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Original Article

Static Structural Analysis and Static Fluid Pressurized on Marlin Glider Wing Torpedo's

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Abstract - *The design technique for the glider wing torpedo is open to design parameter changes and gives the designer insight into the security of the final configuration. Constructing a torpedo finite element model and testing its static properties as a function of design parameters structural analysis of torpedo's were significantly used to strengthen our defence system. In this paper, three models, circular, elliptical and black marlin glider wing torpedoes, were introduced, and the results of the three models were compared at static load and pressure conditions. The parameters were taken at the deepest point of the Pacific Ocean under standard conditions. The black marlin glider wing torpedo shows better results than the other two models.*

Keywords - *Glider wing, Strengthen, Static load, Static pressure, Pacific Ocean standards.*

1. Introduction

Combining NACA profiles creates a glider wing [1]. We used Solid Aluminum alloy because the wing needed to be strong while being as light as possible [2]. The skin of a glider wing is an essential component that helps the wing retain its hydrodynamic shape and transfers various types of loads to the structural members of the wing [3]. Traditional stretch-forming methods are used to create a skin for torpedo [4].

Loads operate perpendicular to the wing surface and have varying magnitudes throughout the wing's length [5]. The same concept of simplification and weight reduction of the Glider wing is used to prepare hearing primarily focused at work.

The design perspective determination of the acting loads on the torpedo is of paramount importance [6]. The task now is to decide which critical load combinations are most likely to occur to determine the maximum loads at each stage [7]. Hydrostatic pressure rises in proportion to the depth from the surface measured by the fluid's weight increasing and supplying downward force from above.

The size and features of the mesh are controlled via a global mesh size and tolerance parameter and designed with Aluminum alloy material. Marlin glider wing torpedo with different analyses are worked.

2. Methodology

2.1. Structural Load on Wing

On and beyond the limits of the representative manoeuvring envelope, the strength criteria must be met at each combination of fluid speed and load factor. Other loading conditions are often overlooked because the structure is likely to withstand all intermediate loads produced.

The forces that act on any structure, causing it to deflect and vibrate, resulting in stresses and strains, are referred to as circular, elliptical and black marlin glider wing torpedoes masses as 133.82, 128.02 and 122.63kg. Torpedo's must withstand a variety of static and dynamic loads. The computation is carried out in a straight forward manner by integrating loads along the torpedo components using analytical formulae obtained from the hydrodynamic model simplification.

