

DESIGN AND ANALYSIS OF IOT-BASED TWO-SEATER SOLAR BOAT

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Abstract: Solar energy has been supposed as the most suitable renewable energy coffers to substitute the part of energy in the ship's application. In this exploration the two-seater solar boat is Fabricated and Tested; this is more effective than another solar boat system that is presently available in the request. It's a combination of energy storehouse and IOT operation with detectors used to cover its parameters. The outgrowth of this exploration is to run the boat 4 hours a day with the help of direct solar radiation collected on the solar PV Panels and it can run up to 3 hours at night with the help of a battery and another important parameter like power. To gain the overall electrical power claim, originally, the length of the boat was designed as 8 bases and the beam width is 4 bases, and the height of the boat was 3.5 bases. also grounded on the carrying capacity for 2 travelers, relegation of water (910 kg), and boat speed 6.07 km/ h (3.28 knots) were reckoned. Eventually designed the power of dc motor 5kW to drive the boat up to 3000 rpm and the necklace needed to drive the motor is 11872.95 NM. These are the parameter that will help to increase the effectiveness of the boat. This exploration shows the overall system used as solar-operated water boats useful for water superiority and volume dimension. Development of a further provident, safe and precise system for chancing depth standards and water superiority indicators of water bodies with the support of a solar-based water boat.

Keywords: -Solarenergy, Design, Analysis, IOT, Two-seater

I. INTRODUCTION

As this aims to solar boat, the name itself indicates solar, which means solar energy from the sun is veritably important and abundant in nature and it's renewable, no way-ending energy. It's used for driving a boat or it produces electricity which can be stored in a battery Solar energy is clean and non-polluting, and indefatigable energy, it's also non-hothouse emigration energy. When solar radiation enters through the atmosphere some of the energy is missing so that on a clear atmosphere bright day in summer 800 to 1000 W/ m². Solar energy is so useful that reduces the threat and cost of power outages and provisory

power systems. Nearly two billion people in the world have no electricity for them solar energy would be the cheapest electricity source, but they cannot go it. By the adding no. of peoples of the earth, experimenters must suppose about alternate types of energy because main type of energy is limited in stock. So, researchers are looking for renewable energy sources like sun, wind, water, and tidal inflow. Solar power is a high cause of renewable energy as it can grow fluently by nature. A nation that has huge solar energy eventuality that can be supposed to use it in differentiated sectors. Especially, the mounting and least advanced countries can suppose solar power as a fundamental source of energy to meet energy failure. Some nations like Bangladesh, Indonesia, and Maldives use this kind of solar-operated ship for their inland direction finding. The manufacturing and assembly of this solar-operated ship are veritably humble and dependable. Donato et al. [1] he has improved the battery life, and during the direction-finding, we have real-time controller of the navigation autonomy. Also, we've calculated boats with zero contamination and veritably small handling charges; all the required energy for navigation has beginning by renewable. Pandurang Sonne. et al. [2] The different operations, changes, and vaticinations of solar power used in water boats were existing in this paper. It was mentioned how the solar power application can ameliorate the superiority and volume of products while dropping the hothouse vapour emigrations. It takes set up that together solar thermal and PV systems are fit for colourful operations. Adi Kurniawan. et al. [3] The technology to establish solar-powered boats is developing in advance. The stylish system to optimize the effectiveness of solar energy uprooted by a solar panel is by using a quadratic MPPT system which is proven to be suitable to induce maximum power in rapid-fire changes of solar irradiation. Khizir Mahmud et al. [4] the extreme time to reduce the reliance of energy of conservative energy sources gradationally and side by side to inspire renewable energy sources. For this reason, the use of solar energy in ships for inland navigation in emerging nations can help a lot to decrease reactionary energy reliance and reduce cost. The ship is constructed together electrically and mechanically for a certain weight transporter and specific range of distance. A. Nasirudin. et al. [5][22] It has been introduced with two stages of the solar-powered ship optimization



process. A basic boat size optimization based on the boat designed for carrying minimal thrust power by using the Golden hunt section procedure has been applied. An optimization of PV system size for carrying the number of PV modules and batteries with minimal price by the using Simplex procedure has been planned. G. Spagnolo. et al. [6] The proposal of a Solar- Electric Ship for excursionists' transference along the seacoast, in the gutters, in the ponds has been presented. By our system, it's likely to substitute the standard energy appliance with an electric one, by accepting a damage in power, and short of changing the weight and the dimension of the ship. Rodrigues. et al. [7] During the design process it turned out that the area for the solar panels should be bigger so that the machine can run with maximum power. Light and affordable accoutrements were named to manufacture the boat. Wood and fiberglass were named due to their relatively low price and weight. The rainfall conditions in which we covered data for that specific case showed low irradiation, caused by shadows and rain.

