Numerical Analysis of Solar Floats Made of LDPE for Upwind Condition

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Abstract— Drifting PV establishments are regularly built on inland colossal waterways, whether normal or man-made. The recommendations amalgamate a drifting mounting component that upholds solar photovoltaic modules above the water level with an edge equipment comparable to the standard land framed PV framework. The two most common kinds that of photovoltaic powered solar trackers easily accessible are single-hub and double hub. Single axis solar-based trackers follow the sun from east to west while turning about a singular point. Double axis solar based trackers permit boards to screen the solar rays in two different axes. Single axis solar based trackers are majorly involved sun powered trackers in India since they move east-west. When contrasted with a decent sunlight-based tracker mount board, single-pivot trackers are roughly 32.17 percent proficient. The Single axis and Double Axis Solar based trackers monitor the sun from East direction to West Direction, guaranteeing harmonious power supply age over course of the day. Trackers give 15-16% a greater number of yearly power than a static plant with a similar introduced limit. This is an occasional slant structure that is intended to meet the plan rulesfor slant points going from 5 to 15 degrees. During the season, manual shifting is performed. In view of the guideline of lightness productive and light weight configuration, construct and recreate the mockup with lesser mass and minimum expense support materials for different outer burdens.Consider the Securing Productive Plan in view of the breeze and wave loads. The LDPE material plan will be exposed to Limited Component Study [FEA], as well as a weakness examination. The sun powered floats ought to be built in a measured design to work with simple development and dismantling as well as transportation starting with one region then onto the next.

Keywords— *FEA (Finite Element Analysis), CFD (Computational Fluid Dynamics), LDPE (Low Density Poly Ethylene), PV (Photo Voltaic)*

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I. INTRODUCTION

Drifting Sunlight based Solar Power Plant otherwise called Floating Solar Plant it is a framework having Sun-powered chargers over the drifting framework. Having a working principle from sunlight-powered chargers that are introduced over the barge or pontoons[1]. Sun power gets introduced over the water supplies, Hydroelectric power plants, lakes, trenches, Water Purifying Plants, Mining, and so forth. The Experiment location is Situated over the River Riva Waterway through province M.P., central India. The Location of experiment is 24°31'45.9"N 81°16'49.4"E. Originating at directions, locations longitude is entirely settled at 24 Degrees also scope of experiment location is 81 Degrees. Up Wind Loading Condition (UW), Live burden loading condition (LL) and Dead load (DL) these various loading conditions are considered for the analysis.

II. MATERIALS USED

High Density Polyethylene (HDPE) utilized for manufacturing of Sun based pontoons made up for the drifting sun powered utility centers. Low density polyethylene, Fiber Reinforced Plastic as well as different plastic materials can be seen as High density Poly Ethylene alternatives. For lesser temperature values High Density Polyethylene material has a decreased effect strength, though Low Density Poly Ethylene enjoys a benefit for such manner[2]. For the domain in which Sun based Floats, changing to Low Density Polyethylene from High Density polyethylene turns out to be more financially savvy[3]. For upkeep needs, the Sun oriented Floats' secluded design made up of Low-density polyethylene becomes basic.

The table 1 lists the Properties of Low-Density Polyethylene needed for the installation circumstances.

Table 1: Low Density Polyethylene Properties

Density	917 kg/m^3
Youngs Modulus	172000 kg/m^2
Yield Strength	18 mpa
Poisson's Ratio	0.439
Allowable Stress	12 mpa
Specific Heat	1842 J/(kg*k)
Tensile Strength	13270 KN/m^2

III. OBJECTIVES

The Sun powered Drifting model should be planned and tried within the sight including of higher waves and weariness straining. The plan as well as execution that involves pristine solar floats idea which joins the secondary float with the primary float. It consists an occasional slant structural geometry which consents to plan details of important slant points. Improvement and reenactment geometry utilizing lesser weight, reasonable properties of material which can get through the scope outer loading conditions as well as stick with lightness effective plan standard. Limited Component Investigation will be utilized to plan the LDPE material and weariness examination. Taking into account the Securing Productive Plan in view of the breeze loadings as well as suspended burden.

IV. DESIGN AND ANALYSIS

Design involves savvier and productive than conventional land/housetop establishments. The IS 875 Code tends to the breeze stacks that should be considered while planning structures with inclusion of singular components. Necessities of the Code: Wind Burdens on Structures and Designs (IS: 875(Part3))[10]. More Burden Limit Ability and the Impervious with bright beams. Determination for the required material is done for a minimal price.

