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EVALUATION OF THE VERTICAL STRENGHT OF A 3000 TDW BARGE USING THE EQUIVALENT BEAM APPROACH

Dumitru-Silviu Perijoc
"Dunarea de Jos" University of Galati,
Faculty of Naval Architecture,Galati,
47 Domneasca Street,800008,Romania,
E-mail: silviu.perijoc@ugal.ro

Leonard Domnișoru
"Dunarea de Jos" University of Galati,
Faculty of Naval Architecture,Galati,
47 Domneasca Street, 800008,Romania,
E-mail: leonard.domnisoru@ugal.ro

ABSTRACT

For the preliminary design stage, the evaluation of vertical strength is mandatory for the preliminary scantling of the structure. This paper presents the evaluation of the vertical sectional efforts by equivalent beam approach, using the 3D-CAD lines plan of a 3000 tdw barge and mass diagram. For numerical analysis the own program P_QSW is used, for sagging and hogging wave condition, ship headings 0 and 45º, wave height max. 1.2 m. The vertical sectional efforts are compared with the maximum bending moment and shearing force prescribed by the classification societies for the 3000 tdw preliminary vertical strength assessment.

Keywords: equivalent beam formulation, barge structure, maximum vertical sectional efforts.

1. INTRODUCTION

The current paper presents the evaluation of the vertical sectional efforts of a 3000 tdw barge, which is characterised by a large deck opening and prismatic shape. The numerical analysis is done with the P_QSW program code [1]. The program evaluates the sectional efforts employing a 1D mass distribution and a 3D-CAD ship lines description [2].

Table 1. Barge description [2]

Length overall	L_{OA}(m)	90
Breadth	B(m)	11
Depth	D(m)	4.5
Draught	T(m)	3.8
Displacement, Lightship	Δ_{light}(t)	507.5
Displacement, Ballast	$\Delta_{ballast}$(t)	529.5
Displacement, Full load	Δ_{full}(t)	3620.8
c_b	-	0.923
Ballast, no trim condition	$M_{ballast}$(t)	22

2.THEORETICAL BACKGROUND

The numerical formulation consists of the classical formulation for the evaluation of vertical bending moments, shear forces computed for the equivalent ships beam [3].

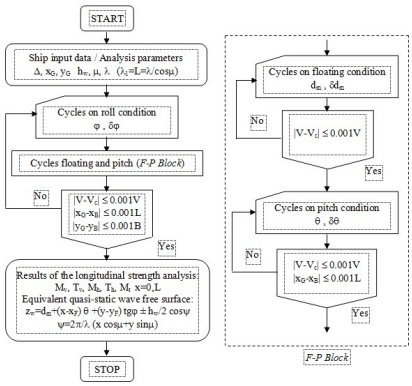

Fig. 1. P_QSW code scheme [1]

The calculation is performed for a free-floating condition, having as result the sectional efforts acting on the given barge girder and compared with the maximum

values prescribed by the classification societies [4]. The resulting equilibrium parameters can be also used for the loading definition of the 3D finite element models, thus insuring the proper loading with equivalent design wave pressures.

3. EVALUATION OF 3000 TDW BARGE VERTICAL EFFORTS – BALLAST LOADING

The following data present the results for the ballast loading scenario:
-Tables 2-5 present the maximum value calculated for the vertical bending moment and shear force, heading angles of 0º and 45º, hogging and sagging conditions.
-Figures 2-9 present the vertical bending moments and shearing forces diagrams.

Table 2. Ballast loading, hogg, 0º

	Hw	0	0.3	0.6	0.9	1.2
VBM	MAX.VALUE	6.48E+03	1.19E+04	1.72E+04	2.23E+04	2.66E+04
	% RULE	7.4%	13.7%	19.8%	25.6%	30.6%
VSF	MAX.VALUE	2.84E+02	3.93E+02	5.83E+02	7.77E+02	9.53E+02
	% RULE	8.3%	11.5%	17.1%	22.8%	27.9%

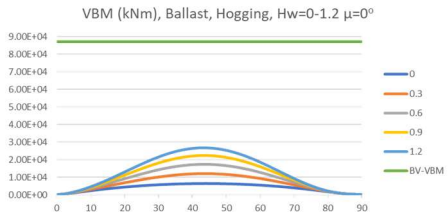

Fig. 2. VBM [kNm], ballast, hogg, 0º

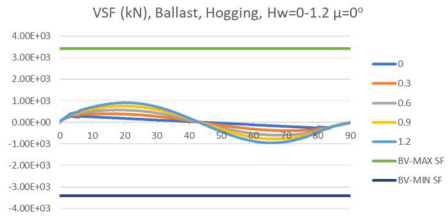

Fig. 3. VSF [kN], ballast, hogg, 0º

Table 3. Ballast loading, sagg, 0º

	Hw	0	0.3	0.6	0.9	1.2
VBM	MAX.VALUE	6.48E+03	2.28E+03	4.69E+03	1.04E+04	1.61E+04
	% RULE	7.4%	2.6%	5.4%	11.9%	18.5%
VSF	MAX.VALUE	2.84E+02	2.42E+02	2.77E+02	4.87E+02	6.98E+02
	% RULE	8.3%	7.1%	8.1%	14.3%	20.5%