W. Kapucik. et al. [8][21] The outcomes of the presently directed study show important features of the process of the solar-powered ship together from the viewpoint of power production and its ingesting during races and from the viewpoint of minimization of CO₂ emigration. H. Kawai. et al. [9] a new method for boat landing with the backing of independent tugboats. A creative regulator was existing to suppose the query of system limitations. The control provision was measured as an optimization problem under the limitations that a tugboat can only ply a limited aggressive force and that it can only slowly changes its way. R. Pruna. et al. [10] The overall thing in this exploration is to design, make and examination a model solar-powered ship. I accomplished all these objectives. I exposed that solar panels work by using a semi-conductive material like silicon to engross the energy from the sun and two essence connections erected into the panel we made an electric circuit to practice the energy from the solar panel. After substantial exploration, I exposed that I was obviously not the first to make a model solar ship. D. Nachman. et al. [11] The work in this paper is fastening to plan a solar-powered electric ship with a single airman, contributing to the Government's energy strategic plan. The propulsion system is considered while defining the type of steering system for the ship. S. Mekhilef. et al. [12] This exploration is substantially concentrated on using solar thermal energy in artificial operation with the help of a photovoltaic system. Solar thermal energy can be used to induce electricity, process chemicals, food, non-metallic or business-related diligence. A. Asari. et al. [13] Solar-powered boats are getting advanced and help to reduce the impact of global warming by adding the use of electric boats rather than diesel machine boats. For maximizing the light immersion capacity of solar panels solar shadowing system is used. Tensile strength and eight distribution area reason play an

important part for adding the effect of the boat.

M. Gopal. et al. [14] The new ways like IoT can greatly help to increase the plant's performance and monitoring. Using an IoT system quantum of voltage and current entered are shown on the affair device i.e., LED display. We can see the readings on our mobile also by connecting it to a WI-FI network. However, it's easy to descry it with the help of IoT, If there's any problem in the system. O. Gamage. et al. [15] Concerning the solar system, the system has 30 solar units (10.5 kW), 5 li-ion battery boxes(47 kWh), and is powered with a 75 kW HVH type motor-powered. vengeance period of 8.22 times and a optimistic net present value for 20 times of application and provident. The solar- powered vessel will save 6475 litres of diesel per time and 1794 kg of carbon emigration when compared to the being vessels. J. Han. et al. [16] Integrated energy cells(FCs) in mongrel energy systems a power source can be an effective result because of its low emigration and high effectiveness. mongrel system consists of the suggestion of a proton exchange casing energy (PEMFC) cell and battery set. MATLAB/ Simulink terrain is used to present fine models of colourful factors. P. Sonne. et al. [17] The deepness of water at predefined set points in water zones plays a vital part to calculate exact volume of water. Water quality is a pivotal part in controlling health and the state of complaint. Development of further provident, harmless and precise system for chancing deepness values and water superiority indicator of water bodies with the help of solar operated water ship is reviewed in this exploration paper. M. Mehedi. et al. [18] The system design element sizing and enforced MPPT charge regulator, DC motor IGBT regulator and motor architecture over current protection switch are presented. The model is erected on MATLAB Simulink to check proper working of designed system. The PV protection system is introduced with diode. P. Sekar. et al. [19][20] The solar PV monitoring device will prop the costumer for assessing the overall performance of solar panel. There are multitudinous tips of workshop that can be proposed for a in the future so that we can ameliorate the performance of present day analysis. For a better circuit, it's better to design the circuit PCB to ease the relationship between the detectors with the microcontroller. In this research paper novel design of solar based on both and analysis is done. Boats have conventionally been driven by force, like by means of paddles, by air or mot and or, similar by means of gasoline. With time, that driving agent has advanced, and momentarily, we indeed have solar- operated ships that harness the suns energy as part of moving to eco-friendly sustainability [20]. Thus, these revenues that solar ships are ships that get their energy from the sun – by means of solar panels and warehouse batteries to transfigure the sun into electrically operated, which powers the boat. They're an, for this purpose, energy-effective and eco-friendly volition that removes the use of reactionary energies. However, then are the causes you should conclude for solar ships and a list of



the fashionable solar panels for solar ships, If you like traveling and enjoying in joy a boat.

List of nomenclature

Abbreviation Explanation

(L)	Length of boat (Feet)
(W)	Width of boat (Feet)
(H)	Height of boat (Feet)
(B)	Buoyant force (Kg m/s ²)
(PF)	Fluid density of water (Kg/m ³)
(V)	Displaced body volume (m ³)
(G)	Gravity (m/s ²)
(LWL)	Length of water line(Feet)

II. DESIGN CALCULATION SOLAR BOAT

The boat is made of FRP material which is more reliable and less weight. Following are the dimensions are considered from market survey and certain consideration length of FRP Boat is 8 feet (2.43 m) in length and considering width 40% of the length i.e., 4 feet (1.21m) and height is 1.60 feet (0.5 m).

