Design and Structural Analysis of Torpedo

Pothuraju. V.V. Satyanarayana[1], A. Vamsi Krishna[2]

[1]*Assistant Professor, Department of Mechanical Engineering, Avanthi Institute of Engineering and Technology, Makavarapalem, Visakhapatnam-531113*
[2]*Graduate student, Department of Mechanical Engineering, Avanthi Institute of Engineering and Technology, Makavarapalem, Visakhapatnam-531113*

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Abstract - In designing a heavyweight torpedo, multiple performance criteria from many disciplines, including structures have to be satisfied in order to maintain a high probability of success for the mission. These criteria could conflict with each other as design requirements, in which case the final design will be the configuration that minimizes conflicts. Performance criteria depend on various design parameters that constitute the configuration of the torpedo and these are usually assigned deterministic values. However, in reality, the parameters would exhibit variations, and thus the design criteria could potentially violate the feasible design space. Therefore, this models presents a robust torpedo design strategy that provides the designer insight into the safety of the final configuration, subject to variations in design parameters. In this project of torpedo is modeled using finite elements and its static characteristics are analyzed subject to variations in the design parameters structural problem.

Key Words: Conflict, Violate, Robust

1. INTRODUCTION

The torpedo is one of the oldest weapons in the naval inventory, having been invented over 130 years ago, but at the same time it remains one of the deadliest anti-ship and anti-submarine weapon, it is far more lethal to submarines and surface ship than any other conventional weapon. torpedo warhead explodes under water, and that increases its destructive effect. When projectile explodes, the surrounding air absorbs a part of its force. Homing torpedoes are a relatively recent development they have been perfected since the end of world war ii. With homing torpedoes, a destroyer can attack a submerged submarine, even when its exact position and depth are unknown.

2. WORKING PRINCIPLE OF THE TORPEDO

The torpedo is equipped with mechanical devices which make it self propelling after it is launched. The reduced pressure air also fires the igniter, which ignites the fuel in the combustion flask, where the combination of fuel, air, and water is converted into gases and steam at a high temperature and fed through a pipe to the nozzles of the turbines, furnishing the power for propelling the torpedo.

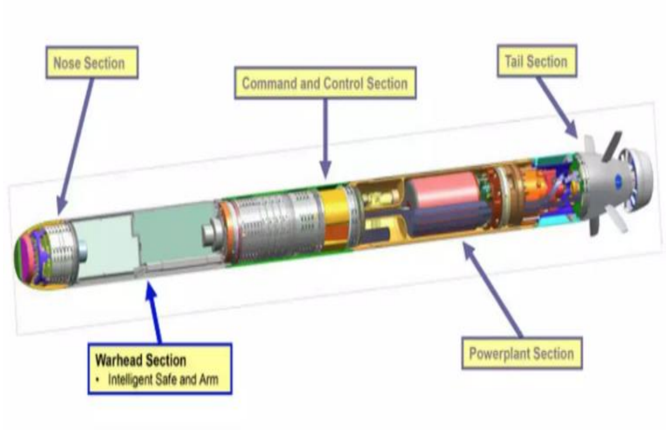

Fig -1: Torpedo sections view

3. DESIGN OF TORPEDO

The energy needed to propel a torpedo should overcome the drag and the skin-friction when water flows around the weapon. For maximum efficiency the flow of water should be laminar within the boundary layer or in other wor ds, a streamlined condition should exist. At the rear of the torpedo, the flow along the boundary layer should be gathered in by the propulsion for achieving maximum propulsion efficiency. As a result of the mechanical work done by the propulsion, the water ejected from the stem to give the required thrust. Experiments done in test tanks show that the an ideal ratio of length to diameter of a torpedo is 7: 1. Universally, the heavy-weight torpedo has a diameter of 53 cm and to meet the ideal shape , the torpedo's length should be of the order of about 3.5 m. However, the normal length is anywhere between 6 and 7.5 m. Though the designer would like to keep the length near about the. ideal length , it is impractical to do so as the major sub-assemblies like the warhead, propulsion system, and guidance, have to be accommodated. The requirement of space becomes more stringent as the range increases, owing to increased capacity needed for storing the fuel, oxidant, etc . In the case of light-weight torpedo, the diameter is around 35.2 cm and the length around 4 m. The shape of the torpedo itself is a compromise and far from the ideal. This in practical terms means a reduction in the total propulsion efficiency of the torpedo. This aspect will be dealt with in detail in a subsequent chapter.

