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Analysis and Evaluation of Manoeuvrability Characteristics of Polish Ferries m/f „Polonia" and m/f „Gryf"

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ABSTRACT: The paper describes some specific manner of M/F "Polonia" manoeuvring at the Ystad harbour where she is regarded to be "over maximal ship" and also M/F "Gryf" manoeuvring at Trelleborg, taking part into consideration the effect of wind pressure into the ship's superstructures and houses.

1 INTRODUCTION

The ferry "Polonia" shown on Fig. 1 is one of the biggest ships entering the Ystad harbour.

It should be noted that "Ystadmax" ship is determined as 150 meters length when M/F "Polonia" has the OA Length of 169,9 meters. The very limited space of harbour basin, the large windage area of over 3506 square meters, and for the most part bad weather conditions in Ystad, makes the manoeuvres extremely difficult.

Figure 1. M/F "Polonia"[ferry-site.dk]

Four modern engines, through two transmission gears, are driving two inside turning propellers, making power of 7920 KW per each one shaft. Three thrusters are located in bow, one is placed in aft part of the ferry. Two rudders with braking blades (*rudder back)* can be used separately or coupled, giving the rudder angle of 45 Deg.

The main ship particulars are listed below:

Gross Capacity	32 000 RT
Displacement	6 950 T
Length Overall	169,9 m
Breadth	28,0 m
High	42,3 m
Draught	6,1 m

Propulsion: Twin controllable pitch propeller propulsion plant.

Main engines: 4 x STORK-WARTSILA ,3.960 kW each at 600 rpm, total 15.840 kW.

Manoeuvring machinery: Rudders - 2x BARKEMEYER flap type. Synchronous or individual

operation. Rudder surface area 14,49 m2 per rudder. Rudder max. angle 2x44 degrees; for speed above 17 knots rudder angle limited to 35 degrees.

Side thrusters (BRUNVOLL type SPA/VP, electrically driven): 3 bow thrusters 1600 kW each;1 stern thruster 1600 kW.

The both plans of Ystad Harbour and Trelleborg are presented in Fig.2. The berthing place of the ferry "Polonia " is located at the 170 m of length quay Jä rnvä gsfä rja. All dimensions of the inner harbor basin are comparable with the ferry size which is beyond the "Ystadmax".

Due to the wide windage area of the vessel, the critical for the ferry are the entry manoeuvres, specifically during the winds beyond 19 meters per second (8° B), as it was described in subsequent chapters.

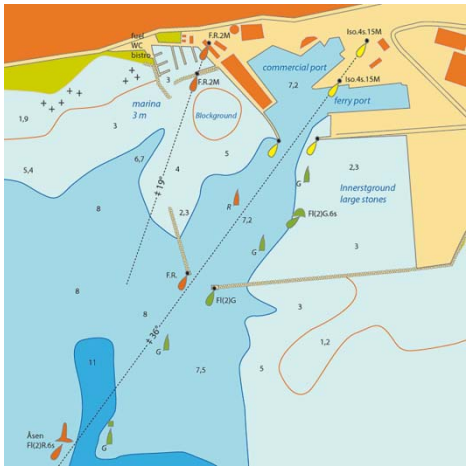

Figure 2a. Ystad harbour

Figure 2b. Trelleborg harbour.

The ferry "Gryf" is shown in Fig. 3. She is entering the Trelleborg harbour in wide spectrum of weather conditions, when the basin areas are very limited, too.

The space of 170 meters only, available for rotating the ship of LOA=158 m and the windage area of 2600 square meters into the harbour, makes serious difficulties in the port manoeuvres. Due to the wide windage area of the vessel, the critical for the ferry are the entry manoeuvers, specifically during the winds beyond 14 meters per second (6° B), as it was described in subsequent chapters.

The main M/F "Gryf" particulars are listed below:

Gross Capacity	18 653 RT
Displacement	13 692 T
Length Overall	158,0 m
Breadth	24,0 m
High	45,0 m
Draught	5,90 m

Twin controllable Propulsion :ULSTEIN pitch propeller propulsion plant.