$$\text{Passenger capacity} = (L \times W) / 15 \quad (1)$$

$$= 2.13 = 2 \text{ Persons}$$

a) Weight of system

The hull weight of boat = 250 kg Total number of persons 2
 Weight of persons – 160 (Consider 80 kg each) The Weight of solar panel= 10kg
 Total solar panel required – 8 Total weight of solar panel – 80 kg
 Weight of battery = 60 kg
 Total battery required – 4
 Total Weight of battery – 240 kg Weight of DC Motor – 30 kg

According to formula

$$\text{Total Weight of system} = \text{Hull weight} + \text{weight of person} + \text{weight of solar panel}$$

$$+ \text{weight of battery} + \text{weight of DC motor}$$

(2)

$$= 744$$

Considering Factor of safety as 3 (Assumption) Total Weight = 744*1.3 = 950 kg b) Mechanical Data

$$1. \text{ Volume of Boat} = L * B * H \quad (3)$$

$$= 96 \text{ cubic feet} = 2.71 \text{ m}^3$$

$$2. \text{ Surface Area of Boat} \\ \text{Area of Rectangle} = \text{Length} * \text{Breadth} \quad (4)$$

$$= 2.94 \text{ m}^2$$

$$\text{Area of Triangle} = \frac{1}{2} * \text{Length} * \text{Breadth} \quad (5)$$

$$= 1.47 \text{ m}^2$$

$$\text{Total Surface Area} = \text{Area of Rectangle} + \text{Area of Triangle} \quad (6)$$

$$= 4.41 \text{ m}^2$$

3. Buoyant Force
 According to formula

$$B = \rho * V * g \quad (7)$$

$$B = 33,255 \text{ kg m/s}^2$$

The hull speed calculation can be calculated with the help of following equation,

$$\text{Hull Speed} = 1.34 * \sqrt{LWL} \quad (8)$$

$$\text{Putting value in equations Hull Speed} = 1.34 * \sqrt{6} \\ = 3.28 \text{ Knots Maximum}$$

$$\text{Speed} = 3.28 \text{ Knots} = 6.07 \text{ Km/hr}$$

4. Solar Boat Power

$$\text{Motor Power} = (\text{Displacement}) * (80)^2 * (\text{Hull Speed})^2 \quad (9)$$

Converting weight into pound

$$1 \text{ kg} = 2.20 \text{ pound} \quad 910 \text{ kg} = 2006 \text{ Pound} \\ = 2006 / 605$$

$$\text{Motor Power} = 3.31 \text{ HP} = 5 \text{HP}$$

5. Torque required.

$$1 \text{ HP} = 746 \text{ Watt}$$

$$5 \text{HP} = 5 * 746 = 3730 \text{ Watt}$$

$$\text{Motor Torque} = 2 * \pi * N * T / 60000 \quad (10)$$

$$T = 11.87 \text{ NM} = 11872.95 \text{ NMM}$$

6. Energy Available from the solar panel: -

$$\text{Energy Getting from 120 W solar Panel in 1 hour} = 265 \text{ W}$$

$$\text{Energy getting in 4 hour} = 265 * 4 = 1060 \text{ W Assuming 20\% of energy loss} = 212 \text{ watt}$$

$$\text{Total energy getting from solar panel} = 1060 - 212$$

= 848 watts in 4 hours by panel
 No of Solar Panel Required = Total Energy available from the sun in a day by one solar panel (4 hrs. in day) (11)
 Output available from one solar panel = 848 / 120
 = 7.06 = 8 Solar Panel
 The 8 Solar Panel which produces 6800 W energy.

7. Total Number of batteries
 Total power required = 19750 W per day Power available from solar panel = 8600 watt Energy required = 19750 – 6000 = 13750 Watt Total Battery Output = 135 * 48 = 6480 Watt

Total no of battery required = Power Required / Output Wattage (12)
 = 3

c) Charge Controller
 Maximum power point tracking is an significant

arrangement used in charge regulator for removing extreme accessible power from the PV unit under certain conditions by positioning voltage and current. Extreme power varies with solar radiation, atmospheric temperature, and solar cell temperature. The MPPT is rated grounded on the following design.

MPPT Charge Controller = Total Required Power / BUS Voltage (13)
 = 104 A
 25 % more rating is measured.
 MPPT Current Rating = 104 + 25 = 130 A

III. MODELLING OF SOLAR BOAT SYSTEM

Figure 1 shows the system 3D modelling done in modelling software platform, this is a 3D view of model in this figure some parts like Solar Panels, and setting arrangement, propeller, battery, etc is indicated. Figure 2 shows drafting of solar boat model in 4 views i.e Bottom view, Top view, Isometric view & Side view.

