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SOFTWARE NUMERICAL STUDY OF THE STRESSES THAT APPEAR IN THE “FANCAT” CATAMARAN`S STRUCTURE IN CALM WATER

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ABSTRACT

The main objective of this work is to study the stresses that ~~occurs~~ in the structure of the FANCAT catamaran. The catamaran structure was designed using the BV rules clasification for passenger vessels. Using FEMAP software this structure was verified to see where is the critical point regarding stress and strain. The conclusion taken from the FEM analysis will help designers to finalise detail drawings.

Keywords: Ferryboat, Structure, Hydrodynamic pressure, FEM

1. INTRODUCTION

Nowadays, emphasis is on reducing pollution. A solution to reduce pollution is the use of low-power motors, in conditions of low hydrodynamic resistance. An indirect method of reducing hydrodynamic resistance is reducing ship`s displacement, therefore, the use of low-density materials. For this kind of passengers the most used materials is GRP or aluminium, because the stern and prow forms of the catamaran bodies the material chosen for building the body is aluminium.

2. DESCRITPION AND MAIN DIMENSION

The study aims to verify the structural resistance of a catamaran vessel by studying local stresses due to hydrodynamic pressures induced by ship movement.

2.1. Main Characteristics

The main particulars of the studied ship are presented in the below table:

Table 1. Main particulars of the ship

L	21	m
B	6,6	m
H	2,3	m
T	1,4	m
V	7	m/s
Δ	42	t

2.2. Description

“FANCAT” is a passenger ship with a capacity of 74 passengers, with a speed of 25 km/h and sailing on the Danube (Braila- Tulcea route). The shape of catamaran was designed to validate using NUMECA FINE MARINE CFD software. The shape of the catamaran is shown in Figure 1.

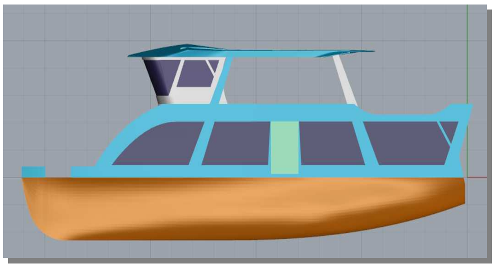

Fig. 1. "FANCAT" Catamaran

3. LOADS

3.1. Determination of pressures

The pressures were identified using the CFD software: Numeca Fine Marine. The hull was analyzed and the pressures exported accordingly.

It can be observed that the pressure varies between 0 kPa and 15 kPa , the maximum pressure being on the bottom and the minimum around the waterline.

The study was done in still water without considering the influence of the waves.

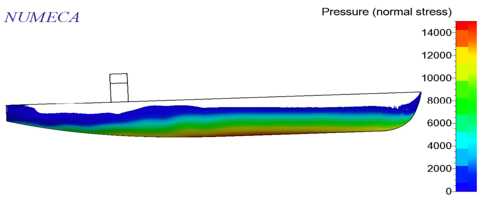

Fig. 1. The pressure distribution from CFD

3.2. Import in FEM

The pressures are exported to the FEM software, FEMAP, as a function of ship's draft: 1,3e-5 * (1400 - z)

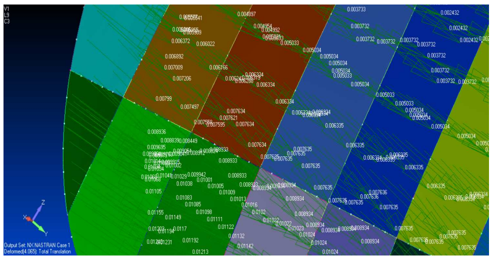

Fig. 2. The pressure distribution to FEM

4. MATERIAL

The hull and framework are built using Aluminium alloy 5454.

The properties of aluminium alloy 5454:

- Density: 2,69 g/cm^3;
- Young`s modulus:70 GPa;
- Ultimate tensile strength: 240-300 MPa.

5. STRUCTURE OF CATAMARAN

The following (using BV rules for passengers ships) construction elements have been chosen for the FANCAT catamaran:

- For hull: plate thickness of 6 mm;
- For frames: L profile 80x40x6, in steps of 600 mm;
- For beams: L profile 80x40x6 in steps of 600 mm;
- The frames and beams are linked through a bracket of 100x100x6;
- For side and deck, the longitudinal stiffeners are L profile 100x50x6 in steps of 500 mm;
- For bottom, the longitudinal stiffeners (keel area) are T profile, of 300x200x10x15.

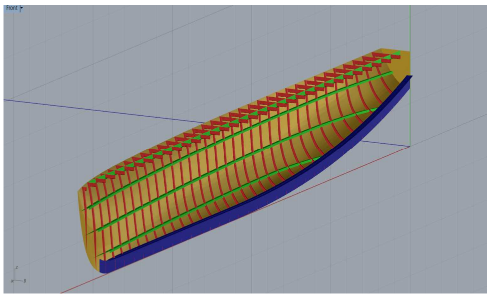

Fig. 3. The structure

To perform stress and strain analysis of catamaran bodies their structure was discretized using four-knot thin plate elements.