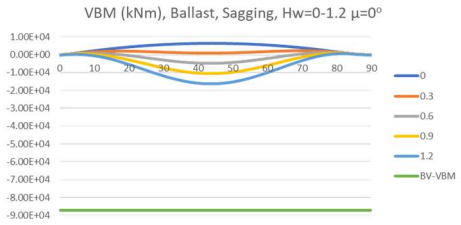

Fig. 4. VBM [kNm], ballast, sagg, 0º

Fig. 5. VSF [kN], ballast, sagg, 0º

Table 4. Ballast loading, hogg, 45º

	Hw	0	0.3	0.6	0.9	1.2
VBM	MAX.VALUE	6.48E+03	1.15E+04	1.65E+04	2.12E+04	2.51E+04
	% RULE	7.4%	13.3%	18.9%	24.3%	28.8%
VSF	MAX.VALUE	2.84E+02	3.80E+02	5.54E+02	7.34E+02	8.87E+02
	% RULE	8.3%	11.1%	16.3%	21.5%	26.0%

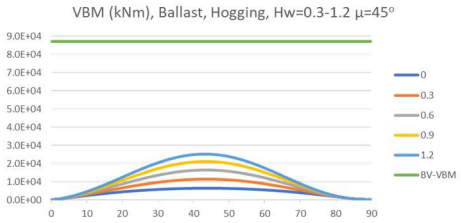

Fig. 6. VBM [kNm], ballast, hogg, 45º

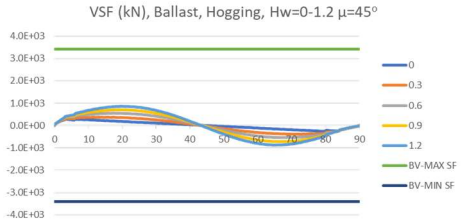

Fig. 7. VSF [kN], ballast, hogg, 45º

Table 5. Ballast loading, sagg, 45°

	Hw	0	0.3	0.6	0.9	1.2
VBM	MAX.VALUE	6.48E+03	2.41E+03	3.87E+03	9.14E+03	1.45E+04
	% RULE	7.4%	2.8%	4.4%	10.5%	16.6%
VSF	MAX.VALUE	2.84E+02	2.45E+02	2.48E+02	4.41E+02	6.36E+02
	% RULE	8.3%	7.2%	7.3%	12.9%	18.7%

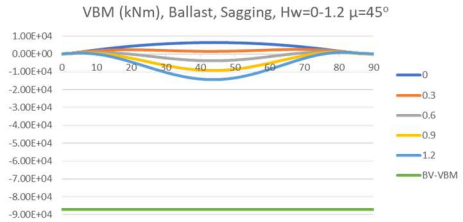

Fig. 8. VBM [kNm], ballast, sagg, 45°

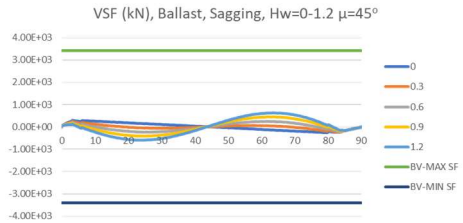

Fig. 9. VSF [kN], ballast, sagg, 45°

4. EVALUATION OF 3000 TDW BARGE VERTICAL EFFORTS – FULL LOAD

The following data present the results for the full loading scenario:

-Tables 6-9 present the maximum values of the vertical bending moments, shearing forces and the percentage from the rule statistic value.

-Figures 10-17 present the vertical efforts diagrams for wave heights 0-1.2 m and heading angles of 0 and 45 degrees.

Table 6. Full load, hogg, 0°

	Hw	0	0.3	0.6	0.9	1.2
VBM	MAX.VALUE	4.76E+04	4.10E+04	3.44E+04	2.78E+04	2.17E+04
	% RULE	55%	47%	39%	32%	25%
VSF	MAX.VALUE	2.29E+03	2.14E+03	1.99E+03	1.85E+03	1.73E+03
	% RULE	67.1%	62.8%	58.4%	54.1%	50.6%

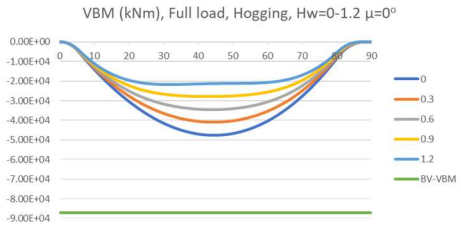

Fig. 10. VBM [kNm], full, hogg, 0°

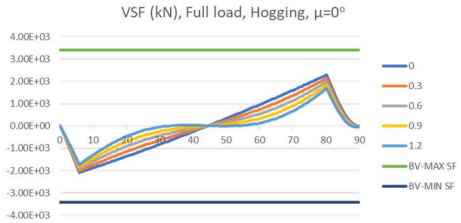

Fig. 11. VSF [kN], full, hogg, 0°

Table 7. Full load, sagg, 0°

	Hw	0	0.3	0.6	0.9	1.2
VBM	MAX.VALUE	4.76E+04	5.42E+04	6.08E+04	6.74E+04	7.40E+04
	% RULE	55%	62%	70%	77%	85%
VSF	MAX.VALUE	2.29E+03	2.43E+03	2.58E+03	2.73E+03	2.88E+03
	% RULE	67.1%	71.4%	75.7%	80.0%	84.3%