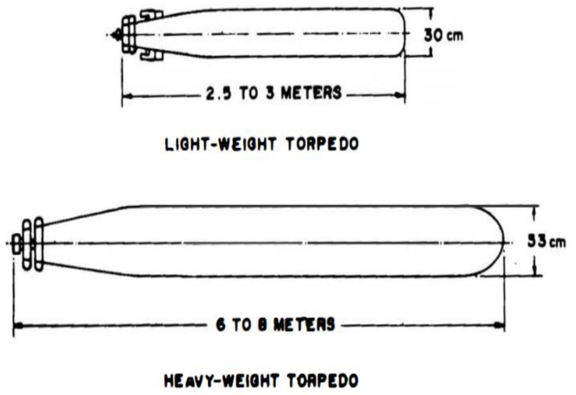

Fig -2: Light-weight and heavy-weight torpedo

If a target is attacked from a long distance, the escape volume for the target also becomes larger if the enemy craft surmises that a torpedo has been launched. In such a situation, the torpedo's terminal homing capability should also be more refined and accurate.

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4. DIFFERENT TYPES OF TORPEDOES

The Torpedoes body is made of aluminum. Three versions of the torpedo exist today, with slight differences in guidance programs and the amounts of data transferred by wire to the launch vessel. The torpedo has a large payload, which, in combination with its guidance systems, ensures the optimum placement of the explosive power.

The torpedo also takes advantage of available over-the horizon techniques, allowing it to target on sights at far greater distances than its predecessors. The torpedo is specially built for passive homing, and thus is able to approach its target under a great variety of stealthy circumstances. The extent of the torpedo's interactivity among its various sensor systems allows the weapon to effectively operate over the horizon as well (range permitting).

The wire guidance provides immunity from interference and exists as a two-way data link between the weapon and its launch pad. The operation is practically wake less, thanks to the electric motor, which also happens to be very quiet. After the guide wire has been terminated, the torpedo continues operation as a highly intelligent, independent unit. The weapon's internal computer takes over the responsibility for target search, target loss, corrective actions, and other operations.

The assembled model of the Torpedo's are as follows

Fig -3: Tiger fish

Fig -4: White head

Fig -5: Mark

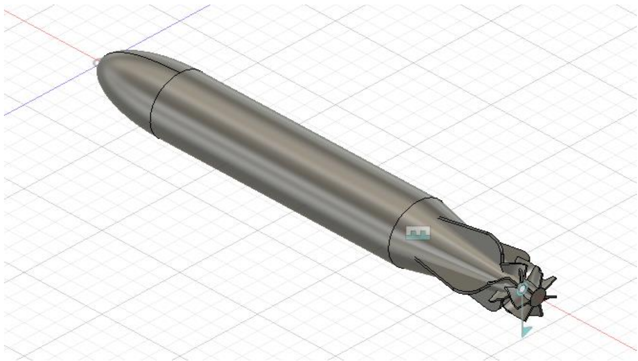

Fig -6: Atlas

5. Material and construction of Torpedo

Torpedo's are made from corrosion resistant materials as they are made operational directly in sea water which is a corrosion accelerator. The materials used for making Torpedos are alloy of aluminium and stainless steel. Other materials used are alloys of nickel, aluminium and bronze which are 10~15 % lighter than other materials and have higher strength.

6. STATIC STRUCTURAL ANALYSIS

ANSYS Workbench combines access to ANSYS applications with utilities that manage the product workflow.

Table -1: Comparison results

MODELS	DEFORMATION (mm)	EQUIVALENT STRESS (Mpa)	EQUIVALENT STRAIN
Tiger fish	0.26343	9.853	0.00011323
White head	0.24936	7.8282	0.00011156
Mark	0.24620	9.2767	0.000013269
Atlas	0.22257	8.0091	0.00011323

RESULTS AND ANALYSIS OF TORPEDO'S

STATIC ANALYSIS OF TORPEDO FOR DIFFERENT MODELS

A) Tiger fish

Mass=1602.3 kg, Nodes= 13822, Elements=2996.

