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[ijirset@gmail.com](mailto:ijirset@gmail.com)

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# The Modification of Stabilizer in Miss Fanfold Hydroplane

Archana Dodiya<sup>1</sup>, Mariyam Kamal<sup>2</sup>, Hirav Patel<sup>3</sup>, Mansha Kumari<sup>4</sup>

U.G. Students, Department of Aeronautical Engineering, Parul University, Vadodara, Gujarat, India<sup>1</sup>

U.G. Students, Department of Aeronautical Engineering, Parul University, Vadodara, Gujarat, India<sup>2</sup>

U.G. Students, Department of Aeronautical Engineering, Parul University, Vadodara, Gujarat, India<sup>3</sup>

Assistant Professor, Department of Aeronautical Engineering, Parul University, Vadodara, Gujarat, India<sup>4</sup>

**ABSTRACT:** Hydroplane is an amphibian aircraft with fixed wing that can take-off and land on water. This subsonic aircraft finds important applications as in deep sea patrol, surveillance and off shore transport or adequate infrastructure. The project summarized the significant study of hydroplane and then several theoretical and practical possible research areas of hydroplane are definitely proposed goal of doing this research to obtain the design of RC hydroplane dimension so as to maintain a stable condition when ship drove at high velocity. The stability fact of aircraft deals with the ability to keep an aircraft in the air in the chosen flight attitude. And maintain the stability stability on water. It would be interesting to investigate the aerodynamic and hydrodynamic interaction for such aircrafts. We are conceiving a method to investigate the horizontal stabilizer of aerofoil design to maintenance stability of hydroplane through Q-blade software to check aerodynamic simulation & performance curves, polar data over a aerofoil and analysis through Computational Fluid Dynamics (CFD) simulation.

Incipiently, ANSYS based simulation were carried out for a N-10 (cambered) aerofoil of horizontal stabilizer in order to estimate the aerodynamic simulation. The results obtained from Q-blade software for aerodynamic simulation. it comes with a user-friendly graphical user interference (GUI). A cambered aerofoil selected for the study since this aerofoil will be able to generate  $C_{mo}$  positive and slope at trim  $\frac{dC_m}{d\alpha}$  will be negative. we conclude from these preliminary simulations that significant lift-to-drag augmentation was experienced by N-10. These results from simulations have to be validated with elaborate experimental setup in short future

**KEYWORDS:** N-10 airfoil, hydroplane, static stability, aero-hydrodynamic interaction, lift-to-drag ratio

## I. INTRODUCTION

The term stability characterizes the motion of an airplane when returning to its equilibrium position after it has been disturbed from it without the pilot taking action. For aircraft has major component as wing as horizontal tail so, whatever disturbance it experiences if at all in a restoring moment has to be generated, it has to come from the interaction of the horizontal tail, wing, fuselage from their interaction it should generate nose down moment for positive disturbance, angular disturbance angle of attack disturbance it has static stability. The project of evolution is our hydroplane is maintaining stability or not when it is flying or water or at high velocity the boat his stability maintains or not. Moreover, we analyse the hydroplane design using ANSYS 2019 R3 and found optimum size of the hydroplane. To increase the stability, we initiate to use hydrofoil hull concept to fix the stability of the hydroplane.

The four main forces acting on an aircraft are lift, drag, thrust and weight. This work is focused on the lift force that is generated by distribution in air pressure. They have immense potential as the future mode of sea transport. Such planes also find a wide range of applications in surveillance, patrol and transportation. They mark a niche in their use for dropping water on forest fires, air transport around archipelagos, and access to undeveloped or road-less areas, some of which have numerous lakes. These planes are also appealing to people of adventure sport exploring lakes or wilderness [1]. Extensive operation of seaplanes can bring down the cost of building airports. A picture of a typical hydroplane is shown in Figure [1]