$$W_{Torpedo} = mg$$

$$D_{Load\ factor} = 3 * W_{Torpedo}$$

$$FOS = 1.5$$

$$D_{Ultimate\ load} = FOS * D_{Load\ factor}$$

$$L_{Load\ on\ wing} = 80\% * D_{Ultimate\ load}$$

$$L_{Load\ acting\ on\ each\ wing} = 0.5 * L_{Load\ on\ wing}$$

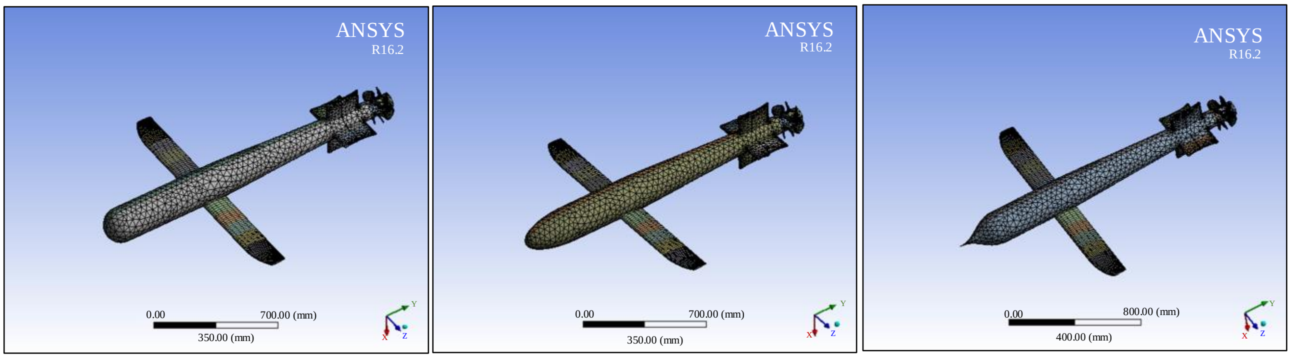

Fig. 1 Meshing for circular, elliptical, and black marlin glider wing torpedoes

Where,
$W_{Torpedo}$ = Weight of torpedo,
m = Mass of torpedo,
g = Acceleration due to gravity,
$D_{Load\ factor}$ = Design of load factor,
FOS = Factor of safety,
$D_{Load\ factor}$ = Design of ultimate load,
$L_{Load\ on\ wing}$ = Lift load on wing,
$L_{Load\ acting\ on\ each\ wing}$ = Lift load acting on each wing.

We concluded from the above measurement that there is an external force on the wing and that the geometric characteristics of the cross section must be determined. The results will be obtained by applying a 4800N lift force to symmetric parts on both surfaces that a fixed support can operate.

2.2. Static Fluid Pressurized Load on Torpedo

An item gets submerged deeper into a fluid when there is greater pressure being applied to it. At sea, a depth is measured. The pressure will begin to rise. The force a liquid exerts on an item per unit area hydrostatic pressure has increased, which is the cause of this. As you delve further into the water, more pressure is applied. A submerged object's depth can be determined. An item is immersed deeper in the fluid as a result of increased pressure exposure. This is due to the fluid's weight being more significant than its own.

The deeper an object is submerged in the fluid, the more significant pressure it is exposed to; this is because the fluid's weight is more significant than its own. The more weight is set on the submerged question due to the fluid's weight. Because of the rising downward force from above attributable to the weight of the fluid, hydrostatic pressure rises as a proportion of the depth measured from the surface is 11022m in Pacific Ocean fluid flow with density 1.075*103 kg/m3.

Calculating the total pressure on an object requires taking into account any additional pressure present if the container is exposed to the atmosphere above. The cumulative pressure on pressure gauge readings is equal to the absolute pressure, and gauge pressure is equal to the fluid pressure. Atmospheric pressure for standard sea level conditions is 101.325Kpa.

$$P_{total} = P_{atmosphere} + P_{fluid}$$

$$P_{total} = P_{atmosphere} + (\rho * g * h)$$

Where,
P_{total} = Total pressure,
$P_{atmosphere}$ = Atmospheric pressure at standard sea level conditions,
P_{fluid} = Fluid pressure at the pacific ocean,
ρ = Density of the pacific ocean,
g = Acceleration due to gravity under seawater,
h = The depth of the pacific ocean.

The cumulative pressure on the torpedo nose section was calculated using the formula above, and the geometric characteristics of the cross-section were determined to do so. The results will be obtained by applying 116.22Mpa to a surface operated by a fixed support.

3. Results and Discussion

The deformation was calculated using a simplified torpedo's structural model under two different conditions i.e load applied on the glider wing and pressure applied at the cross-section of the nose of the torpedo's have shown a satisfactory result even at the Pacific Ocean's deepest point under standard conditions. It can be deduced from the comparisons of results that the black marlin glider wing torpedo has shown better static structural and pressure characteristics.

The variation of maximum principal stress with maximum principal strain was obtained for the black marlin and then the other. By comparing older results, they are unable to find static structural analysis and static fluid pressurized on marlin glider wing torpedo's of load and pressure forces acting at a time, and we find better results compared with older results.