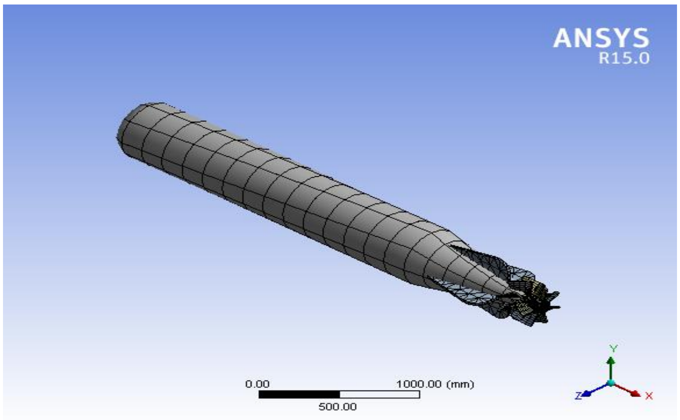

Fig -7: Mesh diagram

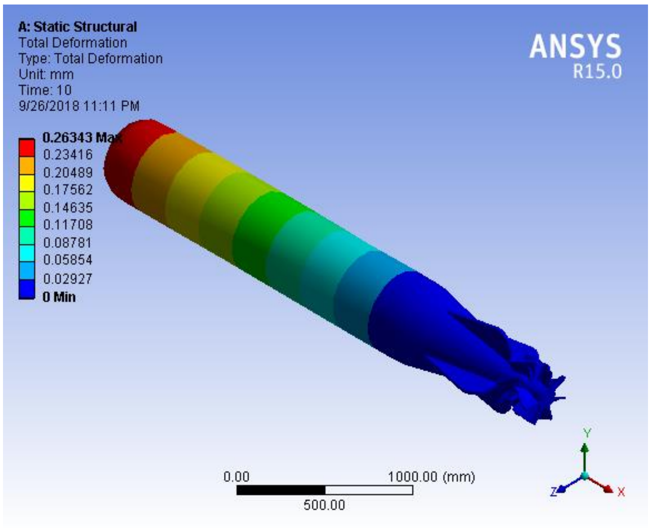

Fig -8: Total deformation

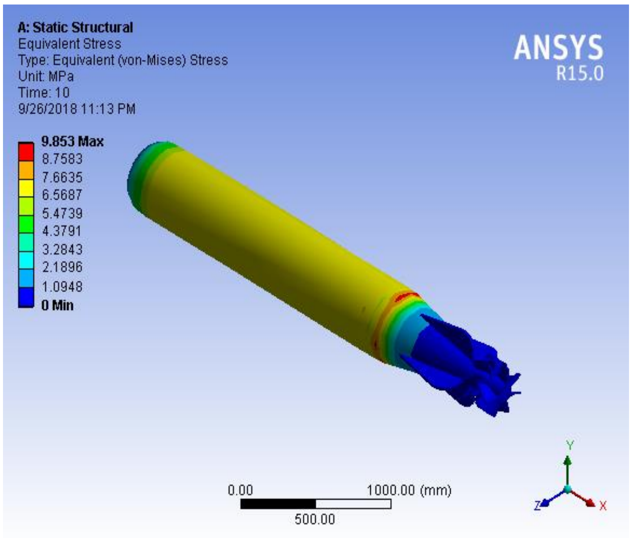

Fig -9: Equivalent stress

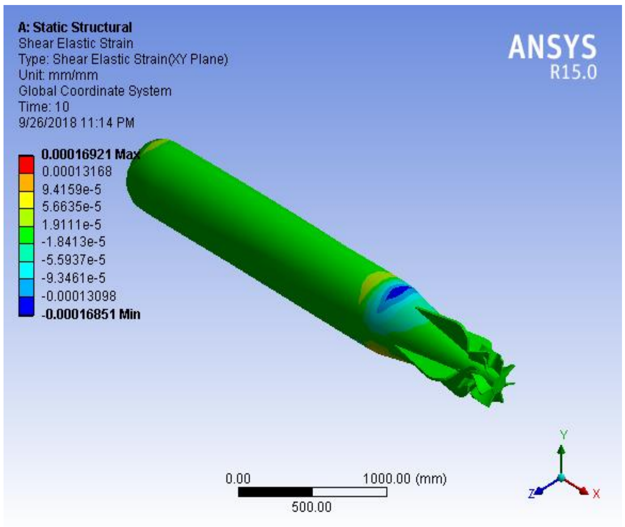

Fig -10: Shear Elastic strain

B) White head

Mass= 1553.5 kg, Nodes= 13269, Elements= 3082.