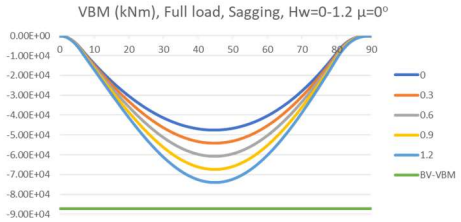

Fig. 12. VBM [kNm], full, sagg, 0°

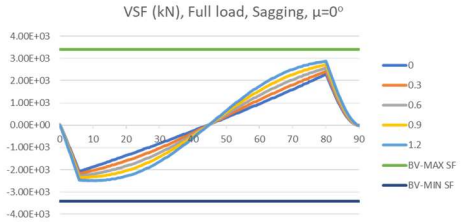

Fig. 13. VSF [kN], full, sagg, 0°

Table 8. Full load, hogg, 45°

	Hw	0	0.3	0.6	0.9	1.2
VBM	MAX.VALUE	4.76E+04	4.15E+04	3.53E+04	2.92E+04	2.33E+04
	% RULE	55%	48%	41%	34%	27%
VSF	MAX.VALUE	2.29E+03	2.15E+03	2.01E+03	1.88E+03	1.75E+03
	% RULE	67.1%	63.1%	59.1%	55.1%	51.4%

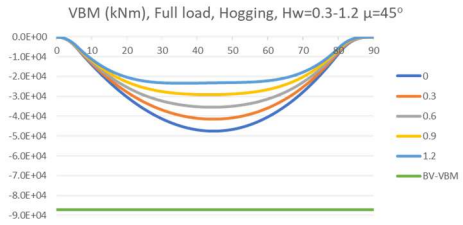

Fig. 14. VBM [kNm], full, hogg, 45°

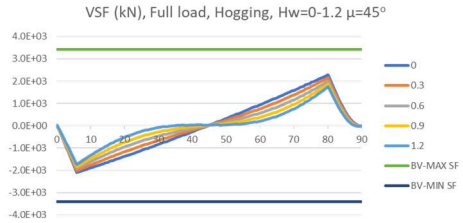

Fig. 15. VSF [kN], full, hogg, 45°

Table 9. Full load, sagg, 45°

	Hw	0	0.3	0.6	0.9	1.2
VBM	MAX.VALUE	4.76E+04	5.37E+04	5.99E+04	6.60E+04	7.21E+04
	% RULE	55%	62%	69%	76%	83%
VSF	MAX.VALUE	2.29E+03	2.42E+03	2.56E+03	2.70E+03	2.83E+03
	% RULE	67.1%	71.1%	75.1%	79.1%	83.1%

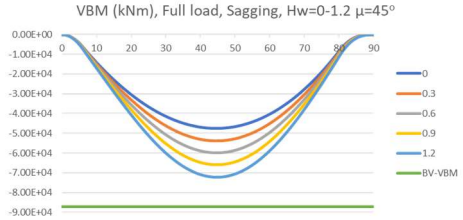

Fig. 16. VBM [kNm], full, sagg, 45°

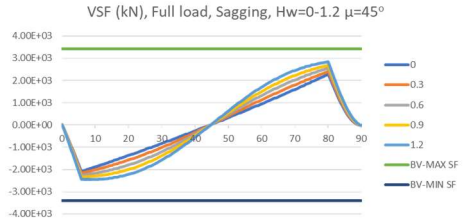

Fig. 17. VSF [kN], full, sagg, 45°

5. CONCLUSIONS

From the performed numerical analysis described within the framework of this paper, the following conclusions are formulated:

1. The results for the sectional efforts of the barge hull, reported to the statistical approach of the classification societies resulted in lower overall values for the vertical bending moment and vertical shear force in all the analysed cases.
2. The maximum values of the vertical bending moment ware obtained in the full loading case scenario, for the wave height h_w=1.2 m, sagging wave, heading angle of 0°, having a maximum value of 7.21E+04 kNm (84.3% from Rule statistical maximum VBM [4]).
3. The maximum vertical shearing force that resulted from the analysis corresponds to the full load condition, a wave height h_w=1.2 m, heading angle of 0°, having a maximum value of 2.83E+03 kN (83.1% from Rule statistical maximum VSF [4]).
4. The resulted equilibrium parameters by the P_QSW program code [1] analysis will be used on extended structural studies for proper loading of a 3D FEA model.

Acknowledgements

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