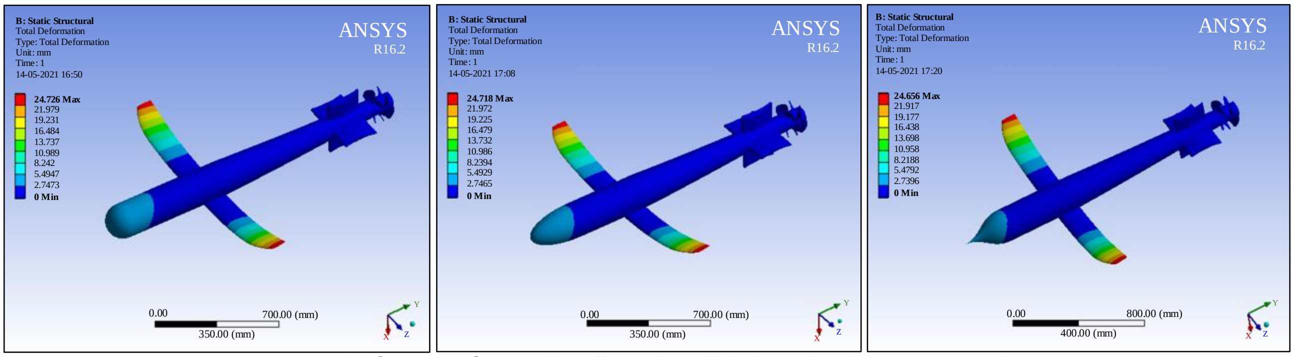

Fig. 2 Total deformation for circular, elliptical, and black marlin glider wing torpedoes

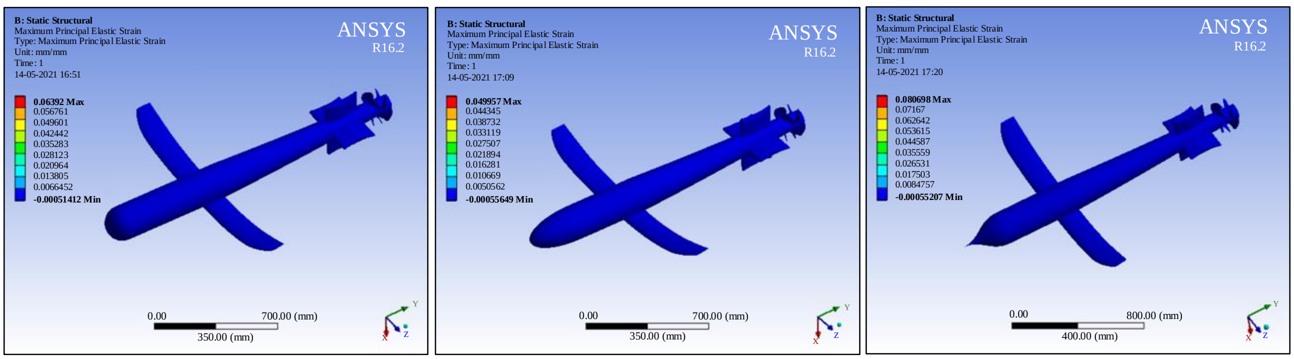

Fig. 3 Maximum principal elastic strain for circular, elliptical, and black marlin glider wing torpedoes

