THE ANNALS OF "DUNAREA DE JOS" UNIVERSITY OF GALATI
FASCICLE XI – SHIPBUILDING. ISSN 1221-4620
2017

DRILLSHIP GLOBAL STRENGTH ANALYSIS UNDER OBLIQUE EQUIVALENT DESIGN WAVES

Leonard Domnisoru
"Dunarea de Jos" University of Galati,
Faculty of Naval Architecture,
Galati, Domneasca Street, No. 47, 800008, Romania,
E-mail: leonard.domnisoru@ugal.ro

ABSTRACT

For the design of off-shore drillships, one of the criteria for initial strength assessment is based on global strength analysis under oblique equivalent design waves (EDW). The global strength procedure is based on an iterative approach, taking into account the ship hull external shape non-linearities, for a set of heading angles and design wave heights according to shipbuilding classification societies rules. This study analyzes the global strength of a drillship having 210 m length, for two relevant displacement cases. The numerical analysis is done by own code, delivering the ship-wave relative position and the generated wave loads. The results are compared to the limit values from several shipbuilding rules and the initial drillship strength is evaluated.

Keywords: drillship, equivalent design wave, oblique waves, initial strength assessment.

1. INTRODUCTION

For the initial design of an off-shore drillship several evaluation criteria are to be checked according to the shipbuilding rules [9].

In previous studies we have presented the hydroelastic response analysis in irregular head waves [6] and the seakeeping response analysis in irregular oblique waves [8] of a large drillship, with maximum length of 210 m, several operation speeds and sea states, and two different loading conditions.

For the same drillship, this analysis is focused on the strength evaluation in the initial design stage under the loads of the equivalent design waves (EDW) [10],[15], according to the shipbuilding classification societies rules [9].

For the strength analysis we use an own developed iterative procedure, modelling the external hull shape non-linearities, for different oblique EDW waves, by program P_QSW. The theoretical elements are in detail presented in reference [7]. The results are delivering the EDW wave limits from global strength criteria.

2. THE DRILLSHIP DATA

The drillship main data are:
- the drillship characteristics and the two loading cases (Table 1) [6],[8];
- the external shape lines of the drillship (Fig.1) [6];
- the mass distributions are considered from reference [6];

Table 1. The drillship characteristics and the two loading cases [6],[8]

L [m]	210	Δ_2 [t]	67868.5
B [m]	34	T_{m2} [m]	12.085
H [m]	17.5	x_{G2} [m]	99.85
ρ [t/m^3]	1.025	y_{G2} [m]	0
g [m/s^2]	9.81	z_{G2} [m]	10.12
N_e	40	z_{R2} [m]	10.10
Δ_1 [t]	59217.5	δx [m]	0.7 ÷ 14.7
T_{m1} [m]	10.684	μ [deg]	0 ÷ 75
x_{G1} [m]	100.56	$\delta\mu$ [deg]	15
y_{G1} [m]	0	h_w [m]	0÷9.896(10)
z_{G1} [m]	10.08	EDW length	$\lambda_1=L$
z_{R1} [m]	10.10		$\lambda=\lambda_1\cos\mu$

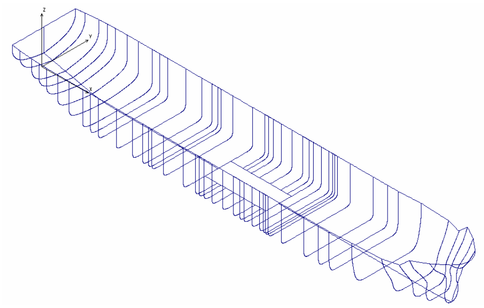

Fig.1.The external shape lines of the drillship

3. THE STRENGTH ANALYSIS FOR THE FIRST LOADING CASE

Table 2. First case Δ_1 equilibrium parameters

drillship 1		sagging			hogging		
μ[deg]	h_w[m]	0	5	9.896	0	5	9.896
0	x_F[m]	96.419	96.850	97.237	96.419	95.967	95.578
	y_F[m]	0.000	0.000	0.000	0.000	0.000	0.000
	T_m[m]	10.685	10.751	10.778	10.685	10.584	10.449
	θ[rad]	-0.002	0.004	0.010	-0.002	-0.009	-0.016
	φ[rad]	0.000	0.000	0.000	0.000	0.000	0.000
	z_H[m]	3.697	3.923	4.471	3.697	3.847	4.283
15	x_F[m]	96.419	96.845	97.227	96.419	95.971	95.584
	y_F[m]	0.000	0.001	0.001	0.000	-0.001	-0.002
	T_m[m]	10.685	10.751	10.778	10.685	10.584	10.451
	θ[rad]	-0.002	0.004	0.010	-0.002	-0.009	-0.016
	φ[rad]	0.000	0.000	0.000	0.000	-0.001	-0.002
	z_H[m]	3.697	3.924	4.475	3.697	3.849	4.288
30	x_F[m]	96.419	96.845	97.227	96.419	95.986	95.607
	y_F[m]	0.000	0.001	0.001	0.000	-0.003	-0.005
	T_m[m]	10.685	10.751	10.778	10.685	10.586	10.457
	θ[rad]	-0.002	0.004	0.010	-0.002	-0.009	-0.015
	φ[rad]	0.000	0.000	0.000	0.000	-0.002	-0.004
	z_H[m]	3.697	3.924	4.475	3.697	3.854	4.306
45	x_F[m]	96.419	96.781	97.098	96.419	96.025	95.664
	y_F[m]	0.000	0.003	0.003	0.000	-0.004	-0.008
	T_m[m]	10.685	10.751	10.785	10.685	10.590	10.472
	θ[rad]	-0.002	0.003	0.008	-0.002	-0.008	-0.014
	φ[rad]	0.000	0.002	0.002	0.000	-0.003	-0.007
	z_H[m]	3.697	3.938	4.521	3.697	3.866	4.349
60	x_F[m]	96.419	96.656	96.844	96.419	96.135	95.832
	y_F[m]	0.000	0.005	0.007	0.000	-0.006	-0.013
	T_m[m]	10.685	10.750	10.792	10.685	10.602	10.513
	θ[rad]	-0.002	0.001	0.004	-0.002	-0.006	-0.011
	φ[rad]	0.000	0.003	0.005	0.000	-0.005	-0.011
	z_H[m]	3.697	3.958	4.581	3.697	3.893	4.443
75	x_F[m]	96.419	96.180	95.943	96.419	96.641	95.973
	y_F[m]	0.000	0.006	0.012	0.000	-0.005	-0.015
	T_m[m]	10.685	10.727	10.756	10.685	10.636	10.539
	θ[rad]	-0.002	-0.006	-0.010	-0.002	0.001	-0.009
	φ[rad]	0.000	0.005	0.011	0.000	-0.004	-0.012
	z_H[m]	3.697	3.921	4.446	3.697	3.889	4.489