Main engines: 2x WARTSILA-SULZER 6ZA40S, 3960 kW each at 510 rpm.

Manoeuvring machinery: Rudders - 2x OFF BECKER with flaps. Synchronous operation. Rudder max. angle 2x45 degrees.

Side thrusters (BRUNVOLL, electrically driven): 2 bow thrusters 1x 760 kW + 1x 800kW.

Figure 3. M/F „Gryf". [Jakub Bogucki 2005 r.]

2 MANOEUVRINGS UNDER THE WIND PRESSURE

When the wind blows against the side of the ship, the bow tends to turn slowly down the wind. Both ferries "Polonia" and "Gryf" have less lateral resistance under water in bow than in stern such they when blown sideways, the bow and stern respond differently. The bow and stern thrusters are designated for pushing the ship against the wind pressure.

We can compare the moments due to wind pressure both ferries "Polonia" and "Gryf". Suitable data are presented in Tables 1 and 2. The above said moments can be useful for calculation of heeling levers due to wind pressure, but for analyse the wind influence for manoeuvres characteristics, too.

The basic model for calculations the wind pressure is shown in Fig. 4.

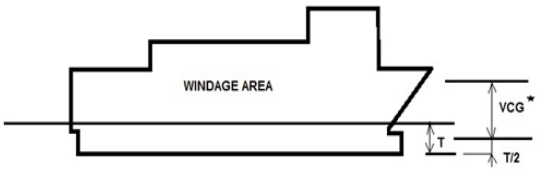

Figure 4. The basic model for calculation of wind pressure. [M.Szymoński]

Table 1. Moment due to wind pressure of M/F "Polonia"

Draught : 5,00 m					
Item	Area m²	Wind pr. N/m²	W. force Tonnes	VCG* m	V. moment Tonn. M
Windage area	3700,40	120,00	45,27	14,44	653,84
Displacement at draught 5,00 m			13667,00		
Draught : 6,20 m					
Item	Area m²	Wind pr. N/m²	W. force Tonnes	VCG* m	V. moment Tonn. M
Windage area	3505,90	120,00	42.89	14,47	620,73
Displacement at draught 6,20 m			18107,00		

[M.Szymoński]

Table 2. Moment due to wind pressure of M/F "GRYF"

Draught : 5,00 m					
Item	Area m²	Wind pr. N/m²	W. force Tonnes	VCG* m	V. moment Tonn. M
Windage area	2449.5	120,00	29.96	12,00	359.56
Displacement at draught 5,00 m			10910,00		
Draught : 5,90 m					
Item	Area m²	Wind pr. N/m²	W. force Tonnes	VCG* m	V. moment Tonn. M
Windage area	2323.5	120,00	28,42	12.45	353.85
Displacement at draught 5,90 m			13692,00		

[M.Szymoński]

The above results are made for ships in ballast conditions (maximum windage area for T= 5.00 m) and fully loaded (T= 6.20 m and T= 5.90 - "Polonia" and "Gryf", respectively).

To compare the analysed manoeuvring characteristics of both ferries the following data, shown in Table 3, should be taken into consideration.

For maximum draught of ferry "Polonia", equal 6.20 m, the wind pressure of 120 N/m² (6º B) which creates the force of 42,89 Tonnes is being defeated by near twice greater side thrusters force of 84,84 Tonnes.

At the same time, for maximum draught of ferry "Gryf", equal 5.90 m , the wind pressure of 120 N/m² is only balanced out by side thrusters with towing force of 27,57 Tonnes.

Table 3. The comparision of data.

Ferry	Wind force for pressure 120 N/m² [tonnes]	Thrusters towing force [tonnes]
POLONIA T= 6.20 m	42,89	84,84
GRYF T= 5.90 m	28.42	27,57

[M.Szymoński]

3 CONCLUSIONS

Presented results and analyse of wind moments for both of ferries are made for static wind influence blowing at right angle against the windage area of the ship.

The relationship between wind force - in meters per second and wind pressure on the windage area – in N/m², are shown in Fig. 5.

