DESIGN AND SIMULATION OF MARINE PROPELLER IN AN ADVANCE METALS ON SOLIDWORKS

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ABSTRACT

The aim of this research is to design, implement and then perform experimental comparison a MARINE PROPELLER under various metals such as Stainless Steel 304, 316, 347. Marine propellers are made from corrosion-resistant materials as they are made operational directly in seawater which is a corrosion accelerator. The materials used for making marine propeller are alloy of aluminum and stainless steel. Other popular materials used are alloys of nickel, aluminium and bronze which are 10~15 % lighter than other materials and have higher strength. The thrust from the propeller is transmitted to move the ship through a transmission system which consists of a rotational motion generated by the main engine crankshaft, intermediate shaft and its bearings, stern tube shaft and it's bearing and finally by the propeller itself. A marine propeller is constructed by sections of helicoidal surfaces acting together to rotate through the water with a screw effect. The purpose of my project is to improve the lifetime of the product & to avoid any unavoidable incidents when running the ship. The reason why I am choosing the ides because to fulfill the factors considering for efficient ship propeller design. The factors are propeller diameter, RPM, number of blades, blade outline, angle of attack and camber, pitch/diameter ratio, stern tunnels, grouches spoilers, rudder bulb system. Here I used SOLIDWORKS software to sketch, evaluate, and some other operations in it. The operations which I have done are sketch, boss-extrude, extrude-cut, fillet, lofted-surface, metals inducing, taking results, simulation, sustainability. As I mentioned earlier, I gave the detailed report of material properties, cut-section, geometry analysis, simulation , evaluation and orthographic view. Atlast I concluded, I chosen Stainless Steel 347 is the suitable material due to its higher yield strength and maximum pressure withstand.

KEYWORDS. **-** *2D Drafting – 3D Designing – Evaluation – Simulation – Resulting.*

1. INTRODUCTION

The simulations were performed by using a 3D CAD model of a vessel of which the length is equal to about 13 m, with reference to a displacement hull condition. The results show that the non-conventional propulsion system still requires improvements to be competitive with respect to the traditional propeller propulsion. These improvements could make it more advantageous than the traditional screw propulsion. Lighter hull structures together with appropriate shaped sterns and bows to increase and reduce the hydrodynamic drag force during backward and forward motion represent some aspects that have to be considered in order to improve the system performances [1]. a method to produce desired signals from desired 3D paths was proposed. By tracking these signals by the controller, MUUV lead to tracking of the 3D path. The simulation results showed that in cases where MUUV tracked the generated signals by SMC with a small error, the 3D path was well tracked. This point validated the derivation of desired signals from desired 3D desired paths. Moreover, in cases where the FLC tracked the signals with high error, the 3D path was also tracked with a relatively large error [2]. Adjustable pitch lateral propulsion is an important control device on a ship heading. Once failure occurs, the ship will free from manipulation and deviant off course. The assembly information model of thruster is established, and the assembly dimension chain automatically generated by the use of UG secondary development tool. The theoretical basis for the system tolerance analysis module has been analyzed, and tolerance analysis process for the chain of thruster assembly dimension based on the Monte Carlo method has been established. The systems select the assembly process for yoke and propeller shaft and propeller hub using the analysis application, and ultimately obtain an optimal tolerance