In the case of first loading case of the drillship, using the iterative procedure from reference [7], the next results are obtained:

- Table 2, the equilibrium parameters drill-ship-EDW wave: h_w wave height, μ heading angle, x_F, z_F the wave medium plane centre, d_m, θ, φ the sinkage, trim and roll angles of the wave medium plane into the reference of the drillship base plan, z_H the pressure centre vertical position, ζ_w wave free surface in the (x,y,z) drillship coordinates system (1);

$$\zeta_w(x,y)=T_m+(x-x_F)\cdot\theta+(y-y_F)\cdot tg(\varphi) \pm\frac{h_w}{2}\cos\left[\frac{2\pi}{\lambda}(x\cos\mu+y\sin\mu)\right] \quad (1)$$

$$h_{w\,\max}=10.75-\left(\frac{300-L}{100}\right)^{1.5}$$

- for hogging and sagging, heading angle μ = 0, 45, 75 deg., the following sectional efforts are obtained: M_v[kNm] vertical bending moment (Figs.2.a,b.1-3); T_v[kN] vertical shear force (Figs.3.a,b.1-3); M_h [kNm] horizontal bending moment (Figs.4.a,b.1-3); T_h[kN] horizontal shear force (Figs.5.a,b.1-3); M_t [kNm] torsional moment (Figs.6.a,b.1-3);
- Table 3, the maximum wave EWD induced loads, for reference $h_{w\ max}$ = 9.896 m, μ=0, 15, 30, 45, 60, 75 deg., sagging and hogging conditions, first case Δ_1.

Table 3. First case Δ_1 maximum wave EDW induced loads

sagging						
μ	0	15	30	45	60	75
λ/L	1	0.966	0.866	0.707	0.500	0.259
M_v	**3.73E+6**	3.71E+6	3.65E+6	3.50E+6	3.06E+6	1.27E+6
T_v	**8.01E+4**	7.98E+4	7.87E+4	7.60E+4	6.85E+4	3.84E+4
M_h	0	7.07E+4	1.51E+5	2.55E+5	4.12E+5	**5.23E+5**
T_h	0	1.97E+3	4.19E+3	7.02E+3	1.11E+4	**1.81E+4**
M_t	0	1.06E+5	2.26E+5	3.77E+5	5.88E+5	**6.84E+5**

hogging						
μ	0	15	30	45	60	75
λ/L	1	0.966	0.866	0.707	0.500	0.259
M_v	**1.53E+6**	1.52E+6	1.47E+6	1.36E+6	1.04E+6	7.98E+5
T_v	**3.99E+4**	3.97E+4	3.89E+4	3.70E+4	3.12E+4	2.69E+4
M_h	0	9.20E+4	1.95E+5	3.25E+5	4.97E+5	**5.56E+5**
T_h	0	2.99E+3	6.34E+3	1.06E+4	1.62E+4	**1.82E+4**
M_t	0	8.92E+4	1.91E+5	3.24E+5	5.27E+5	**6.18E+5**

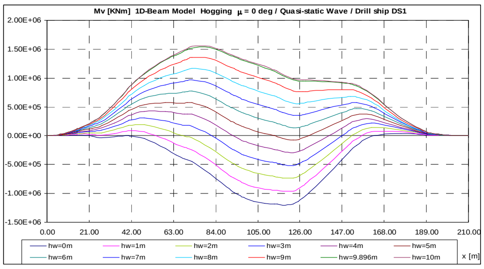

Fig.2.a.1 Case Δ_1,M_v[kNm],μ=0 deg.,hogg.

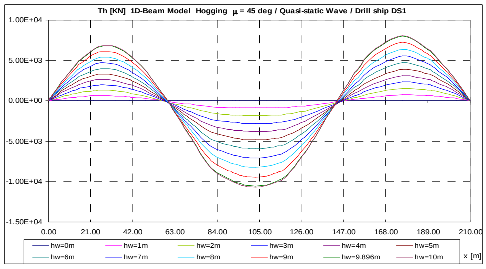

Fig.5.a.2 Case Δ_1,T_h[kN],μ=45 deg.,hogg.

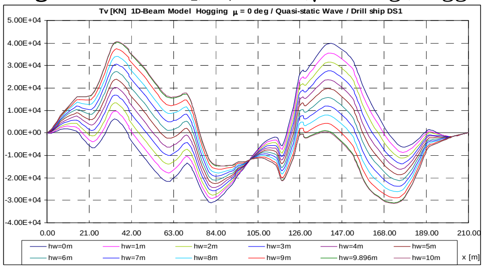

Fig.3.a.1 Case Δ_1,T_v[kN],μ=0 deg.,hogg.

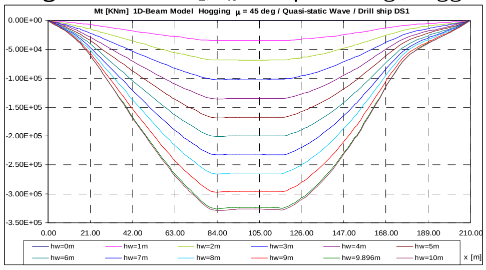

Fig.6.a.2 Case Δ_1,M_t[kNm],μ=45 deg.,hogg.

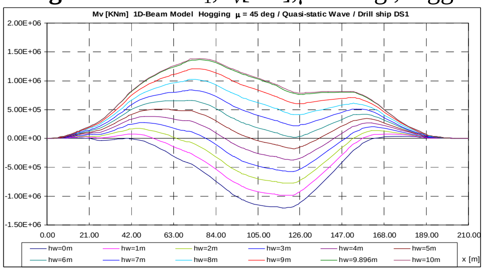

Fig.2.a.2 Case Δ_1,M_v[kNm],μ=45 deg.,hogg.

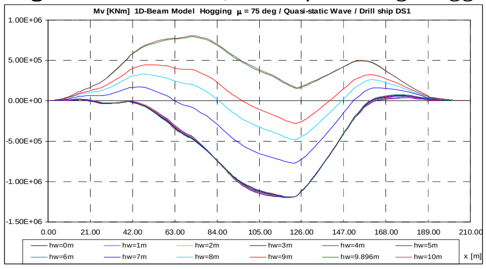

Fig.2.a.3 Case Δ_1,M_v[kNm],μ=75 deg.,hogg.

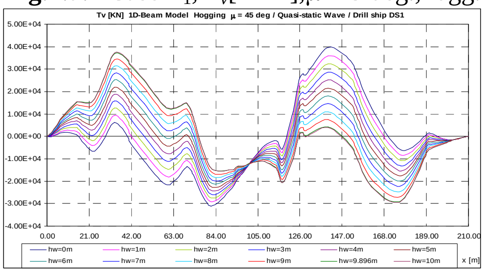

Fig.3.a.2 Case Δ_1,T_v[kN],μ=45 deg.,hogg.