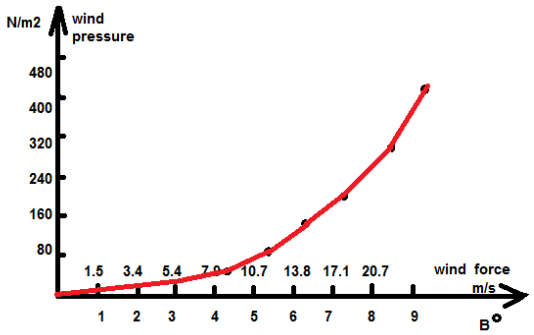

Figure 5. The relationship between the wind force and wind pressure. [M.Szymoński]

Fig. 6 and Fig. 7 are showing the relationship between the wind pressure on the windage area of ferries: "Polonia" and "Gryf", respectively - and the wind force pushing the ship. These figures can also be used for determination of safe range of static wind effect against the side thrusters. For M/F "Polonia" the safe range of the wind effect is determined as 19 m/s or 8 °B. In the above said range of the wind the safe manoeuvring operations can be expected.

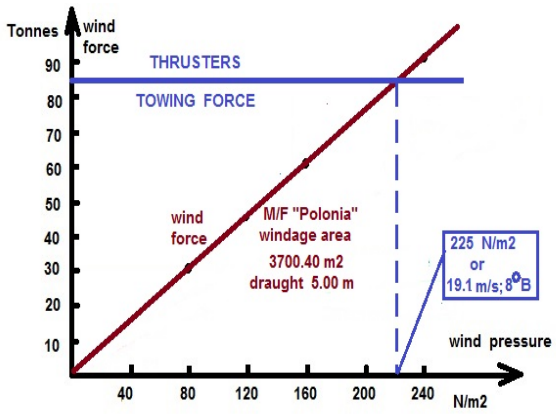

Figure 6. The relationship between wind presure and wind/thrusters towing force for M/F "Polonia". [M.Szymoński]

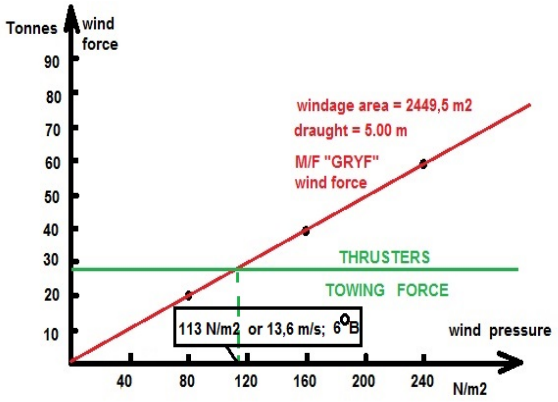

Figure 7. The relationship between wind presure and wind/thrusters towing force for M/F "Gryf". [M. Szymoński]

For M/F "Gryf" the safe range of the wind effect is determined as 14 m/s or 6 °B. In the above said range of the wind the safe manoeuvring operations can be expected.

In real conditions of port manoeuvrings not static but dynamic wind effect has to be considered. It means that in case of dynamic effect, the temporary wind force can be much stronger than its static equivalent . It should be added that in real conditions the angle of wind pressure differs from the right angle, which causes that the dynamic wind force can be also much stronger than its static equivalent.

During the port manoeuvrings not only bow thrusters are being used, but also the main engines, rudder blades and stern thrusters, if available. It is important that not only analysed bow thrusters, but also the above said manoeuvring machinery are being used to drive the ferry against wind pressure.

Having the experience in exploitation of the above ferries in dynamic conditions and recapitulate the presented analyse, it should be concluded that the safe port manoeuvrings can be done when the wind is blowing with temporary force around 40% stronger than it was calculated for static coditions. It means that the right values are as follows : 19 m/s in case of M/F "Gryf" and 27 m/s in case of M/F "Polonia".

BIBLIOGRAPHY

Unpublished documents and technical reports regarding the analysed ferries.