The mesh was generate following classification society rules:

• The mesh size is 10x10 on hull;

• The mesh size is 5x5 on resistance structure.

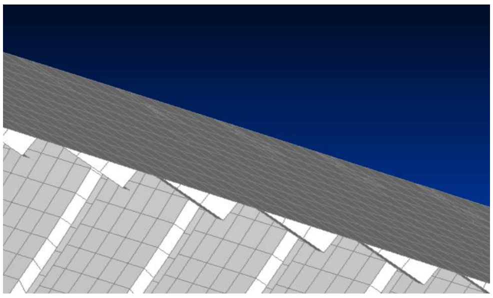

Fig. 4. The mesh

6. ANALYSIS

6.1 The shell

In between stiffeners, where the plate is not stiffened buckling occurs the stress values being between 6 MPa and 10 MPa.

In can be noticed that the maximum stress appears at the intersection area between the bottom plate and each of the frames. The values is 20 MPa.

Table 2. Stress value of hull

Intersection A.	Value (MPa)	
	max	min
Bottom-Frames	19	8
Side-Frames	10	0
Forward Bottom	18	0

As can be seen from the above table, the stress values do not exceed the admissible limits for alloy aluminium 5454. This shows that the dimensions of the sheathing sheets ensure the resistance conditions of the watertight bodies of the catamaran, as is shown in figure 5.

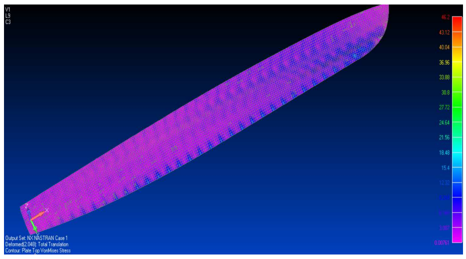

Fig. 5. The shell's analysis results

6.2 The frames

The maximum stress occurs at the intersection area between the transverse frames and the bottom longitudinal stiffeners, the stress value being 40-44 MPa.

The stress value is 18-20 MPa at the intersection area between the frames and the deck beams (on the brackets).

Table 3. Stress value of frames

Intersection A.	Value (MPa)	
	max	min
Frames-Bottom	46,2	25
Frames-Bracket	18,5	15
Frames-Side	18	0
Stiffeners-Deck	31	7

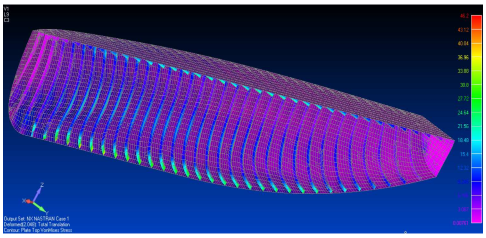

Fig. 6. The frame`s analysis results

The stress with the highest values are obtained at the intersection between the frames with the main deck transverse as well as at the intersection of the keel with frames, as is shown in figure 7.

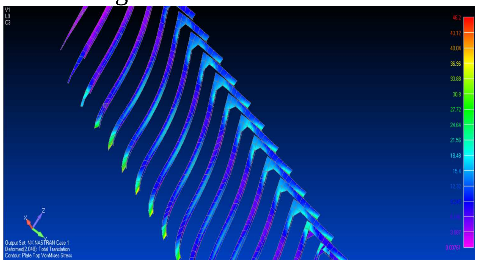

Fig. 7. The bracket`s analysis

6.3. The longitudinal stiffeners

The maximum stress value is 6-8 MPa at the intersection area between the longitudinal stiffeners and the transverse frames.

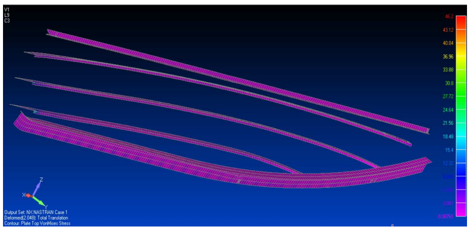

Fig. 8. The stiffener`s analysis results

7. CONCLUDING REMARKS

In conclusion, the maximum stress (44 MPa) that occurs in the structure is small compared to the ultimate tensile strength of the Aluminium alloy 5454 (240 MPa), therefore the structure is fit for purpose.

Aluminium alloy 5454 is sufficiently resistant to still water and can be successfully used in catamarans up to 30 m that sail on the Danube or in similar areas.

Acknowledgements

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REFERENCES

[1]. FEMAP Users Manual
[2]. BV – passengers ship rules
[3]. Ionel Gavrilescu, Costel Iulian Mocanu, "FEM", Galați "Low Danube" University Foundation Publishing House, 1999.
[4]. www.wikipedia.org

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