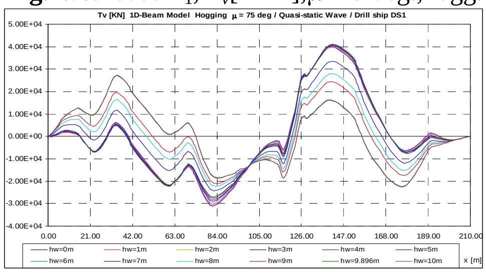

Fig.3.a.3 Case Δ_1,T_v[kN],μ=75 deg.,hogg.

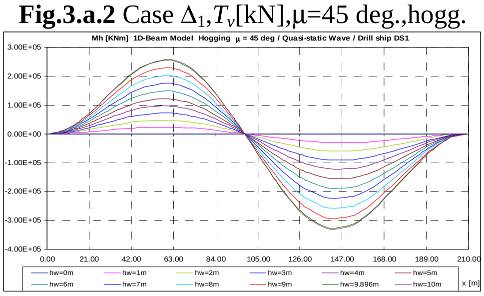

Fig.4.a.2 Case Δ_1,M_h[kNm],μ=45 deg.,hogg.

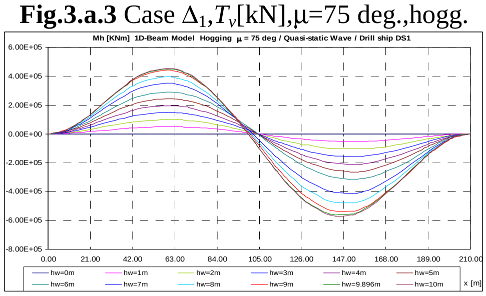

Fig.4.a.3 Case Δ_1,M_h[kNm],μ=75 deg.,hogg.

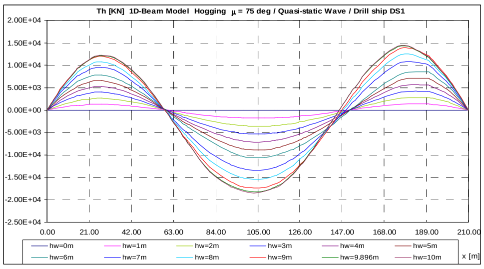

Fig.5.a.3 Case Δ_1,T_h[kN],μ=75 deg.,hogg.

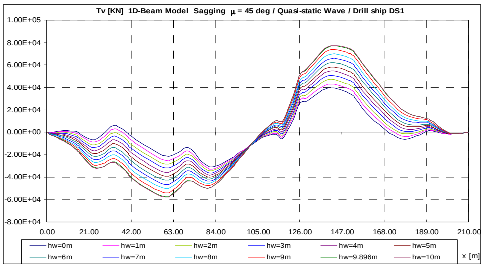

Fig.3.b.2 Case Δ_1,T_v[kN],μ=45 deg.,sagg.

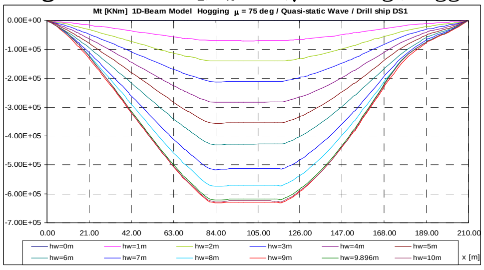

Fig.6.a.3 Case Δ_1,M_t[kNm],μ=75 deg.,hogg.

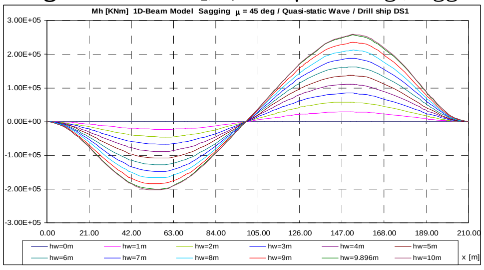

Fig.4.b.2 Case Δ_1,M_h[kNm],μ=45 deg.,sagg.

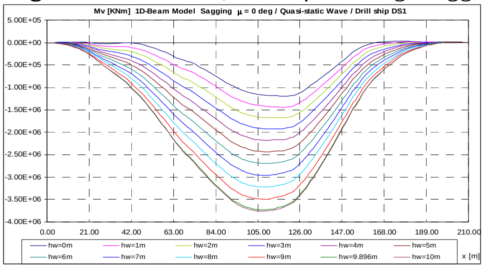

Fig.2.b.1 Case Δ_1,M_v[kNm],μ=0 deg.,sagg.

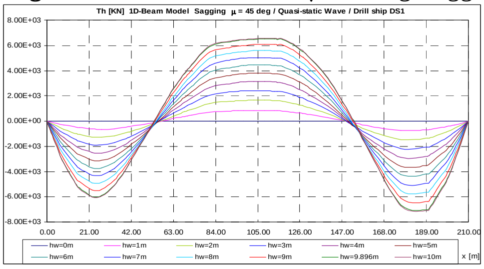

Fig.5.b.2 Case Δ_1,T_h[kN],μ=45 deg.,sagg.

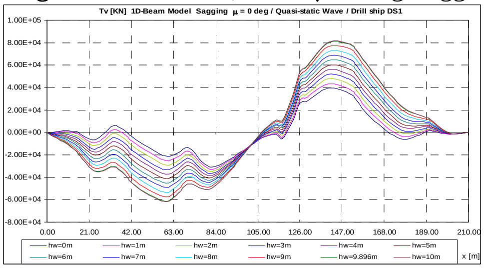

Fig.3.b.1 Case Δ_1,T_v[kN],μ=0 deg.,sagg.

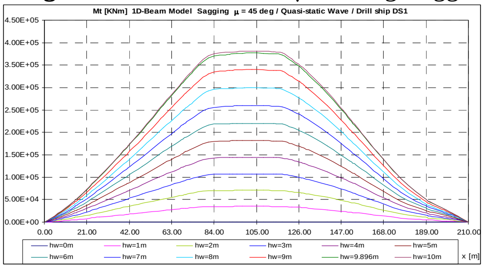

Fig.6.b.2 Case Δ_1,M_t[kNm],μ=45 deg.,sagg.

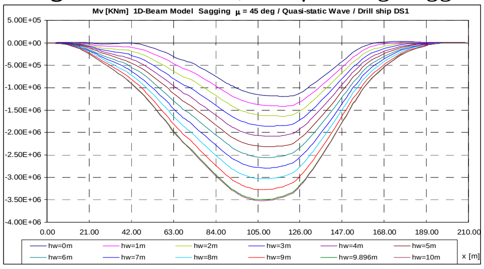

Fig.2.b.2 Case Δ_1,M_v[kNm],μ=45 deg.,sagg.