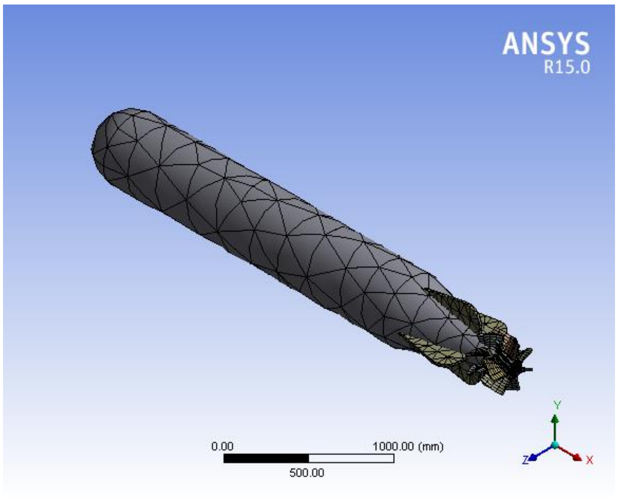

Fig -11: Mesh diagram

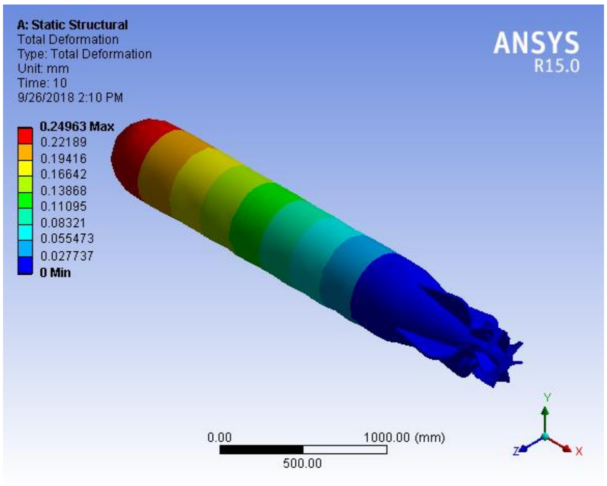

Fig -12: Total deformation

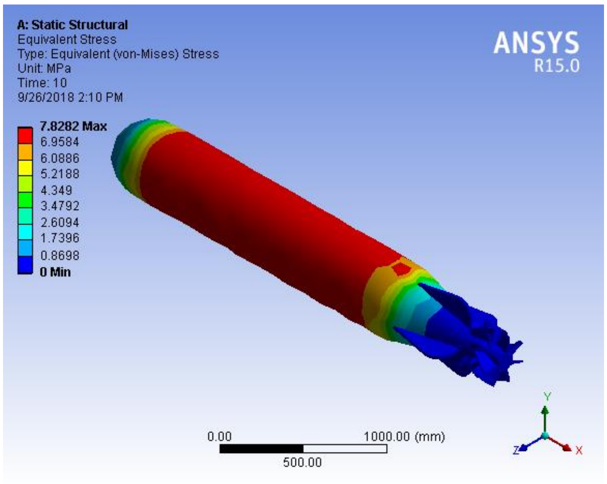

Fig -13: Equivalent stress

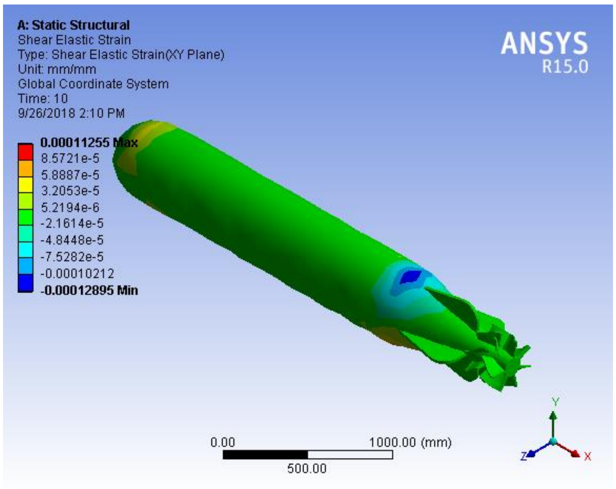

Fig -14: Shear Elastic strain

C) Mark

Mass= 1570.4 kg, Nodes= 13856, Elements= 2989.