allocation scheme [3]. The AUV design was proposed in order to minimize the drag and optimize the energy consumption according to Yucatan Caribbean Basin current conditions. An empirical and CFD tools estimation has been used to minimize the drag as a result we get a nozzle profile with the best performance. The CFD analysis has been used as a cost-effective process to define the parameters AUV's hull. The torpedo body variation presented in this project is based in literature similar design for our particular application, indeed the structure and external design allows to install external devices such as thrusters and sensors. The Myring profile increase the mechanical protection against unforeseen impacts due to its geometrical properties but also the material PLA has low cost and low density [4]. There are lots to be done to produce a fish robot which has the ability or performance of a natural fish. There are many variables and their inter-relations that have not been studied, such as the effect of fin shape, AR, fin stiffness, angle of fin orientation, body shape hydrodynamics, motor torque, the fin position toward center of gravity, and some parameters such as Froude and Reynolds numbers, which may all affect the swimming performance of the fish robot. Further efforts will include these variables and parameters along with more advanced design of control system [5]. A new economic approach to physical modeling of the ocean surface dynamics and interaction of irregular wind waves with a ship of arbitrary configuration in the real-time is developed. The interactive simulation of deep ocean surface is performed by combining the Phillips wave spectrum, which is obtained on the basis of observation data, with inverse two-dimensional non-uniform fast Fourier transform (NUFFT) technique. The interactive simulation of the immersed rigid-body dynamics is performed based on modified Verlet algorithm. The capability of simulating the dynamic wave-body interaction in real-time is achieved by using simple, stable, fast and computationally efficient algorithmic implementations. Despite the relative simplicity of the implemented physical concept, the suggested model can provide any predetermined accuracy (within the framework of the deep-water and open-water assumptions) by refinement the grids covering the sea surface and the ship hull. The described computational method does not impose restrictions [6]. A new economic approach to physical modeling of the ocean surface dynamics and interaction of irregular wind waves with a ship of arbitrary configuration in the real-time is developed. The interactive simulation of deep ocean surface is performed by combining the Phillips wave spectrum, which is obtained on the basis of observation data, with inverse two-dimensional non-uniform fast Fourier transform (NUFFT) technique. The interactive simulation of the immersed rigid-body dynamics is performed based on modified Verlet algorithm. The capability of simulating the dynamic wave-body interaction in real-time is achieved by using simple, stable, fast and computationally efficient algorithmic implementations. Despite the relative simplicity of the implemented physical concept, the suggested model can provide any predetermined accuracy (within the framework of the deep-water and open-water assumptions) by refinement the grids covering the sea surface and the ship hull. The described computational method does not impose restrictions desired rated power, with the help of genetic algorithm selection of blade profiles. , it is more cost effective to manufacture by selecting untwisted blade profile. The influence of nacelle shape on the turbine performance is also discussed in the present paper, namely the traditional cylindrical shape and NACA profiled shape. Both different nacelles can house the same size generator [7]. Instead of decoupling the glider model into two models, lateral and longitudinal, the coupled model has been designed. In addition, the presence of the water currents as a disturbance is included in the mathematical model of the glider. Furthermore, the hydrodynamics of the glider's structure have been analyzed by using CFD. Thus, the analysis of the glider's pressure contours, velocity vectors, and dynamics forces like the drag, The CFD analysis shows that the glider design is acceptable due to a low drag coefficient. In addition, the comparison of the coefficients between the CFD and Strip theory shows that the glider model is acceptable due to the small differences between the coefficients produced by these methods [8]. A methodology to simulate SPIF into the SolidWorks has been successfully devised and it has been demonstrated that this environment can be employed for a correct definition of the process variables and the material properties, especially for plastic behaviour. The results herein obtained show that the stress values are not large and that the achieved strain should be greater from the forming goal viewpoint of Incremental Sheet Forming Processes. For this reason, the tool path should be suitably modified, increasing the Z coordinate. Anyway, the agreement of the simulation results with the experimental ones existing in literature predicts that the technique herein presented will lead to a good evaluation of the process. Another consideration that should be taken into account in future is the friction phenomenon [9]. The results of individual bending coefficients obtained indicate that for soft material in bottom layer the bendability is higher. This can be explained by the fact that the soft material shows higher deflection under tensile stress than the hard one. As a result the deflections before reaching MOR are higher than those for inverse compositions. Such knowledge may become the basis for laminated material design. This way designed materials might have practical use wherever good bendability as well as good structural strength parameters are required [10]. In this present work I designed a marine propeller in Stainless Steel grades (306, 314,347). Here I done the 3D modeling, simulation, sustainability, comparing the mechanical properties and has been properties of Stainless Steel-347 is satisfied.

2. SELECTION OF MATERIAL

Alloy 347 (S34700) is stabilized stainless steel plate which offers as its main advantage an excellent resistance to intergranular corrosion following exposure to temperatures in the chromium carbide precipitation range from 800 to 1500°F (427 to 816°C). Alloy 347 stainless steel plate is stabilized by the addition of columbium and tantalum.