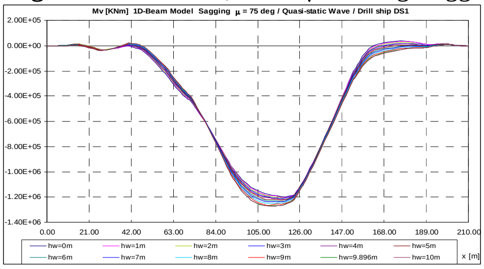

Fig.2.b.3 Case Δ_1,M_v[kNm],μ=75 deg.,sagg.

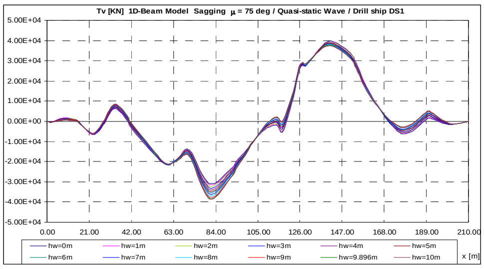

Fig.3.b.3 Case Δ_1,T_v[kN],μ=75 deg.,sagg.

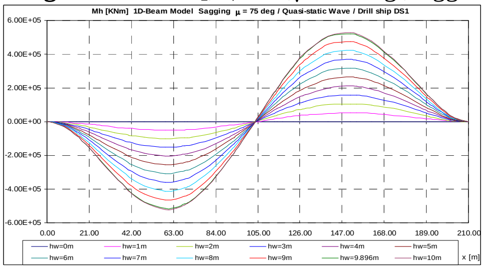

Fig.4.b.3 Case Δ_1,M_h[kNm],μ=75 deg.,sagg.

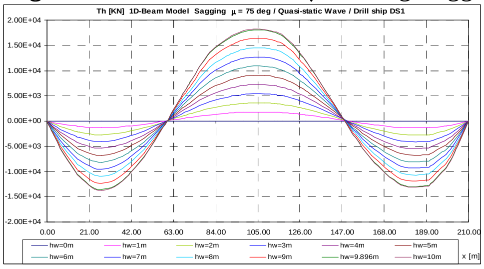

Fig.5.b.3 Case Δ_1,T_h[kN],μ=75 deg.,sagg.

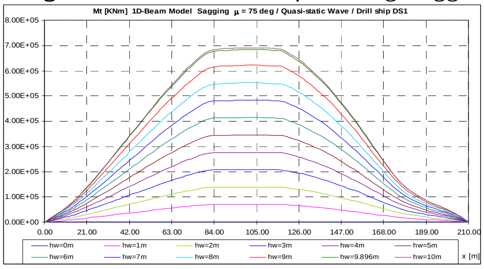

Fig.6.b.3 Case Δ_1,M_t[kNm],μ=75 deg.,sagg.

4. THE STRENGTH ANALYSIS FOR THE SECOND LOADING CASE

In the case of second loading case of the drillship, using the iterative procedure from reference [7], the next results are obtained:
- Table 4, the equilibrium parameters drillship-EDW wave (same notation as Table 2);
- Figs.7 the oblique equivalent design wave-drillship position, μ=0,15,30,45,60,75 deg.;
- for hogging and sagging, heading angle μ = 0, 30, 60 deg., the following sectional efforts are obtained: M_v[kNm] vertical bending moment (Figs.8.a,b.1-3); T_v[kN] vertical shear force (Figs.9.a,b.1-3); M_h [kNm] horizontal bending moment (Figs.10.a,b.1-3); T_h[kN] horizontal shear force (Figs.11.a,b.1-3); M_t [kNm] torsional moment (Figs.12.a,b.1-3);
- Table 5, the maximum wave EWD induced loads, for reference $h_{w\ max}$ = 9.896 m, μ=0, 15, 30, 45, 60, 75 deg., sagging and hogging conditions, second case Δ_2.

Table 4. Second case Δ_2 equilibrium parameters

drillship 2		sagging			hogging		
μ[deg]	h_w[m]	0	5	9.896	0	5	9.896
0	x_F[m]	96.740	97.087	97.392	96.740	96.364	95.992
	y_F[m]	0.000	0.000	0.000	0.000	0.000	0.000
	T_m[m]	12.087	12.132	12.141	12.087	12.007	11.899
	θ[rad]	-0.003	0.003	0.008	-0.003	-0.010	-0.017
	φ[rad]	0.000	0.000	0.000	0.000	0.000	0.000
	z_H[m]	4.182	4.377	4.862	4.182	4.318	4.719
15	x_F[m]	96.740	97.083	97.384	96.740	96.367	95.999
	y_F[m]	0.000	0.000	0.000	0.000	-0.001	-0.002
	T_m[m]	12.087	12.132	12.142	12.087	12.007	11.900
	θ[rad]	-0.003	0.003	0.008	-0.003	-0.010	-0.017
	φ[rad]	0.000	0.000	0.000	0.000	-0.001	-0.002
	z_H[m]	4.182	4.378	4.866	4.182	4.320	4.723
30	x_F[m]	96.740	97.069	97.355	96.740	96.380	96.021
	y_F[m]	0.000	0.001	0.001	0.000	-0.002	-0.004
	T_m[m]	12.087	12.133	12.146	12.087	12.008	11.902
	θ[rad]	-0.003	0.003	0.008	-0.003	-0.009	-0.016
	φ[rad]	0.000	0.001	0.001	0.000	-0.002	-0.004
	z_H[m]	4.182	4.382	4.879	4.182	4.324	4.740
45	x_F[m]	96.740	97.034	97.284	96.740	96.412	96.079
	y_F[m]	0.000	0.002	0.002	0.000	-0.003	-0.007
	T_m[m]	12.087	12.136	12.156	12.087	12.009	11.908
	θ[rad]	-0.003	0.002	0.006	-0.003	-0.009	-0.015
	φ[rad]	0.000	0.001	0.001	0.000	-0.003	-0.007
	z_H[m]	4.182	4.390	4.908	4.182	4.335	4.776
60	x_F[m]	96.740	96.935	97.088	96.740	96.506	96.245
	y_F[m]	0.000	0.003	0.004	0.000	-0.004	-0.009
	T_m[m]	12.087	12.143	12.176	12.087	12.011	11.924
	θ[rad]	-0.003	0.000	0.003	-0.003	-0.007	-0.012
	φ[rad]	0.000	0.003	0.004	0.000	-0.004	-0.010
	z_H[m]	4.182	4.407	4.963	4.182	4.358	4.858
75	x_F[m]	96.740	96.548	96.360	96.740	96.926	96.376
	y_F[m]	0.000	0.004	0.009	0.000	-0.003	-0.011
	T_m[m]	12.087	12.149	12.197	12.087	12.015	11.932
	θ[rad]	-0.003	-0.007	-0.011	-0.003	0.001	-0.009
	φ[rad]	0.000	0.004	0.009	0.000	-0.003	-0.011
	z_H[m]	4.182	4.374	4.844	4.182	4.356	4.897