The table 2 below summarizes the Design Parameters required for accession.

Table 2: Design Parameters

Wind Speed	Tilt Angle	Power Output	Solar Panel
47 m/s	24^0	500KWp	520W

The Figure 1 illustrates the solar panel, solar floats aswell as the components required for making a solar float structure.

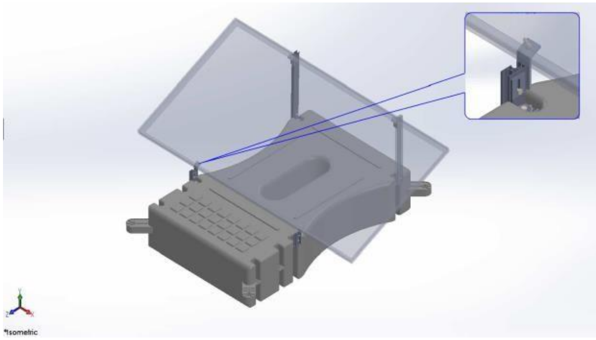
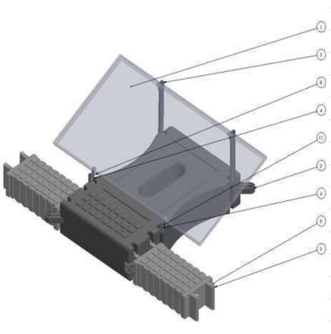


Fig 1: Floating Solar Structure Assembly

Floating Solar Structure involves various components the list for the same is shown below in Figure 2. The assembly consists of solar panel of 144 cell in the MONO PERC configuration.



Sr.No	Part Name	Quantity
1	Solar Panel	1
2	Solar Float	1
3	Joining Float	2
4	Railing 585 mm	2
5	Railing 100 mm	2
6	L Cleat	4
7	Angle Bracket 114deg	2
8	Angle Bracket 66deg	2
9	Connection Pin	8
10	Connection Nut	8
11	M8 Bolt	16
12	M8 Nut	16
13	M8 Washer	32

Fig 2: List of Components

The unit assembly structure of a solar float panel configuration of twenty structures forms a pontoon as shown in Figure 3 which generates 500KWp power at any point of time during the operation in daylight.

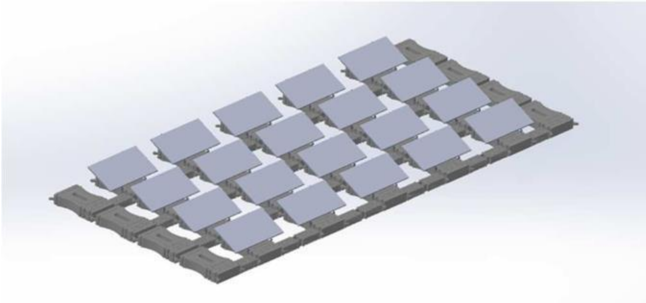


Fig 3: Pontoon Assembly

Computational Fluid Dynamics (CFD) is performed on the pontoon structure based upon the input velocity values on the structure from IS 875 Part 3 code for the wind load on structure[10]. The wind load on the structure will be determined for Upwind conditions. The parameters for the meshing in the flow simulation on the involves fine hexahedral mesh as shown in Figure 4 on the area of contact with the fluid flow which in air.

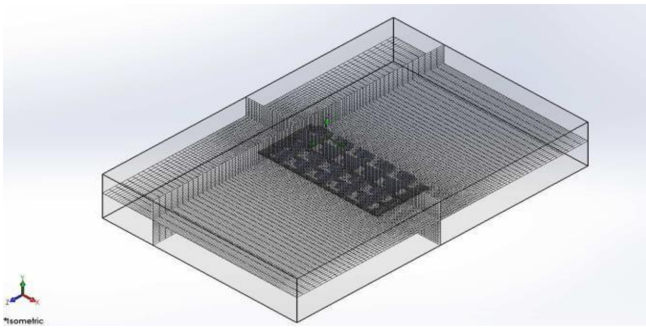


Fig 4: Mesh for CFD

From Figure 5, the maximum Output Velocity value for the flow simulation is 67.79 m/s and the minimum value is found to be0 m/s during the course of flow simulation with the fluid considered as air.