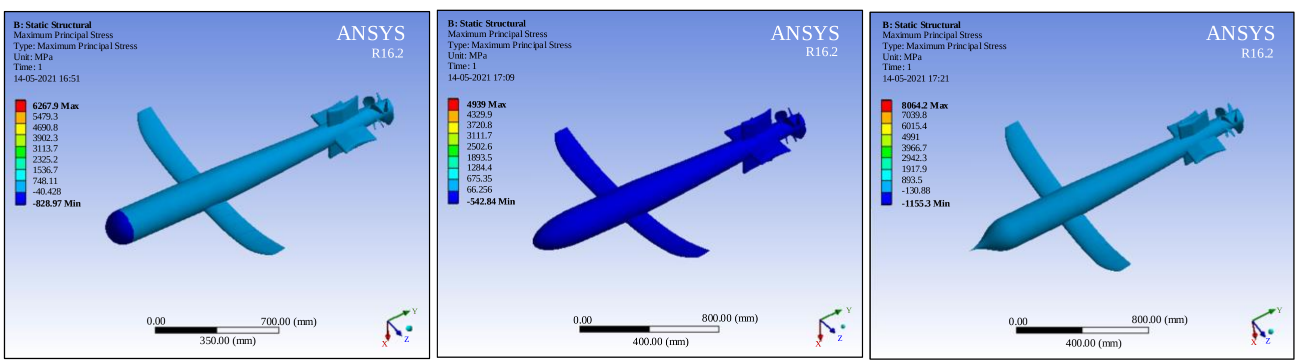

Fig. 4 Maximum principal stress for circular, elliptical, and black marlin glider wing torpedoes

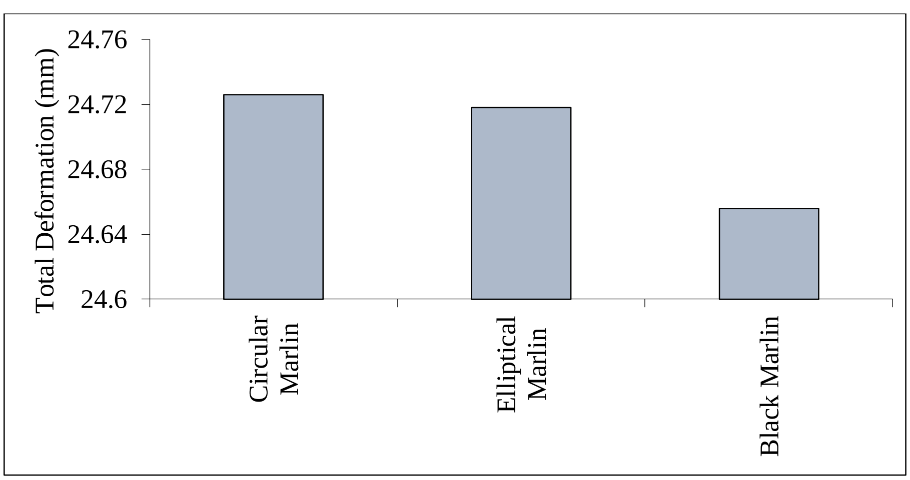

Fig. 5 Variation total deformation with design

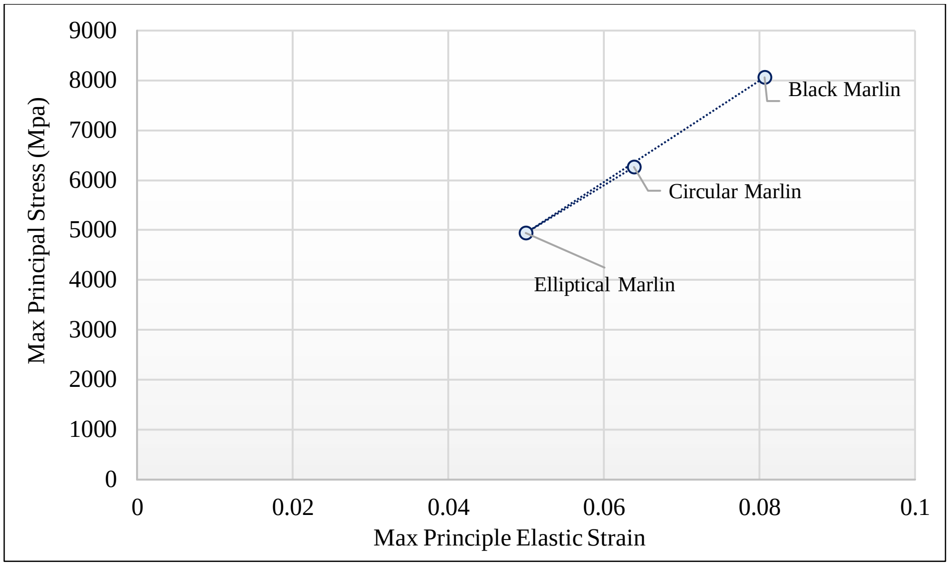

Fig. 6 Comparison of results for total deformation and maximum principle stress and strain