Table 5. Second case Δ_2 maximum wave EDW induced loads

sagging						
μ	0	15	30	45	60	75
λ/L	1	0.966	0.866	0.707	0.500	0.259
M_v	**5.01E+6**	4.99E+6	4.92E+6	4.76E+6	4.31E+6	2.45E+6
T_v	**9.83E+4**	9.80E+4	9.69E+4	9.42E+4	8.66E+4	6.11E+4
M_h	0	8.03E+4	1.72E+5	2.91E+5	4.69E+5	**5.95E+5**
T_h	0	2.20E+3	4.68E+3	7.85E+3	1.27E+4	**2.04E+4**
M_t	0	1.06E+5	2.26E+5	3.79E+5	5.91E+5	**6.89E+5**

hogging						
μ	0	15	30	45	60	75
λ/L	1	0.966	0.866	0.707	0.500	0.259
M_v	**1.07E+6**	1.06E+6	1.01E+6	9.10E+5	6.35E+5	8.90E+5
T_v	**4.26E+4**	4.24E+4	4.15E+4	4.08E+4	4.17E+4	4.24E+4
M_h	0	1.03E+5	2.19E+5	3.65E+5	5.57E+5	**6.24E+5**
T_h	0	3.31E+3	7.02E+3	1.17E+4	1.80E+4	**2.02E+4**
M_t	0	9.07E+4	1.94E+5	3.29E+5	5.34E+5	**6.25E+5**