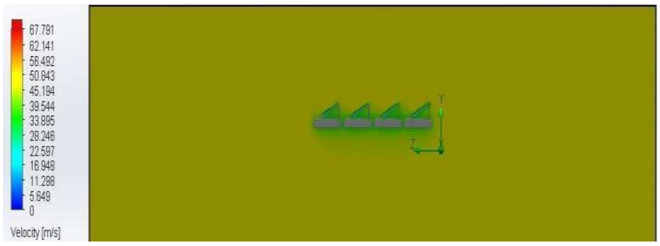


Fig 5: Flow simulation Output Velocity

The strain over the outer layer in gathering provides with various qualities as well as greatest qualities acquired coming out of it are utilized as the input parameter involvingLimited Component Investigation Design on which the impacts on every part is broke down to construction not entirely set in stone for the vacillating impacts as well as the potential disappointments happened due to the various stacking environments.

Table 3: Input Pressure

DOWNWIND PRESSURE(PA)	UPWIND PRESSURE (PA)
-446.48	-153.93
-425.9	-175.24
-396.94	-180.52
-393.85	-185.34
-613.38	-319.95
-393.13	-186.52
-399.29	-180.73
-429.42	-174.92
-445.44	-154.16
-217.84	-215.14
-167.72	-331.8
-143.83	-218.43
-128.23	-181.59
-122.73	-205.72
-130.95	-196.91
-145.39	-221.92
-163.72	-230.41
-226.08	-213.57
MAX=613.38	MAX=331.8

The Static Structural Analysis is done with output values from flow simulation considering it as input parameters for static analysis involving max loading, of 331.8 MPa for the Up Wind loading condition. The Static structural Analysis is carried out involving several scenarios such as downwind load, upwind load, and live load operating on the assembly. Table 3 represents the Input pressure values.

Figure 6 shows illustration for Static Structural analysis 3D Model.

Fig 6: Static Structural Analysis Model

In Figure 7, mesh size of 10mm is taken for meshing of the Assemblyfor accurate results to be obtained from Analysis.

Fig 7: Mesh on the 3D Model

V. RESULTS AND DISCUSSIONS

UPWIND LOAD CONDITION

The boundary condition for the Upwind Loading condition including the self-weight of the structure for static structural simulation is shown in the Figure 8.

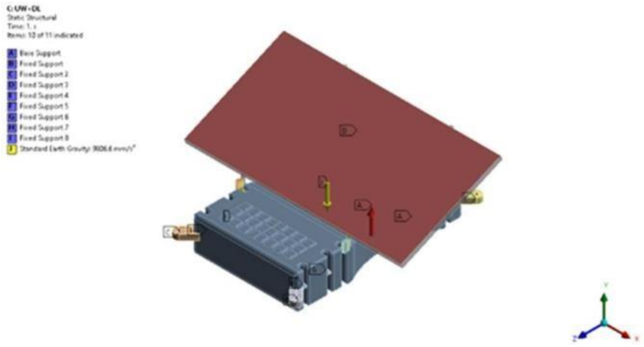


Fig 8: Upwind Loading Condition

The Equivalent stress value obtained on the structure for Upwind loading condition is Maximum 2.8298 MPa and it is located on very small region of the structure as visible in Figure 9. The allowablevalue of the equivalent stress for the Low Density Poly Ethylene Structure is 12 MPa. The Structure can be said to be qualified in the Static Structure Stress Analysis.

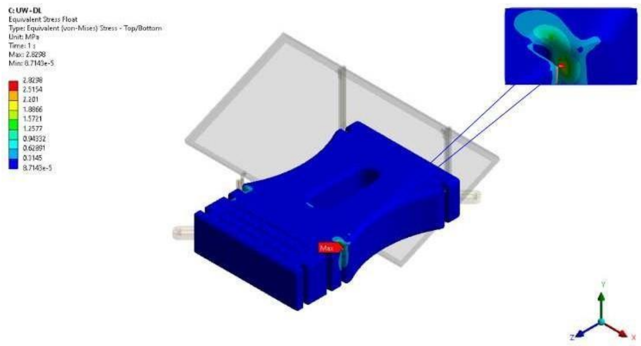


Fig 9: Equivalent Stress Upwind Loading

From Figure 10, total deformation value for the static structural analysis of the structure for upwind loading condition comesout to be 8.6817 mm which lies well within the limit of Allowable value of deformation of 10 mm. The structure qualifies in the static structural deformationanalysis