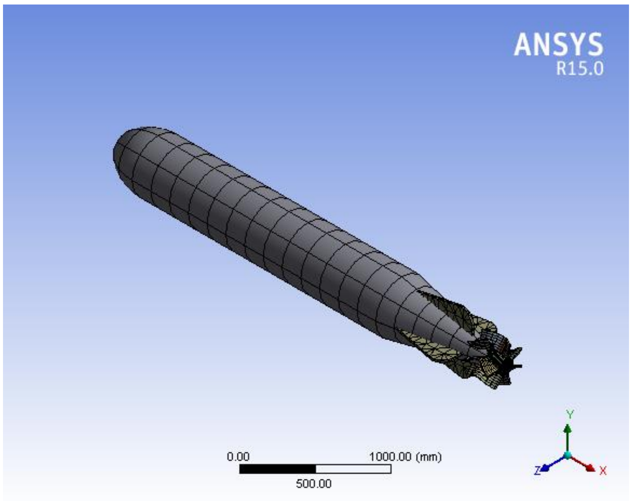

Fig -15: Mesh diagram

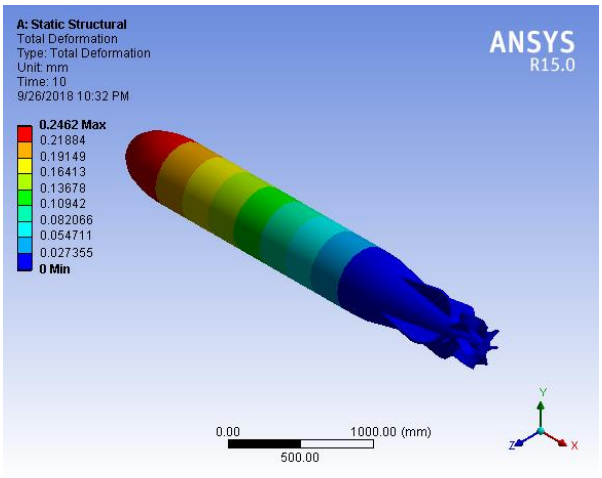

Fig -16: Total deformation

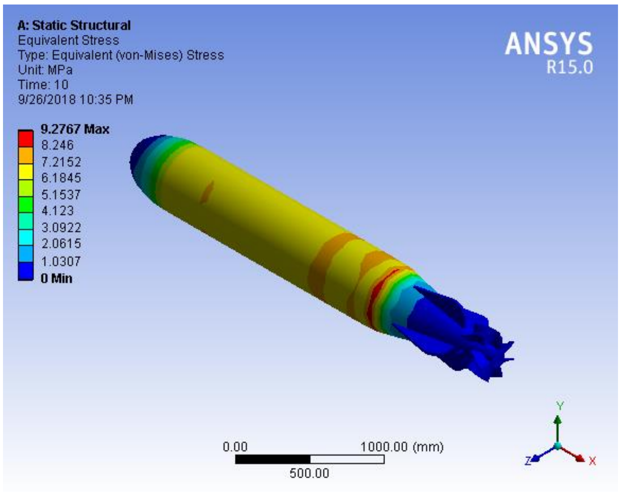

Fig -17: Equivalent stress

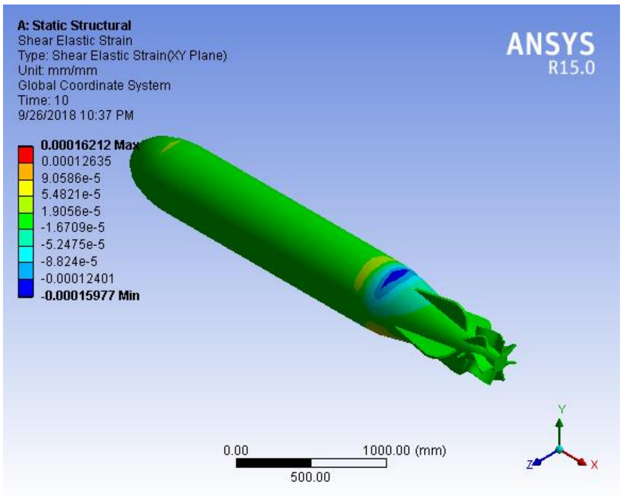

Fig -18: Shear Elastic strain

D) Atlas

Mass=1503.5 kg, Nodes 13159, Elements=3025.