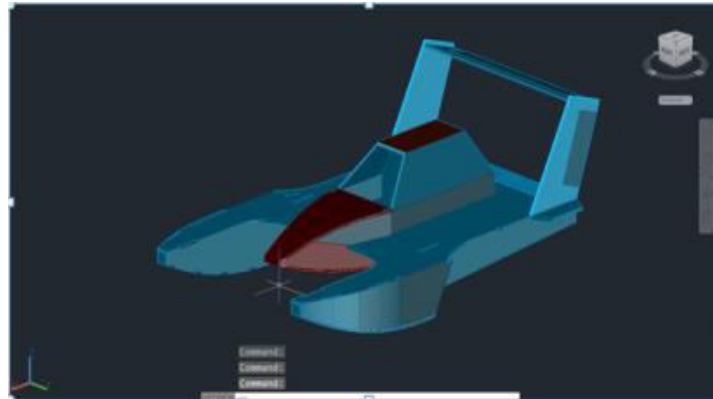


Figure 1: A picture of a typical hydroplane

## II. RELATED WORK

Q-blade is an open-source and aerodynamic simulation. It comes with a user-friendly graphical user interface (GUI) based on Qt. The results obtained from Q-blade software for aerodynamic simulation. A cambered (N-10) aerofoil selected for the study since this aerofoil will be able to generate  $C_{m0}$  positive and slope at trim  $\frac{dC_m}{d\alpha}$  will be negative. We conclude from these preliminary simulations that significant lift-to-drag augmentation ( $c_l/c_d$ ) was experienced by N-10.

Computational Fluid Dynamics (CFD) simulation is a numerical analysis that has to be carried out to investigate the flow properties over hydroplane. CFD is a promising design tool for hydroplane designers, if validation of the simulation results can be successfully carried. A fast, economical and practical method for mathematical modelling of aerodynamic characteristics was presented by Q-blade. Based on calculated values of aerodynamic coefficients. Studies on static stability for aircrafts, the aerodynamic centre is behind the centre of gravity then it processes static stability. The immediate objective of the present work is two-fold. Firstly, the development of a fully coupled CFD methodology through suitable boundary conditions is envisaged, for hydroplane. Further, we attempt to understand the aero-hydrodynamic interaction for a cambered aerofoil.

Thus for static stability,

$$C_{m\alpha} \text{ or } \frac{\partial C_m}{\partial \alpha} < 0 \text{ This is called pitch stiffness}$$

$$C_m = C_{mac, w} - X_{ac} C_L = 0 \text{ At trim/equilibrium}$$

$$\frac{\partial C_m}{\partial \alpha} - \frac{\partial C_{mac}}{\partial \alpha} - \frac{X_{ac}}{c} \frac{\partial C_L}{\partial \alpha} < 0 \text{ static stability requirement}$$

### DESIGN PARAMETERS OF HYDROPLANE:

Body Height	3.5"
Height including superstructure	6.5"
Elevator and rudder controllable part length	1.5"
Rudder height	5.5"
Total height	10"
Horizontal stabilizer length	1.3"
Working surface	1.5"
Total length	24"
Width	15"



**MAXIMUM L/D:**

From the drag polar for NACA 16212, this occurs at the point  $C_l=0.980$ , and  $C_d=0.0042$ . The maximum L/D at this point is 67.723

From the drag polar for NACA 25112, this occurs at the point  $C_l= 0.984$ , and  $C_d= 0.014$ . The maximum L/D at this point is 69.514

From the drag polar for NACA 24112, this occurs at the point  $C_l= 0.980$ , and  $C_d= 0.014$ . The maximum L/D at this point is 67.723

From the drag polar for NACA 23021, this occurs at the point  $C_l= 0.830$ , and  $C_d= 0.020$ . The maximum L/D at this point is 41.932

From the drag polar for NACA 23112, this occurs at the point  $C_l= 0.980$ , and  $C_d= 0.014$ . The maximum L/D at this point is 67.723

From the drag polar for NACA 23015, this occurs at the point  $C_l= 1.128$ , and  $C_d= 0.016$ . The maximum L/D at this point is 68.566

The Comparative results of N-10 (Cambered) aerofoil with the six aerofoils (NACA 16212, NACA 25112, NACA 24112, NACA 23021, NACA 23112, NACA 23015). The assessment results of N-10 aerofoil showed satisfactory aerodynamic efficiency then the six aerofoils (NACA 16212, NACA 25112, NACA 24112, NACA 23021, NACA 23112, NACA 23015) while analysed in the Q-blade software at  $9^0$  angle of attack. The maximum L/D at this point is 64.390 of N-10 aerofoil.