Alloy 347 stainless steel plate is also advantageous for high temperature service because of its good mechanical properties. Alloy 347 stainless steel plate offers higher creep and stress rupture properties than Alloy 304 and, particularly, Alloy 304L, which might also be considered for exposures where sensitization and intergranular corrosion are concerns.

2.1 Material Composition

NAME OF THE STAINLESS STEEL	304	316	347
MATERIAL COMPOSITION			
NAME OF THE METAL	CONTAINMENT IN PERCENTAGES		
Carbon	0.08%	0.08%	0.08%
Manganese	2%	2%	2%
Sulphur	0.030%	0.030%	0.030%
Phosphorus	0.045%	0.045%	0.045%
Chromium	18%	17%	18%
Nickel	8%	11%	11%
Nitrogen	0.10%	0.10%	-
Iron	Balance	Balance	Balance
Silicon	-	0.75%	1%
Molybdenum	-	2%	-
Cb+Ta	-	-	10xC

Table-1: Material composition of Stainless Steel 304, 316, 347

3. DESIGN PROCEDURE

3.1 To Draw The 3D Modeling Of MARINE PROPELLER:

- ❖ Click New option – Advanced – Part – Click OK.
- ❖ Choose Plain white background.
- ❖ Select front plane.
- ❖ Select IPS measurement and increase the image quality option in higher definition to improve the quality of design.
- ❖ Draw the circle with diameter of 1000 inches.
- ❖ Boss-Extrude and give the diameter of 1250 inches and click Mid-plane to set the axis at the midpoint of the object.
- ❖ Top-plane – Reference geometry – Select new plane – Offset distance-375 inches - Click OK.
- ❖ Smart Dimension – Select the centerline and drawn line evenly and the give the pitch angle 48^{0}.
- ❖ Repeat the procedure but now the Offset distance is 2500 inches.
- ❖ View Orientation – Normal To – Draw the centerline with any measurement – Draw one cross-line with 4000 inches which it wants to coincides with centerline.
- ❖ Repeat this procedure another plane but now the line should be straight line with 4000 inches.
- ❖ Hide the Planes.
- ❖ Surface – Lofted surface – Select the edges of the two lines which created on the planes – Click OK.

- ❖ Front plane – Features – Reference geometry – Plane – Offset distance 3000 inches.
- ❖ View orientation – Normal To – Click the spline option and draw the fin – Exit sketch.
- ❖ Features – Curves – Project curve – Select On Faces – Select the sketch which we drawn on the plane and the select lofted surface – Reverse direction.
- ❖ Hid the plane.
- ❖ Insert – Surfaces – Trim surface – Select the surface which we want to trim – Click OK.
- ❖ Insert - Boss-extrude – Thichness-10 inches.
- ❖ Fillet – Select the edges of the thickened surface and bottom of the fin– Give the value of 10 inches for thickened fin and 30 inches for bottom of the fin – Click OK.
- ❖ Features – Linear pattern – Circular pattern – Bodies – Select the whole Body - Give the parameters such as Degree-360^0 and Number of fins-4 (To get the high propulsive efficiency.
- ❖ Select right plane – View orientation – Normal to.
- ❖ Draw the line from top edge to midpoint and extend it two time One is straight and another is on top.
- ❖ Click Spline – Draw the straight line from the first and last point of the extended line.
- ❖ Click the centre-point – Click Horizontal – Ok.
- ❖ Smart Dimension – Give the value for straight from cenre-872 inches and for top extended line-72 inches.
- ❖ Feature – Revolved Boss/Base – Select the extended straight line – Click OK.
- ❖ Insert – Features – Dome – Select font face and give value-25 inches – Click OK.
- ❖ Go to backside of the Hub.
- ❖ Draw the circle with 700 inches.
- ❖ Features – Extruded cut – Give the vaue-1250 inches.
- ❖ Finalize the Design.

3.2 To Simulate The 3D Modeling Of MARINE PROPELLER:

- ❖ SolidWorks Add-Ins – SolidWorks Simulation – Simulation – New study.
- ❖ Click Static – Click OK.
- ❖ Select the material which we want to test.
- ❖ Fixtures – Select the fixed part of the geometry – Click OK.
- ❖ External Loads – Pressure – Apply the maximum pressure of the material where it is needed – Reverse direction – Click OK.
- ❖ Mesh – Select the level of mesh – Give the meshing parameters – Click OK – Ensure the meshing is done.
- ❖ Run the result.