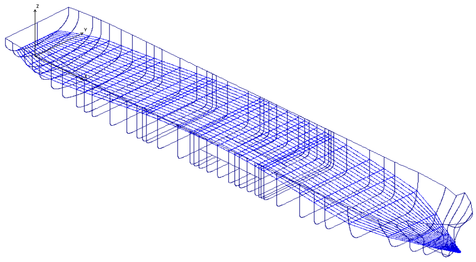

Fig.7.a.1 Δ_2, h_w=9.896m, μ=0 deg., hogging

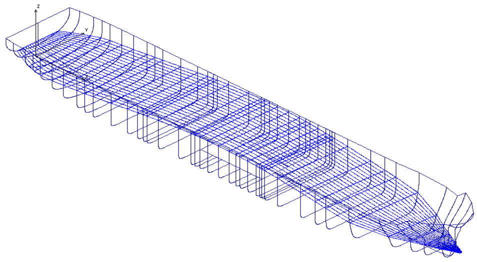

Fig.7.a.2 Δ_2, h_w=9.896m, μ=15deg., hogging

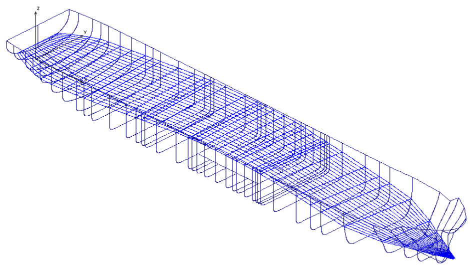

Fig.7.a.3 Δ_2, h_w=9.896m, μ=30deg., hogging

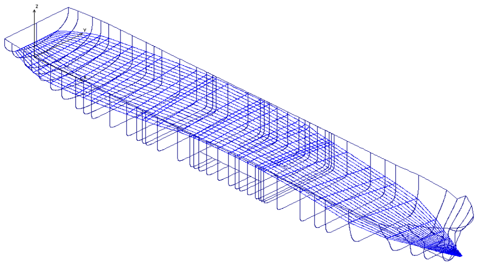

Fig.7.a.4 Δ_2, h_w=9.896m, μ=45deg., hogging

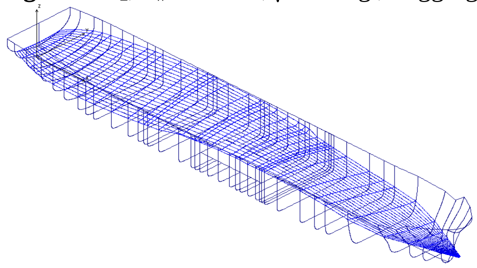

Fig.7.a.5 Δ_2, h_w=9.896m, μ=60deg., hogging

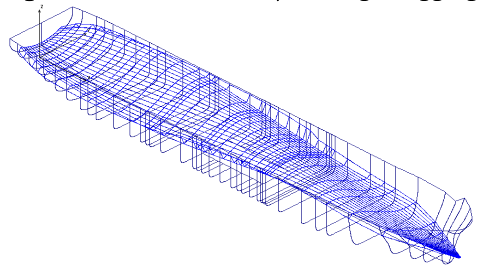

Fig.7.a.6 Δ_2, h_w=9.896m, μ=75deg., hogging

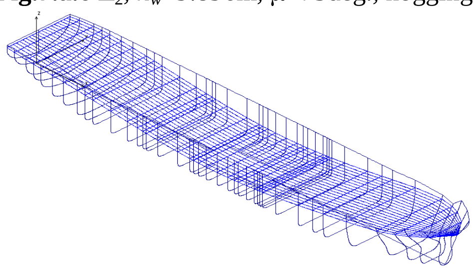

Fig.7.b.1 Δ_2, h_w=9.896m, μ=0 deg., sagging

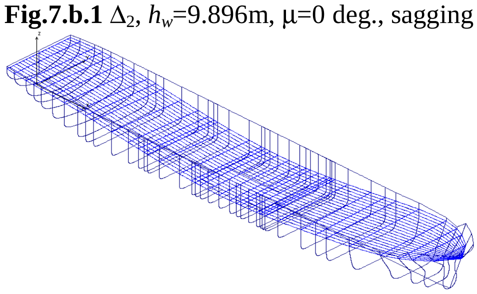

Fig.7.b.2 Δ_2, h_w=9.896m, μ=15deg., sagging

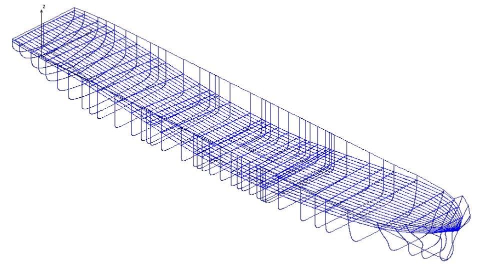

Fig.7.b.3 Δ_2, h_w=9.896m, μ=30deg., sagging

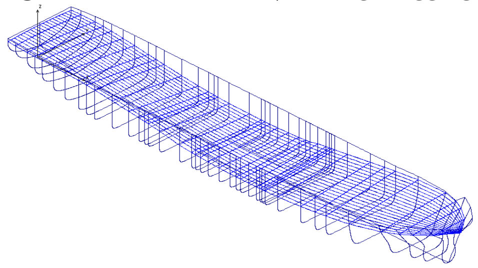

Fig.7.b.4 Δ_2, h_w=9.896m, μ=45deg., sagging

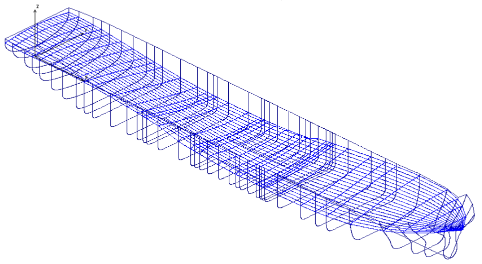

Fig.7.b.5 Δ_2, h_w=9.896m, μ=60deg., sagging

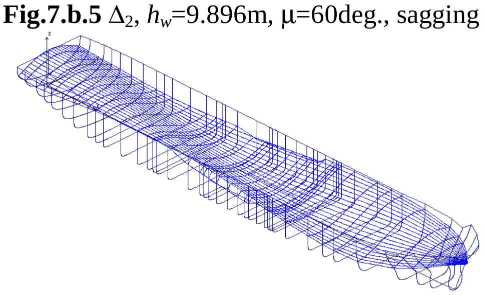

Fig.7.b.6 Δ_2, h_w=9.896m, μ=75deg., sagging

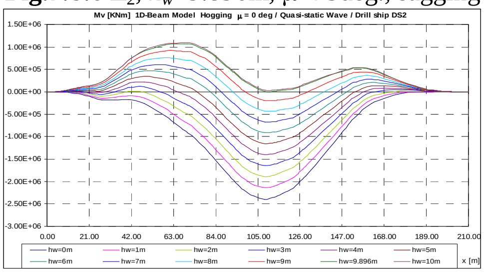

Fig.8.a.1 Case Δ_2,M_v[kNm],μ=0 deg.,hogg.

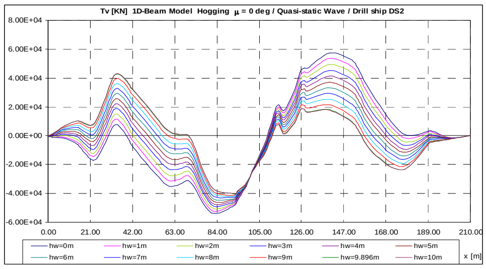

Fig.9.a.1 Case Δ_2,T_v[kN],μ=0 deg.,hogg.

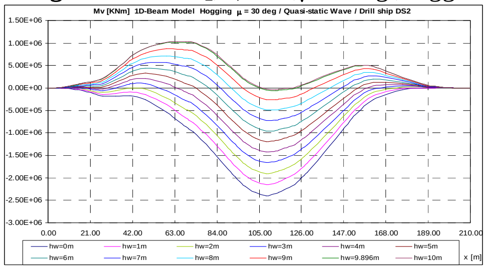

Fig.8.a.2 Case Δ_2,M_v[kNm],μ=30 deg.,hogg.

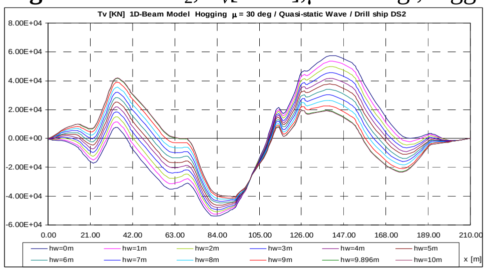

Fig.9.a.2 Case Δ_2,T_v[kN],μ=30 deg.,hogg.

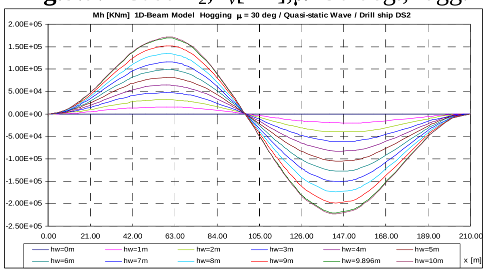

Fig.10.a.2 Case Δ_2,M_h[kNm],μ=30 deg.,hogg

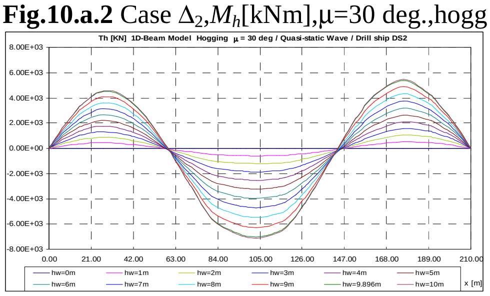

Fig.11.a.2 Case Δ_2,T_h[kN],μ=30 deg.,hogg

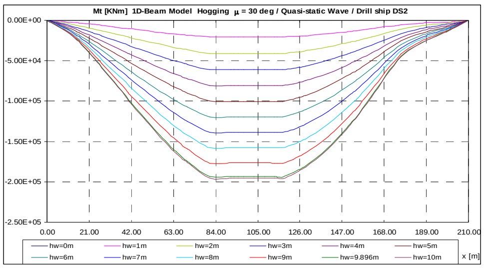

Fig.12.a.2 Case Δ_2,M_t[kNm],μ=30 deg.,hogg

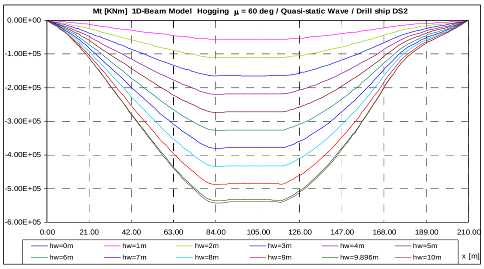

Fig.12.a.3 Case Δ_2,M_t[kNm],μ=60 deg.,hogg

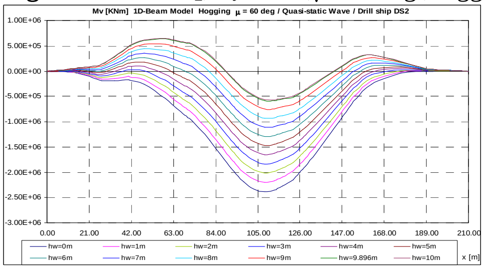

Fig.8.a.3 Case Δ_2,M_v[kNm],μ=60 deg.,hogg.

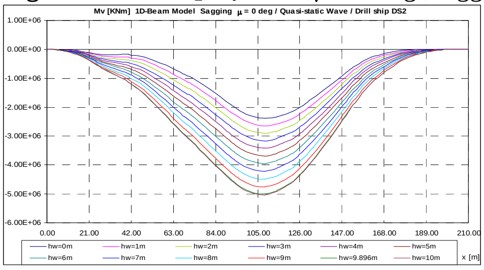

Fig.8.b.1 Case Δ_2,M_v[kNm],μ=0 deg.,sagg.