**INLET BOUNDARY CONDITIONS:**

NO	PHYSICAL PROPERTIES	MAGNITUDE	UNIT
1	Density	1.225	$Kg/m^3$
2	Velocity	120	$Kg/m-s$
3	Gauge pressure	0	pascal
4	Turbulent intensity	5	%
5	Turbulent viscosity ratio	10	

**III. METHODOLOGY**

The case presented is on the subsonic flight of a cambered infinite wing with N-10 profile. Q-Blade method was implemented to study the polar graphs of  $c_l$  vs  $c_d$ ,  $c_l$  vs  $\alpha$ ,  $c_l/c_d$  vs  $\alpha$  and  $C_m$  vs  $\alpha$  and the subsequent computations of lift and drag forces. CFD method was used to study to flow over hydroplane and N-10 airfoil.

**IV. EXPERIMENTAL RESULTS**

The “lift polar” shows the lift coefficient  $C_l$ , plotted versus the angle of attack  $\alpha$ . [2] When N-10 Camber of airfoil, the zero lift angle decreases and the  $C_l$  vs  $\alpha$  curve shift to the left. it is observed that  $\alpha_{stall}$  at  $15^0$  does not decrease significantly due to the increase of camber and a higher  $C_{L_{max}}$  at 1.285 is realized. [2]. For a given lift coefficient of 1.285, we read a drag coefficient of 0.020 from the graph. [3]

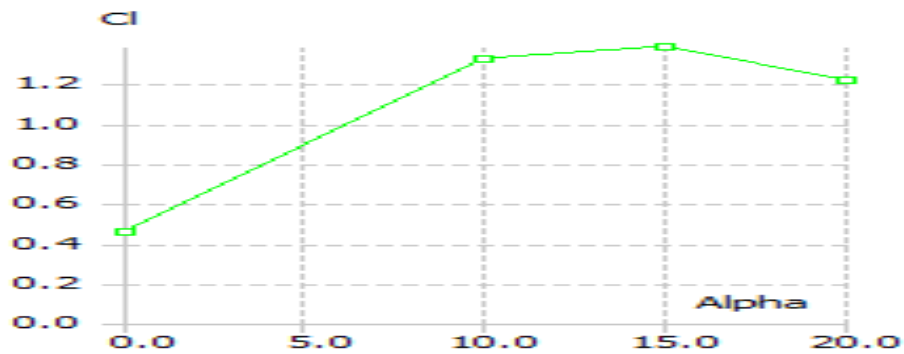


Figure.2:  $C_L$  verses Alpha graph

Fig. 4 The “moment polar” is similar to the “lift polar”, but shows the moment coefficient  $C_m$  of N-10 airfoil section instead of the lift coefficient versus the angle of attack [2]. For an angle of attack  $\alpha$  of  $9^\circ$  we find a corresponding moment coefficient  $C_m$  of -0.005. A negative moment coefficient indicates a pitch down tendency for the reference point. [4]. The next graph to look at is the  $C_l/C_d$  vs  $\alpha$  graph. The maximum lift/drag ratio and maximum glide ratio is 55. At the angle of  $10^\circ$ . [5]