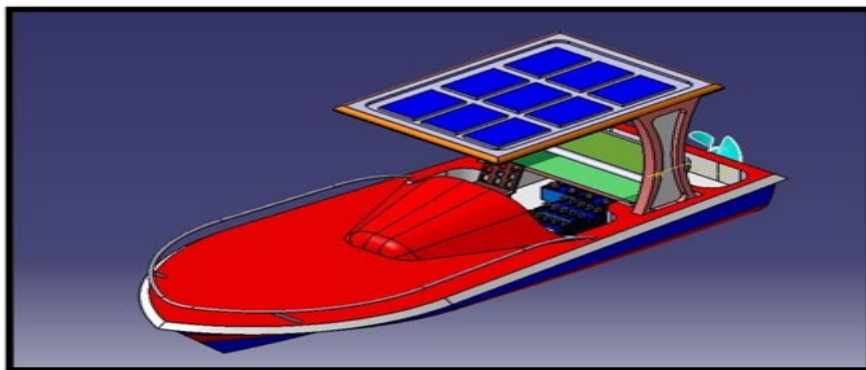


Fig.1 Assembly of Solar Boat

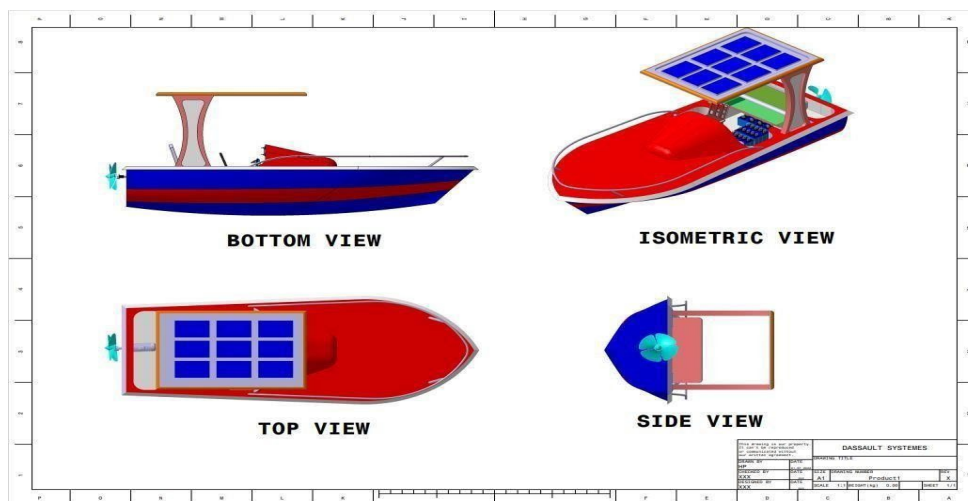


Fig.2 Drafting of Solar Boat

IV. RESULTS & DISCUSSION OF SOLAR BOAT

In this section software analysis of solar powered both is done and performance parameters are calculated

4.1 Air resistance analysis of boat materials

This analysis shows the air resistance of boat materials

which is plastic. It gives data like young's modulus, poisson's ratio, density, coefficient of thermal expansion and yield strength etc. These are very important data while designing

the boat and selecting raw materials for the boat as shown in table 1.

Table1 Air resistance analysis of boat Materials

Sr.No.	Property	Specification
1.	Material	Plastic
2.	Young's modulus	2.2e+009N_m2
3.	Poisson's ratio	0.38
4.	Density	1200kg_m3
5.	Coefficient of thermal expansion	6.84e-005_Kdeg
6.	Yield strength	0N_m2

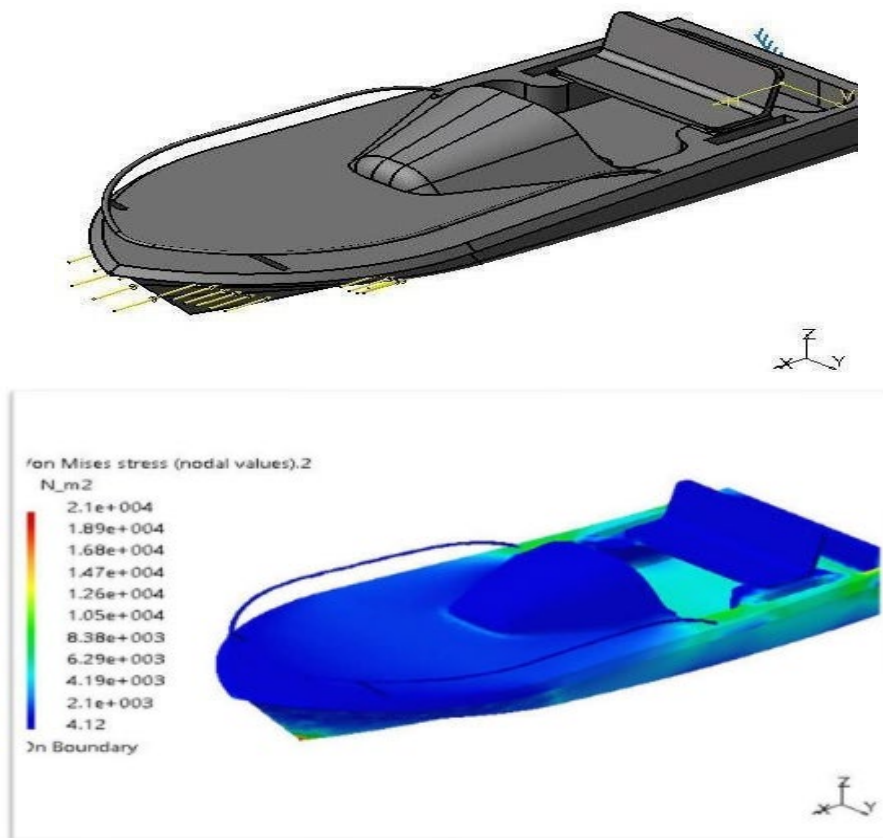


Fig.3 Stress Analysis of Boat

Figure 3 shows the results of the Von mises stress of the product analysed in the analysis software. The colour indicates stress values inside the product and values of stress

are in N/mm².The higher and lower stress get 4190 N/mm²and 1050 N/mm².