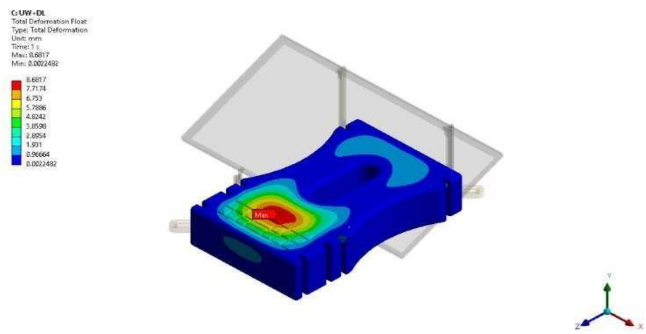


Fig 10: Total Deformation Upwind loading

LIVE LOAD CONDITION

The Solar Float, which is designed of LDPE, is subjected to a live load test to verify that the 100 kg of load put to it would cause the desired amount of deformation and stress. The live load boundary conditions is as shown in Figure 11.

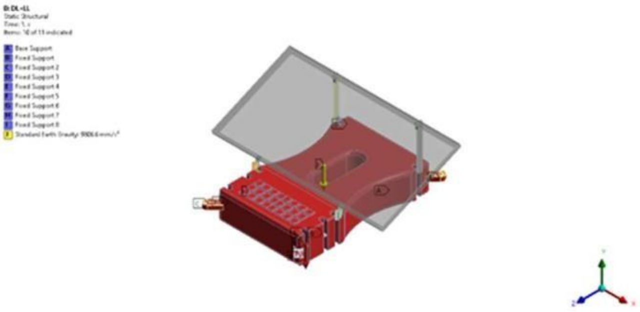


Fig 11: Live Load Boundary Conditions

The Equivalent stress value obtained on the structure for Live loading condition is Maximum 6.3202 MPa as shown in Figure 12 and it is located on very small region of the structure. The Allowable value of the equivalent stress for the Low Density Poly Ethylene Structure is 12 MPa. The Structure can be said to be qualified in the Static Structure Stress Analysis.

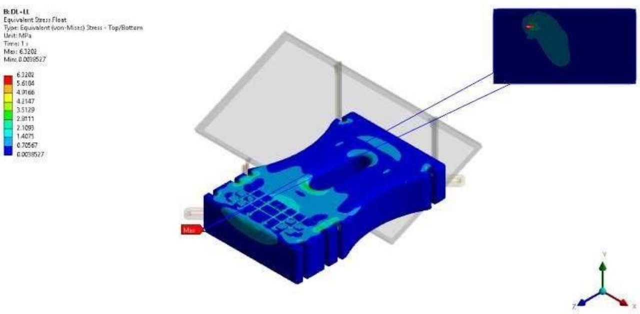


Fig 12: Equivalent Stress Live Loading Condition

From Figure 13, total deformation value for the static structural analysis of the structure for Static loading condition comes out to be 8.1313 mm which lies well within the limit of Allowable value of deformation of 10 mm. The structure qualifies in thestatic structural deformation analysis.

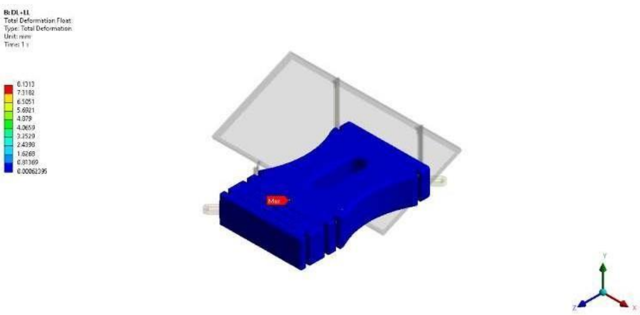


Fig 13: Total Deformation Live Loading Condition

VI. CONCLUSIONS

This study examines the concept of Solar Floating Power plant, the design calculations, input parameters along with static structural analysis for various conditions the with the outcome validation. Maximum wind speed and dead load have both been taken into account in the analysis. Wind pressure CFD analysis findings were quite near to analytical output values. Up Wind Loading conditions using flow simulation modelling are 331.8 PA and 347.835 PA, respectively.

Analytical study and CFD simulation both calculate the downwind condition at 613.38 PA and 626.10 PA, respectively. Pressure Using FEA software, a static structural analysis was carried with Up wind loading as well as live loading conditions. The results reveal that the stresses produced in the required areas are within acceptable ranges, indicating that the LDPE float is adequate for the intended application of the floating solar power plant.

According to fatigue testing for the number of cycles to failure as per standard float standards, the system for the specified material is safer and more trustworthy for less intensely undulating water bodies. To guarantee that the buoyancy assessment of the floats for the live load was safe for scheduled service, analytical techniques were applied

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