Figure.3:  $C_M$  verses Alpha graph

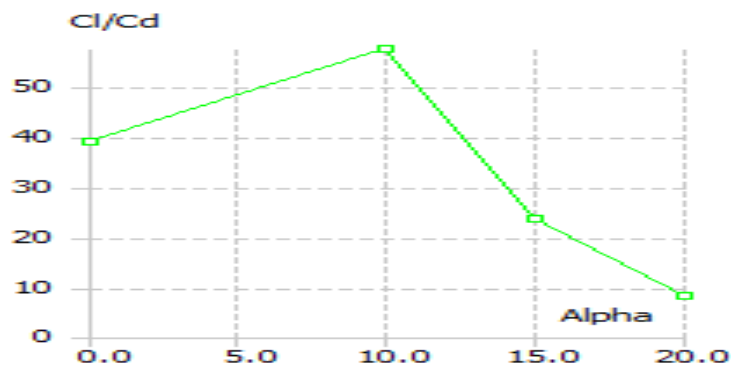


Figure.4:  $C_L/C_D$  verses Alpha graph

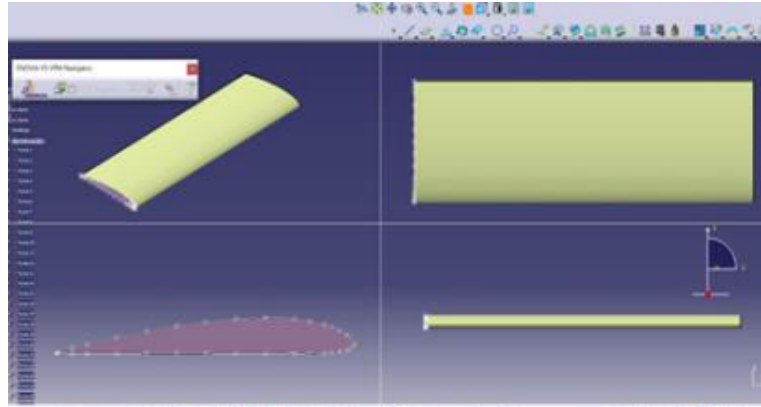


Figure.5 The geometry of N-10 aerofoil

Fig.5 The geometry of N-10 aerofoil is created by CATIYA 19.0 by importing coordinates. The maximum camber 5.29%, the maximum camber position 30.00%, maximum thickness position 30.00% and maximum thickness is 11.22%.[6]. Fig.6 Successfully for the generation of hexahedral meshing the maximum size of mesh is 0.053 and minimum mesh size is 0.00263672 [7]

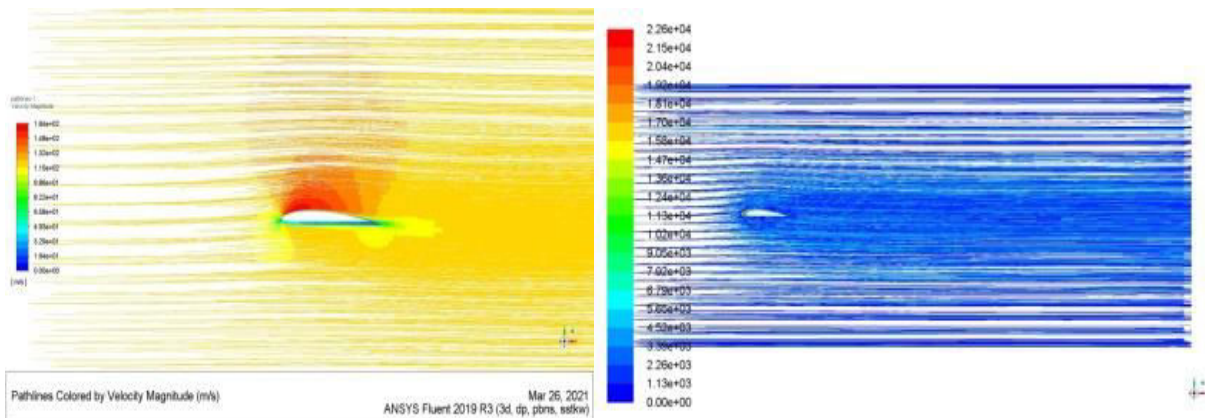


Figure.6: Hexahedral meshing

Fig. shows the velocity variation on N-10 aerofoil at  $0^{\circ}$  angle of attack. blue colour indicates minimum velocity  $1.64e+01$  m/s and orange colour indicate maximum velocity of  $1.64e+02$  m/s. thus resulting in a higher velocity above the wing and lower velocity below the wing.

Fig. shows the pressure variation on N-10 aerofoil at  $0^{\circ}$  angle of attack. Blue colour indicates minimum static pressure  $1.13e+03$  pascal and orange colour indicate maximum static pressure of  $2.26e+04$  pascal. High lift aerofoil characterized by having pronounced the camber, the static pressure at upper surface will be lower than that magnitude at the lower surface and this will create a pressure difference between both surface.

### V. CONCLUSION

A Cambered aerofoil has different upper and lower surface, with a greater curvature of the aerofoil above the chord line than below. The mean camber lines and chord line are different. The nonsymmetric aerofoil design can produce useful lift at zero angle of attack. The advantages are more lift production at given angle of attack than a symmetrical design, an improved lift-to-drag ratio, and better stall characteristics. The Q-blade open-source, aerodynamic simulation



method software was giving the graphical representation of N-10 aerofoil (cambered) like  $c_l$  vs  $c_d$ ,  $c_l$  vs  $\alpha$  and  $c_m$  vs  $\alpha$ , present work provides a useful input to the height of operation of a lifting surface.

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