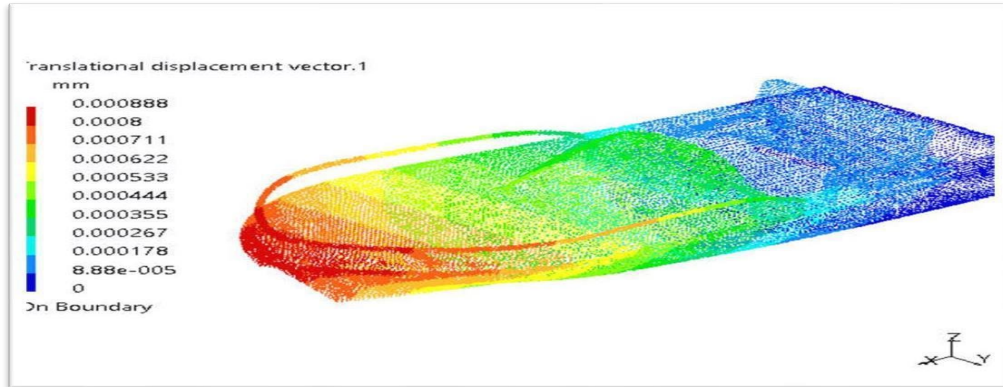


Fig.4 Displacement Analysis of Boat due to Air Resistance

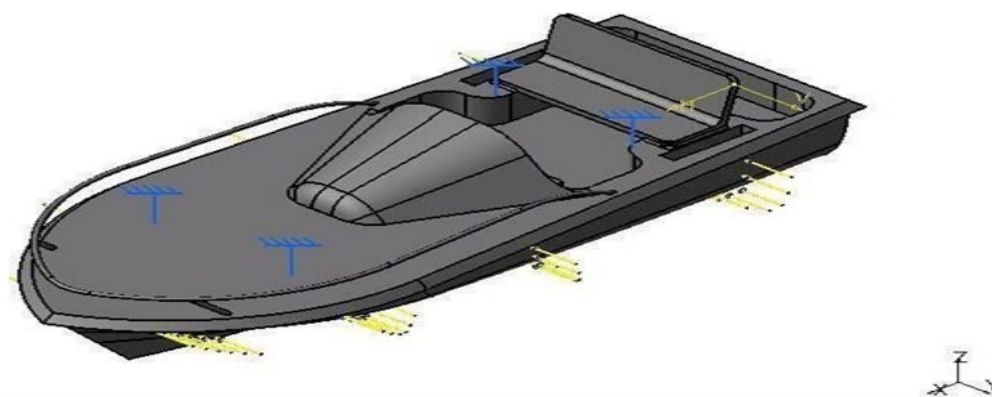
Figure 4 shows the translational displacement result of the product analysed in the analysis software. The colour indicate displacement values inside the product and values of displacement are in mm. The higher and lower displacement getting 0.000888 mm and 0.000178 mm.

This analysis shows the water resistance of boat materials which is plastic. It gives data like young's modulus, poissons ratio, density, coefficient of thermal expansion and yield strength etc. These are very important data while designing the boat and selecting raw material for the boat as shown in Table 2.

4.2 Water resistance analysis at side of boat

Table 2 Water resistance analysis at side of boat

Sr. No.	Property	Specification
1.	Material	Plastic
2.	Young's modulus	2.2e+009N_m2
3.	Poisson's ratio	0.38
4.	Density	1200kg_m3
5.	Coefficient of thermal expansion	6.84e-005_Kdeg
6.	Yield strength	0N_m2