4. EXPERIMENTAL WORK

In my project experimental work is meant by designing the MARINE PROPELLER in SolidWorks software. IN this research I done the works like 2D drafting, 3D modeling, evaluation, taking analysis report, and then simulation. Here I include the orthographic view, simulated diagram (Von-Mises and Displacement).
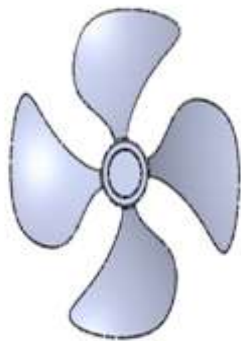
4.1 ORTHOGRAPHIC VIEW:

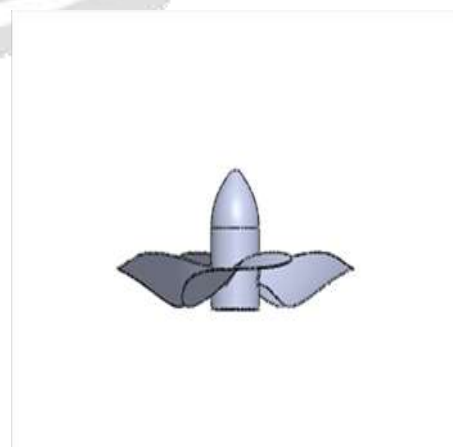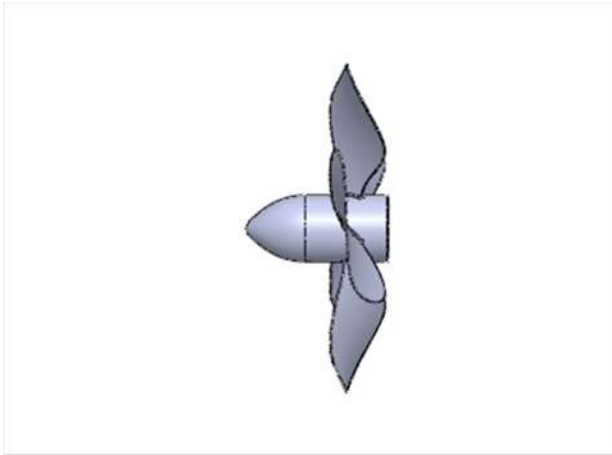**Fig-1: Front Plane of Marine Propeller**   **Fig-2: Top Plane of Marine Propeller**

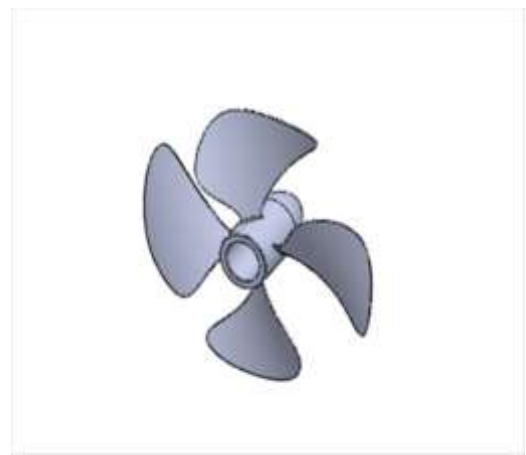**Fig-3: Left Plane of Marine Propeller**

Fig-4: Trimetric Plane of Marine Propeller

4.2 Mass Properties of Stainless Steel

- ❖ Density = 0.29 pounds per cubic inch

- ❖ Mass = 332872901.73 pounds

- ❖ Volume = 1151736580.78 cubic inches

- ❖ Surface area = 34144327.31 square inches

- ❖ Center of mass: (inches)
  $X = 0.00$
  $Y = 0.00$
  $Z = -313.36$

- ❖ Principal axes of inertia and principal moments of inertia: (pounds * square inches)
  Taken at the center of mass.
  $I_x = (0.00, 1.00, 0.00)$ $P_x = 225363743186495.50$
  $I_y = (-1.00, 0.00, 0.00)$ $P_y = 225363743186495.50$
  $I_z = (0.00, 0.00, 1.00)$ $P_z = 260706124851174.87$