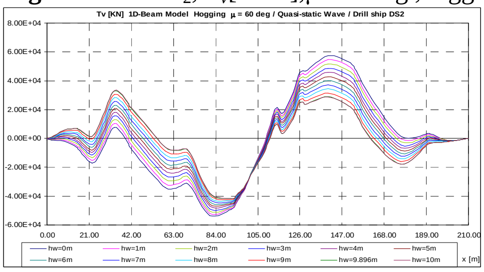

Fig.9.a.3 Case Δ_2,T_v[kN],μ=60 deg.,hogg.

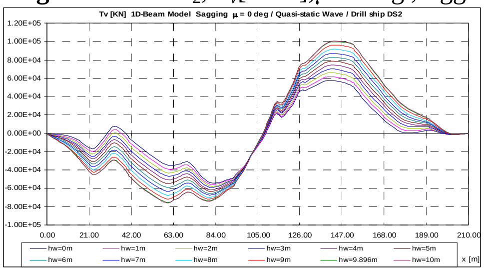

Fig.9.b.1 Case Δ_2,T_v[kN],μ=0 deg.,sagg.

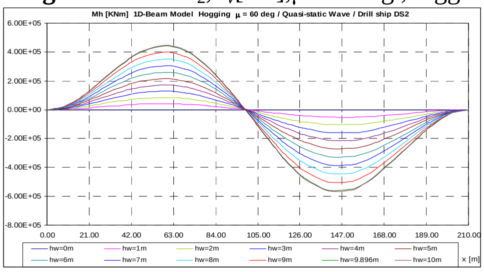

Fig.10.a.3 Case Δ_2,M_h[kNm],μ=60 deg,hogg

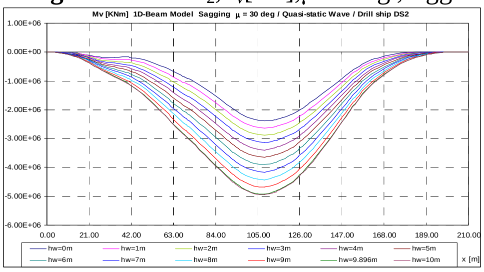

Fig.8.b.2 Case Δ_2,M_v[kNm],μ=30 deg.,sagg

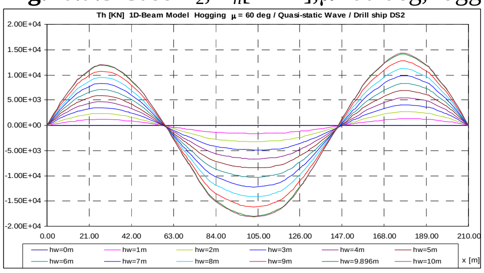

Fig.11.a.3 Case Δ_2,T_h[kN],μ=60 deg.,hogg

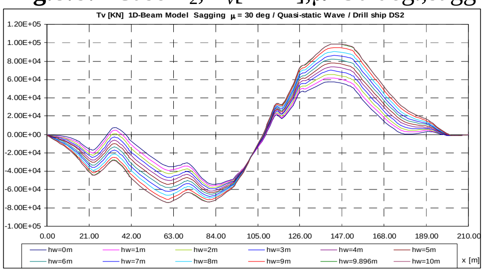

Fig.9.b.2 Case Δ_2,T_v[kN],μ=30 deg.,sagg.

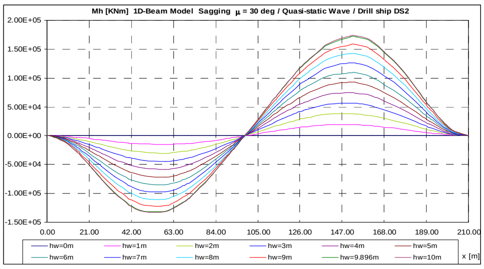

Fig.10.b.2 Case Δ_2,M_h[kNm],μ=30 deg.,sagg

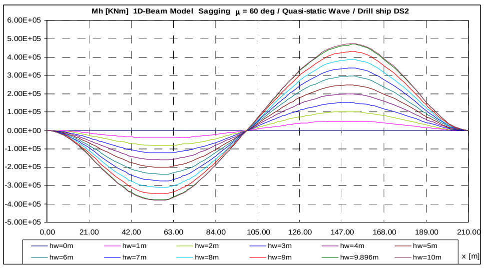

Fig.10.b.3 Case Δ_2,M_h[kNm],μ=60 deg.,sagg

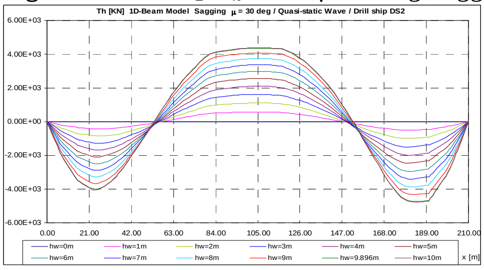

Fig.11.b.2 Case Δ_2,T_h[kN],μ=30 deg.,sagg.

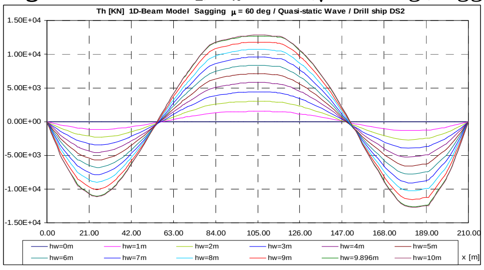

Fig.11.b.3 Case Δ_2,T_h[kN],μ=60 deg.,sagg.

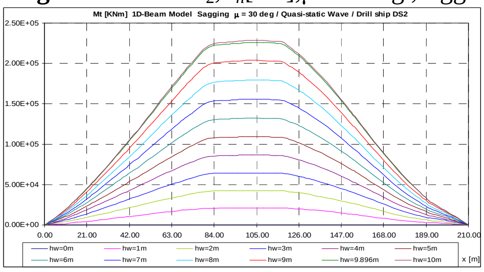

Fig.12.b.2 Case Δ_2,M_t[kNm],μ=30 deg.,sagg

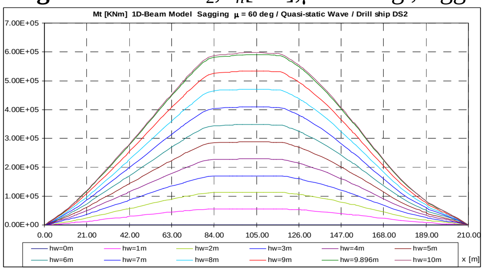

Fig.12.b.3 Case Δ_2,M_t[kNm],μ=60 deg.,sagg

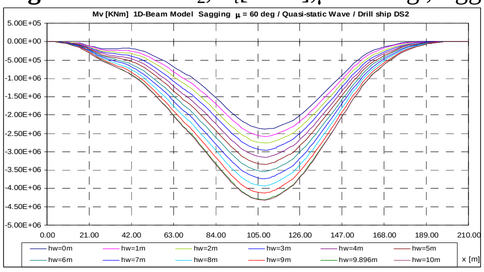

Fig.8.b.3 Case Δ_2,M_v[kNm],μ=60 deg.,sagg.