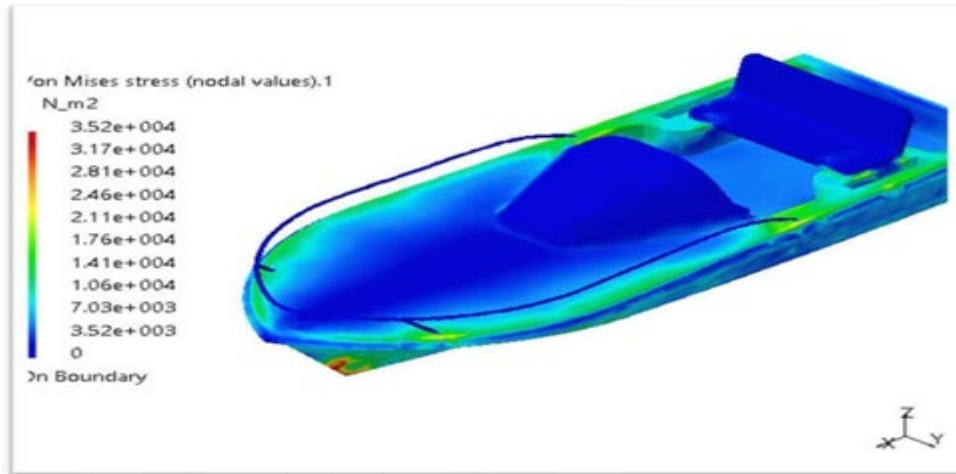


Fig.5 Stress Analysis of Boat due to Water Resistance

This is the Von mises stress result of the product analysed in the analysis software. The color indicate stress values inside the product and values of stress are in N/mm².The higher

and lower stress getting 14100 N/mm² and 3502 N/mm² as shown in above Figure 5.

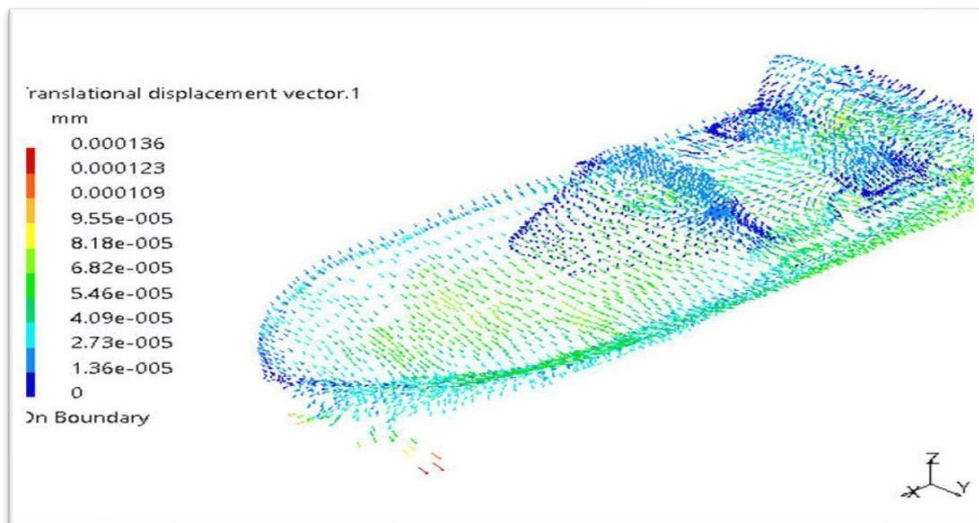


Fig.6 Displacement Analysis of Boat due to Water Resistance

This is the translational displacement result of the product analysed in the analysis software. The color indicate displacement values inside the product and values of displacement are in mm. The higher and lower displacement getting 0.000054mm and 0.00014mm as shown in Figure 6

4.3 Analysis of Propeller

This table shows the propeller analysis of boat materials which is aluminum. It gives data like young's modulus, poissons ratio, density, coefficient of thermal expansion and yield strength etc. These are very important data while designing the boat and selecting raw material for the boat.

Table3PropellerAnalysisofboat

Sr.No.	Properties	Specification
1.	Material	Aluminium
2.	Young's modulus	$7e+010N_m^2$
3.	Poisson's ratio	0.346
4.	Density	$2710kg_m^3$
5.	Coefficient of thermal expansion	$2.36e-005_K$
6.	Yield strength	$9.5e+007N_m^2$

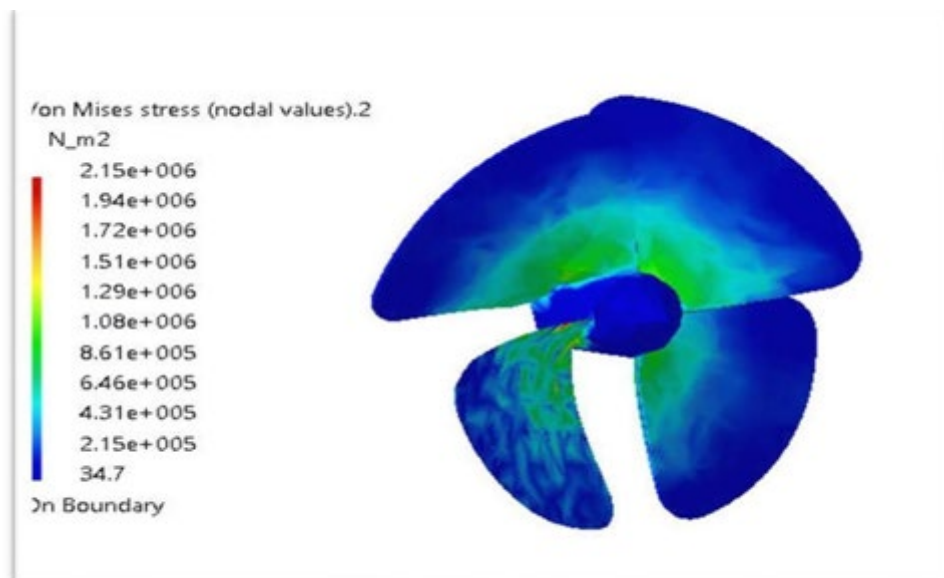
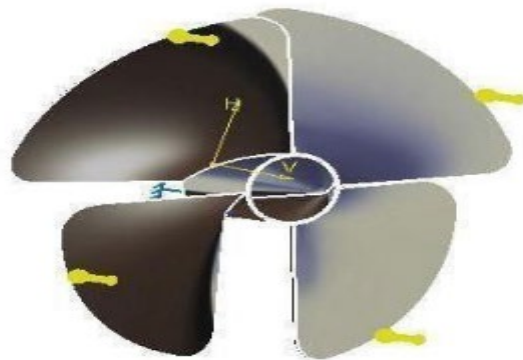