- ❖ Moments of inertia: (pounds * square inches)
  Taken at the center of mass and aligned with the output coordinate system.
  $L_{xx} = 225363743201222.37$ $L_{xy} = -0.77$
  $L_{xz} = 991522060.39$

  $L_{yx} = -0.77$ $L_{yy} = 225363743199586.00$
  $L_{yz} = 0.17$

  $L_{zx} = 991522060.39$ $L_{zy} = 0.17$
  $L_{zz} = 260706124823357.50$

- ❖ Moments of inertia: (pounds * square inches)
  Taken at the output coordinate system.
  $I_{xx} = 258050124539149.84$ $I_{xy} = -0.77$
  $I_{xz} = 1222786786.01$

  $I_{yx} = -0.77$ $I_{yy} = 258050124539149.75$

  $I_{yz} = 0.02$

  $I_{zx} = 1222786786.01$ $I_{zy} = 0.02$

Izz = 260706124824993.75

5. SIMULATED DIAGRAM

5.1 STAINLESS STEEL (304)
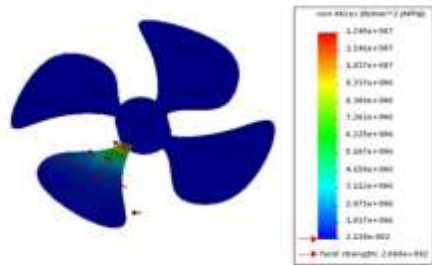
Fig-5 Von-Mises for SS304   Fig-6 Displacement for SS304

5.2 STAINLESS STEEL (316)

Fig-7 Von-Mises for SS316   Fig-8 Displacement for SS316

5.3 STAINLESS STEEL (347)
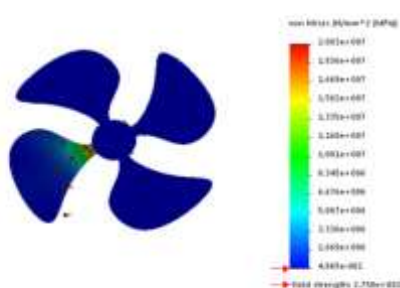
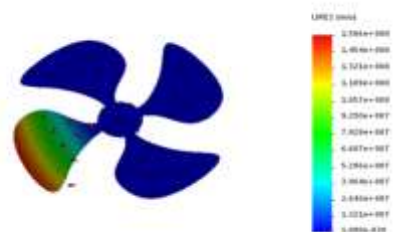Fig-9 Von-Mises for SS347   Fig-10 Displacement for SS347

6. RESULTS AND DISCUSSION

As the table concludes increased comparative study of mechanical properties. There is a step-by-step increment in maximum pressure, elastic modulus, tensile strength, yield strength. As it shows the increment of properties in Stainless Steel 304 – 316 – 437. Here I enclosed the comparative property table below:

Mechanical Properties *Name of the Stainless Steel*	Max. Pressure	Density	Elastic Modulus	Poisson's Ratio	Tensile Strength	Yield Strength
304	19000 psi	8000 Kg/m^3	1.9 e+011	0.29 N/A	517017000 N/m^2	2.068 e+002 N/m^2
316	20000 psi	8000 Kg/m^3	1.9299 e+011	0.27 N/A	580000000 N/m^2	1.379 e+002 N/m^2
347	30000 psi	8000 Kg/m^3	1.950 e+011	0.27 N/A	654999998.5 N/m^2	2.75 e+002 N/m^2

Table-2: Material comparison of Stainless Steel 304, 316, 347

7. CONCLUSION

SolidWorks grades with Stainless Steel 304, 316, 347 was successfully designed via SolidWorks software. Test results revealed that grade 347 enhances the mechanical properties of Stainless Steel. There is a increment of mechanical properties like maximum pressure, elastic modulus, tensile strength, yield strength one-by-one which is shown in results and discussion chapter. Hence It is purely done by own through SolidWorks software.

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