Table 1. Comparison of results static structural analysis results

Static Structural	Circular Marlin	Elliptical Marlin	Black Marlin
Total Deformation (mm)	24.726	24.718	24.656
Max Principal Stress (Mpa)	6267.9	4939	8064.2
Max Principle Elastic Strain	0.06392	0.049957	0.080698
Equivalent Stress (Mpa)	4489.4	3471.6	4537.4
Equivalent Elastic Strain	0.063231	0.048896	0.064199
Strain Energy (mJ)	13356	14606	14191

4. Conclusion

The torpedo's structural analysis computed at static load and pressure made of three different models, i.e. circular, elliptical and black marlin glider wing torpedoes consisting of aluminium alloy. The compared results were calculated by using ANSYS static structural software. The deformation was obtained from the simplified structural model of the torpedo under two different conditions, i.e. load applied on the glider wing and pressure applied at the cross-section of the nose of the torpedo's have shown a satisfactory result even at the Pacific Ocean's deepest point under standard conditions. It was observed that the higher value of maximum principal stress was 8062.2Mpa, equivalent stress 4537.4Mpa, maximum principal elastic strain 0.080698, and equivalent elastic strain was 0.064199 for the black marlin glider wing torpedo. It can be deduced from the comparisons of results that the black marlin glider wing torpedo has shown better static structural and pressure characteristics.

Nomenclature

M - Mass (kg)
G - Acceleration due to gravity (m/s^2)
L - Load (N)
P - Pressure (Mpa)
P - Density of the Pacific Ocean (kg/m^3)
H - Height of the fluid (m)

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References

[1] Xueyan Zhang, Yan Zhao, and Fan Si, "Analysis of Wing Flexure Deformation Based on ANSYS," *2018 IEEE/ION Position, Location and Navigation Symposium*, USA, pp. 190-196, 2018. [CrossRef] [Google Scholar] [Publisher Link]

[2] Kang Yang et al., "Design and Static Testing of Wing Structure of a Composite Four-Seater Electric Aircraft," *Science and Engineering of Composite Materials*, vol. 27, no. 1, pp. 258-263, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[3] Muhammad Amir Mirza Bin Mohd Zakuan, Abdul Aabid, and Sher Afghan Khan, "Modelling and Structural Analysis of Three-Dimensional Wing," *International Journal of Engineering and Advanced Technology*, vol. 9, no. 1, pp. 6820-6828, 2019. [CrossRef] [Google Scholar] [Publisher Link]

[4] Pan Changjun, and Guo Yingqing, “Design and Simulation of Ex-Range Gliding Wing of High Altitude Air-Launched Autonomous Underwater Vehicles Based on SIMULINK,” *Chinese Journal of Aeronautics*, vol. 26, no. 2, pp. 319-325, 2013. [CrossRef] [Google Scholar] [Publisher Link]

[5] A. Ramesh Kumar, S.R. Balakrishnan, and S. Balaji, “Design of an Aircraft Wing Structure for Static Analysis and Fatigue Life Prediction,” *International Journal of Engineering Research and Technology*, vol. 2, no. 5, pp. 1154-1158, 2013. [CrossRef] [Google Scholar] [Publisher Link]

[6] Surasak Phoemsapthawee et al., “An Underwater Glider Flight Simulator,” *Journal of Marine Science and Application*, pp. 1-3, 2013. [Google Scholar]

[7] K. Sruthi, T. Lakshmana Kishore, and M. Komaleswara Rao, “Design and Structural Analysis of an Aircraft Wing by Using Aluminum Silicon Carbide Composite Materials,” *International Journal of Engineering Development and Research*, vol. 5, no. 4, pp. 949-959, 2017. [Google Scholar] [Publisher Link]