Fig.7 Propeller Stress Analysis of boat

This is the Von mises stress result of the product analysed in the analysis software. The colour indicate stress values inside the product and values of stress are in N/mm².The

higher and lower stress getting 10800 N/mm² and 2150 N/mm² as shown in Figure

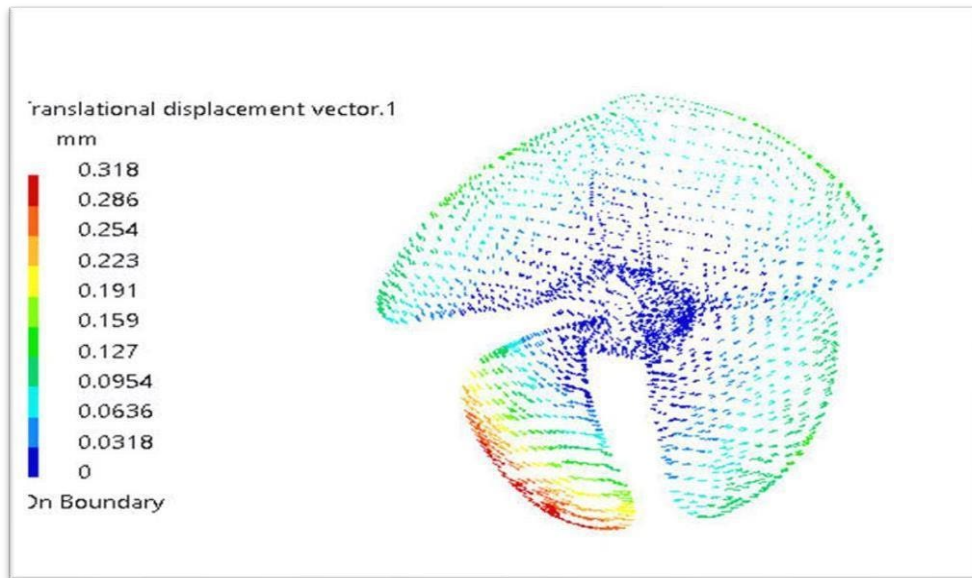


Fig.8 Propeller Displacement analysis of boat

This is the translational displacement result of the product analysed in the analysis software. The color indicate displacement values inside the product and values of displacement are in mm. The higher and lower displacement getting 0.318 mm and 0.0636 mm as shown in figure 8.

4.4 Analysis of roof

This table shows the roof analysis of boat materials which is aluminum. It gives data like young's modulus, poissons ratio, density, coefficient of thermal expansion and yield strength etc. These are very important data while designing the boat and selecting raw material for the boat.

Table4 Analysis of roof

Sr. No.	Properties	Specification
1.	Material	Aluminium
2.	Young's modulus	7e+010N_m ²
3.	Poisson's ratio	0.346
4.	Density	2710kg_m ³
5.	Coefficient of thermal expansion	2.36e-005_K
6.	Yield strength	9.5e+007N_m ²