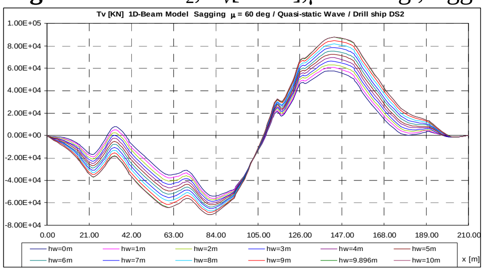

Fig.9.b.3 Case Δ_2,T_v[kN],μ=60 deg.,sagg.

5. CONCLUSIONS

From Table 3 and Table 5, Figs.2-6 and Figs.7-12, the maximum values for sectional efforts are selected in Tables 6,7, including the rules admissible values [1],[5],[9],[11].

Table 6. Maximum and admissible values, Δ_1

SW+EDW	max	BV	DNV	GL	ABS
M_v[kNm]	3.73E+6	4.13E+6	4.03E+6	4.86E+6	4.03E+06
T_v[kN]	8.01E+4	7.26E+4	6.18E+4	8.36E+4	6.18E+04
M_h[kNm]	5.56E+5	1.13E+6	1.17E+6	2.06E+6	1.43E+06
T_h[kN]	1.82E+4	1.61E+4	1.74E+4	3.07E+4	2.13E+04
M_t[kNm]	6.84E+5	3.53E+5	3.78E+5	5.27E+5	5.35E+05
SW	max	BV	DNV	GL	ABS
M_{sw}[kNm]	1.20E+6	1.75E+6	1.65E+6	2.48E+6	1.65E+6
T_{sw}[kN]	3.96E+4	4.17E+4	3.09E+4	5.27E+4	3.09E+4

Table 7. Maximum and admissible values, Δ_2

SW+EDW	max	BV	DNV	GL	ABS
M_v[kNm]	5.01E+6	4.17E+6	4.04E+6	4.88E+6	4.04E+6
T_v[kN]	9.83E+4	7.34E+4	6.22E+4	8.38E+4	6.22E+4
M_h[kNm]	6.24E+5	1.30E+6	1.26E+6	2.19E+6	1.64E+6
T_h[kN]	2.04E+4	1.84E+4	1.88E+4	3.27E+4	2.44E+4
M_t[kNm]	6.89E+5	3.77E+5	4.01E+5	5.22E+5	5.29E+5
SW	max	BV	DNV	GL	ABS
M_{sw}[kNm]	2.39E+6	1.78E+6	1.65E+6	2.48E+6	1.65E+6
T_{sw}[kN]	5.75E+4	4.23E+4	3.11E+4	5.27E+4	3.11E+4

From the numerical results of this study (Tables 6,7), on global strength of the drillship in oblique EDW waves, the following conclusions are obtained:

- In the case of head and follow EDW waves (μ=0 deg., hogging and sagging), the vertical bending moments and shear forces maximum values are obtained, on both displacements (Tables 3,5).
- In the case of oblique EDW waves (μ=75 deg., hogging and sagging), the horizontal bending moments, horizontal shear forces and torsion moments maximum values are obtained, on both displacements (Tables 3,5).
- The maximum still water and EDW wave loads, by global strength analysis, have values around of the shipbuilding rules admissible limits (Tables 6,7).
- Using the equilibrium drillship-EDW wave parameters from this study (Tables 2,4), can be used for 3D-FEM global strength analysis, for stain and stress state assessment.

Acknowledgements

In this study the theoretical model and program code were developed in the frame of Research Centre of the Naval Architecture Faculty from "Dunarea de Jos" University of Galati.

The numerical analyses were accomplished for the research project "*The linear and non-linear analysis of the hydroelastic dynamic response for DRILLSHIP 12000" (seakeeping preliminary analysis),* of ICE ICEPRONAV ENGINNERING Galati (1041/2013).

REFERENCES

[1]. **ABS**, Rules, American Bureau of Shipping, TX, 2013.

[2]. **Bidoae, I.,** "*Ship theory. Ship statics"*, University Publishing House, Galati, 1985.

[3]. **Bidoae, R., Ionas, O.,***"Ship theory. Statics"*, E.D.P. Publishing House, Bucharest, 2004.

[4]. **Biran A. B.,** *"Ship hydrostatics and stability"*, Elsevier Publishing House, 2003.

[5]. **BV,** Rules, Bureau Veritas, Paris, 2013.

[6]. **Domnisoru, L., Rubanenco, I., Domnisoru, D.,** *"On the linear and non-linear dynamic hydroelastic response analysis of an off-shore drillship elastic structure*", The Annals of "Dunarea de Jos" University of Galati, Fascicle XI Shipbuilding, pp. 5-14, 2013.

[7]. **Domnisoru, L.,** *" Numerical approach for global ship strengths analysis based on 1D-beam model, under oblique equivalent quasi-static wave loads*", The Annals of "Dunarea de Jos" University of Galati, Fascicle XI Shipbuilding, pp. 27-36, 2015.

[8]. **Domnisoru, L.,** *"On the seakeeping response analysis of a large off-shore drillship*", The Annals of "Dunarea de Jos" University of Galati, Fascicle XI Shipbuilding, pp. 51-60, 2016.

[9]. **DNV**, Rules, Det Norske Veritas, Novik, 2013.

[10]. **Fricke W, Bronsar R. (editors),** *"Proceeding of the 18th International Ship and Offshore Structures Congress-ISSC"*, Schiffbautechnischen Gesellschaft, Hamburg, 2014.

[11]. **GL,** Rules, Germanischer Lloyd's, Hamburg, 2013.

[12]. **Ionas O., Domnisoru L., Gavrilescu I., Dragomir D.,** *"Computing techniques in shipbuilding", Evrika Publishing House, Braila, 1999.*

[13]. **Rawson K.J., Tupper E.C.,** *"Basic ship theory*", (2 vol.) Butterworth Heinemann, Oxford, 2001.

[14]. **Tetsuya Yao,** *"Hull girder strength"*, Marine Structures, 16: 1-13, 2003.

[15]. **Toki N.,** *"A study on the determination of design wave condition",Transactions West-Japan Society of Naval Architects; 89:191–208, 1995.*

Paper received on December 4th, 2017