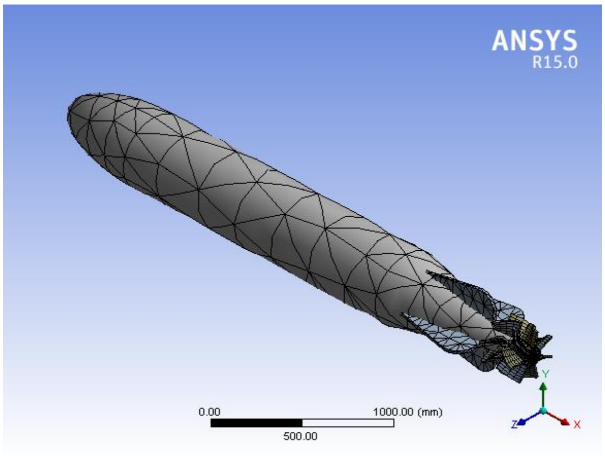

Fig -19: Mesh diagram

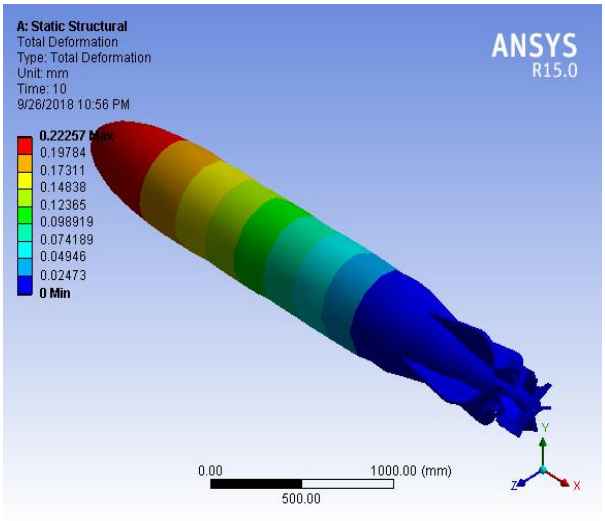

Fig -20: Total deformation

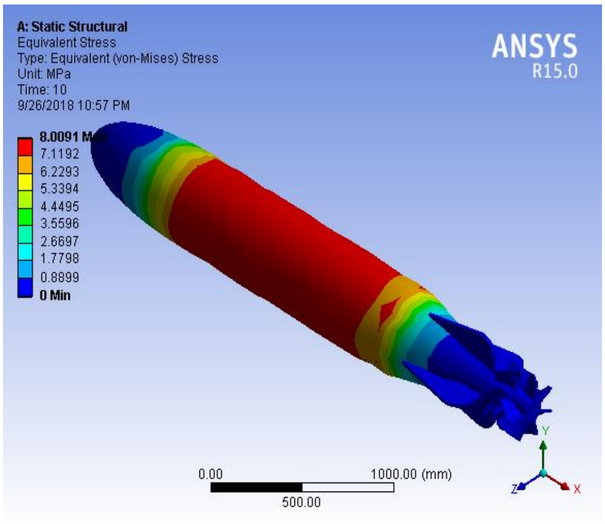

Fig -21: Equivalent stress

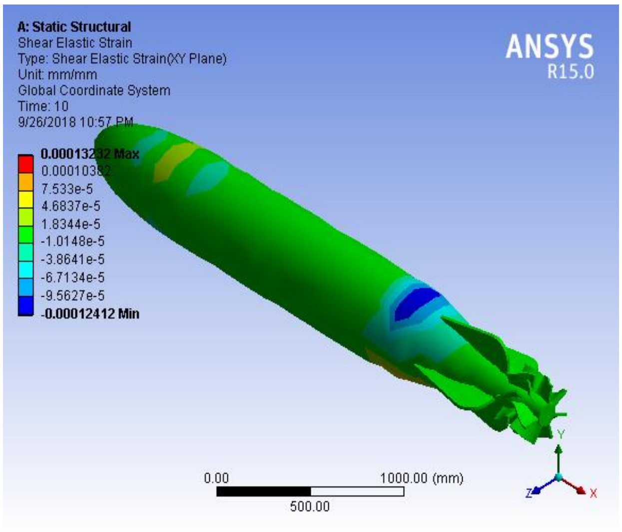

Fig -22: Shear Elastic strain

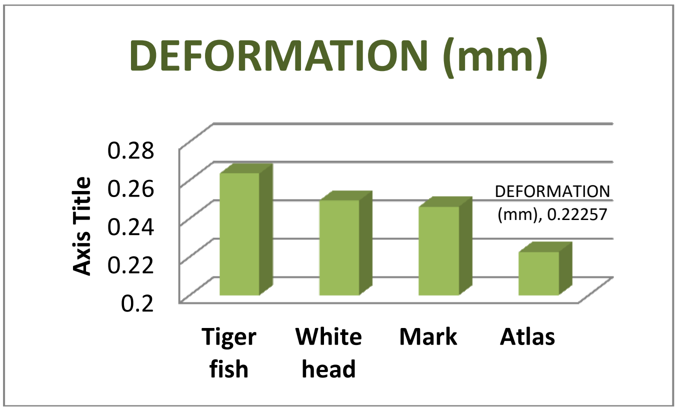

Chart -1: **Deformation of different torpedo models**

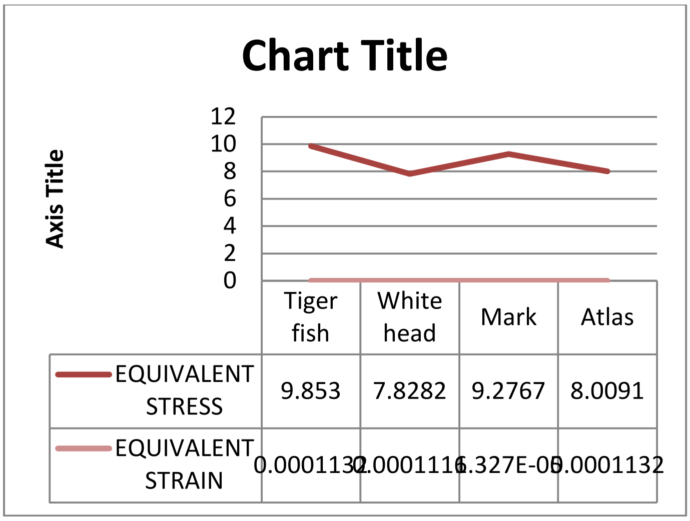

Chart -2: Equivalent stress & strain for different torpedo models

CONCLUSION

The purpose of the present project is to structurally design and ensure that the torpedoes has a sufficient strength with lowest and highest weight possible and We can perform the parametric analysis with the use of different parameters like Material properties, loading condition, boundary condition, mesh resizing by virtue of which we obtain some useful information without experimental cost and we can finally optimize our model. In our project we have designed different torpedoes. The three dimensional torpedoes is designed by using FUSION360 and we created four different models and structural analysis using Aluminum Alloy material. By observing these results from four different models we find Atlas obtained better results comparing with the other models.

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BIOGRAPHIES

Mr. POTHURAJU.V.V.SATYANARAYANA
Assistant Professor in Avanthi Institute of Engineering and Technology, Makavarepalem, Visakhapatnam, INDIA. Areas of Interest in Machine Design and Aerospace Research.

Sri. A. Vamsi Krishna
Graduate student in Avanthi Institute of Engineering and Technology, Makavarapalem, Visakhapatnam, INDIA.