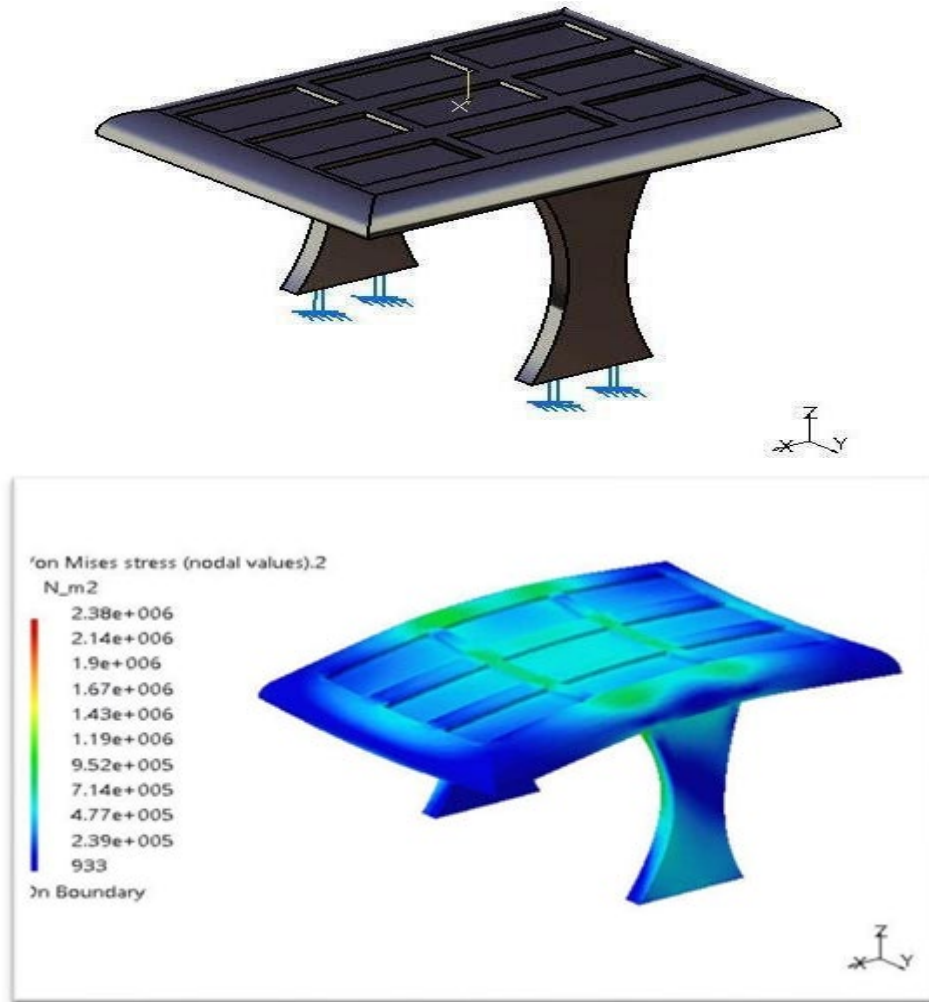


Fig.9 Upper Roof Stress Analysis of boat

This is the Von mises stress result of the product analysed in the analysis software. The colour indicate stress values inside the product and values of stress are in N/mm².The

higher and lower stress getting 9520 N/mm²and 2390 N/mm²as shown Figure9.

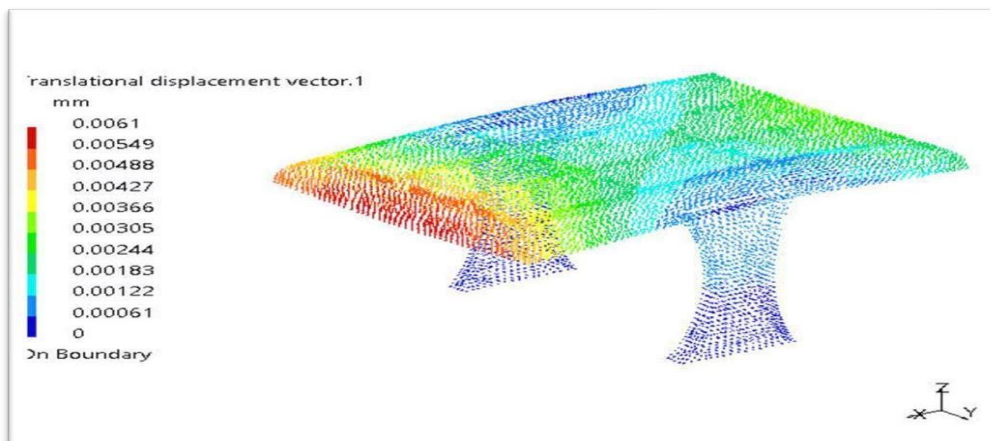


Fig.10 Upper Roof Displacement Analysis of boat



This is the translational displacement result of the product analysed in the analysis software. The colour indicate displacement values inside the product and values of displacement are in mm. The higher and lower displacement getting 0.00549 mm and 0.00122 mm as shown in Figure 10.

V. CONCLUSION

This presented the best possible resolution to exchange the diesel engine boat with an automatic solar-operated electric boat, which is reasonable for the minimum earning people in developing nations.

To achieve the total electrical power necessity, first, the length of boat was calculated as 8 feet and a beam width of 4 feet and height of the boat 3.5 feet. Then built on the load carrying capacity for 2 persons along for the ride, displacement of water (910kg), boat speed 6.07 km/h (3.28 knots) were calculated. After all, designed the dc powered motor 5kW to drive the boat up to 3000rpm and the torque needed to drive the motor is 11872.95 NM.

A hybrid power arrangement involves the solar PV, gas inventor, and battery set has been planned to supply the total load claim of the boat. The proposed arrangement and control system was designed by the low amount but higher efficiency and better superiority, so that advanced gadget's life.

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