equivalent notch stress range

The equivalent notch stress range, in N/mm², is to be obtained by:

$$\Delta\sigma_{N,eq} = \left(\frac{\mu\Delta\sigma_{N,a}{}^3 + \mu\Delta\sigma_{N,c}{}^3}{2}\right)^{1/3}$$

Where:
It is assumed $\Delta\sigma_{N,b} = \Delta\sigma_{N,a}$ and $\Delta\sigma_{N,d} = \Delta\sigma_{N,c}$

$$\mu = 1 - \frac{\Gamma_N\left[\frac{3}{\xi}+1, \nu\right] - \Gamma_N\left[\frac{5}{\xi}+1, \nu\right]\nu^{-2/\xi}}{\Gamma_C\left[\frac{3}{\xi}+1\right]}$$

$$\xi = \frac{73 - 0{,}07L}{60} \ge 0{,}85$$

$$\nu = \left(\frac{S_q}{\Delta\sigma_N}\right)^{\xi} \ln N_R$$

$$S_q = \left(K_p 10^{-7}\right)^{1/3}$$

$$K_p = 5{,}802\left(\frac{22}{t}\right)^c 10^{12}$$

Where the thickness exponent *c* in the different relevant configurations can be found in Table 10 below.

Table 10: thickness exponent c

Free edge	0,3	
Welded joint	Grinded	Not grinded
	0,6	0,75

$N_R = 10^5$

t: net thickness, in mm, of the element under consideration is not to be taken less than 22 mm

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4.1.1 Loads

The following load cases defined in Table 11 are to be considered.

Table 11: load cases - deck primary members

Still water loads	~~Water~~ Wave loads	Local load	Partial safety factors
$\gamma_s M_{SW,H}$	0,625 $\gamma_w M_{WV,H}$	$p_s (1+ \gamma_w a_{z1}/g)$	γ_s = 1,00
$\gamma_s Q_{SW,H}$	0,625 $\gamma_w Q_{WV,H}$	(1)	γ_w = 1,10
(1) a_{z1} is the vertical acceleration in the “b” load case, calculated according to Pt B, Ch 5, Sec 3, [3.4]			

For the analysis of deck reinforced longitudinal girders the direct stresses due to the application of maximum hull girder hogging/sagging global cases are also to be included.
To that scope, stress decomposition needs to be carried out to obtain global and local components and corrected these following the procedures in [2.9.4] and [4.1.1.1] respectively.

4.1.1.1 Correction of local stresses

Local stresses components can be obtained by the following formulae:

$$\sigma_{x-l} = \sigma_{x-FEM} - (\alpha_{M_x} M + \beta_{Q_x} Q)$$
$$\sigma_{y-l} = \sigma_{y-FEM} - (\alpha_{M_y} M + \beta_{Q_y} Q)$$
$$\tau_{xy-l} = \tau_{xy-FEM} - (\alpha_{M_{xy}} M + \beta_{Q_{xy}} Q)$$

Where:

σ_{x-l}, σ_{y-l}, τ_{xy-l}: local direct stresses and shear stresses at the element centroid,

$\sigma_{x-FEM}, \sigma_{y-FEM}, \tau_{xy-FEM}$: finite element direct stresses and shear stress at the element centroid,

M and *Q*: resultant bending moment and shear force from the finite element moment at the longitudinal position of element centroid,

$\alpha_{M_x}, \alpha_{M_y}, \alpha_{M_{xy}}$: influence factors for bending moment, calculated in [2.9.2],

$\beta_{Q_x}, \beta_{Q_y}, \beta_{Q_{xy}}$: influence factors for shear force, calculated in [2.9.2].

The local stresses components as above calculated are to be amplified by means of factor *(1+ γ_w a_{z1}/g)* in order to reach the design inertial deck loads.

4.1.2 Checking criteria of fine mesh models

It is to be checked that the equivalent stress σ_{VM} and the shear stress τ calculated are in compliance with Pt B, Ch 7, Sec3, [5.3] and thus with the following formulae:

$$\sigma_{VM} \le \frac{R_Y}{\gamma_m \gamma_R}$$

$$\tau_{xy} \le 0{,}5 \frac{R_Y}{\gamma_m \gamma_R}$$

using γ_m = 1,02 and γ_R = 1,10 as prescribed in Pt B, Ch 7, Sec 3, Table 4.

Buckling checks of associated plating: ref. to Tasneef Rules, Pt B, Ch 7, Sec 1, [5.3].

4.1.3 Checking criteria of refined mesh models

Peak stress check and fatigue check verifications as described in [3.6.1] and [3.6.2] are to be performed.

4.2 Pillars

4.2.1 Loads

Compressive normal stresses may be obtained from the deck partial models, on the basis of reaction forces in the vertical direction, where constraints have been placed in way of pillar positions.

4.2.2 Checking criteria

Buckling checks of pillars are to be conducted in accordance with Pt B, Ch 7, Sec 3, [6.2.2].

Boundary condition of the pillar is to be:
$f = \sqrt{2}/2$ with brackets, $f = 1$ in other case.

5 GUIDELINE ON STRUCTURAL VERIFICATIONS OF STEEL STRUCTURES OF GLAZED COVERS (MAGRODOME AND GLAZED ROOFS)

5.1 General

This paragraph [5] contains a guideline for the strength verification of the steel structures of glazed covers according to Tasneef requirements.
Note:

- The guideline in this paragraph covers the strength verifications required in Part B of the Tasneef Rules for the Classification of Ships. Any further check relevant to the proper operation of glazed covers is the responsibility of the supplier, including structural checks during opening/closing scenario.
- Global hull girder displacements are provided, in order to take into account their effects on sliding cover structure if it (or only a part of it) is sensible to the longitudinal forced displacements.
- Deck main scantling plan is provided in order to evaluate restraint conditions. It is recommended

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