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DESIGN & ANALYSIS OF SOLAR PANEL ON WIND LOAD

Durgesh Singh Thakur [1]*, Ashwini Bhoi [2], Dr Rajeshwar Verma [3]

[1]*M. Tech Scholar, Energy Management, Department of Mechanical Engineering, Raipur Institute of Technology Raipur.*
[2]*Assistant Professor, Department of Mechanical Engineering, Raipur Institute of Technology Raipur*
[3]*Head of Department, Department of Mechanical Engineering, Raipur Institute of Technology Raipur.*

Abstract

Solar energy is the abundantly found renewable energy which is free of cost and the use of solar energy resources is increasing rapidly. Following this trend, the implementation of large area solar arrays is considered to be an essential. Many design approaches of the supporting structures have been presented in order to achieve the maximum efficiency. They are loaded mainly by aerodynamic pressures. Optimization plays very key role in product design and prevent un-necessary inventory satisfying the functional needs. But optimization with apt design helps to build efficient products in the everyday competing market. Stress analysis plays important role in optimizing the design. Due to the advance in computer based finite element software's design process is made simple by easier simulation methods fast replacing prototype built up and testing. In current work investigates the effect of real time wind flow on stress developed and torque generated. CAD model and drawings of solar panel support structure is developed using CREO 2.0 software with the help of existing model and CFD analysis is conducted using ANSYS CFX. In order to find the most optimum result several models in the form of different deflector design (flat, conical, circular, elliptical, and parabolic) were tested.

Keywords: *Wind Loads, FEA, Aerodynamic loads, ANSYS CFX, Renewable Energy.*

** Corresponding author*

1. INTRODUCTION

PV panels absorb sunlight as a source of energy to generate electricity. A photovoltaic (PV) module is a packaged, connected assembly of typically 6x10 photovoltaic solar cells. Photovoltaic modules constitute the photovoltaic array of a photovoltaic system that generates and supplies solar electricity in commercial and residential applications. Wind load plays a central role for two reasons: The wind subjects the solar PV modules, and the PV mounting system to excessive force and the wind load influences how close the solar PV panels must be mounted to the edges of the roof. The higher the wind load, the larger the distance to the roof edge should be chosen. The wind load is defined as the exerted loading which flows on the building (or even the solar PV modules). This effect is divided into the loading via the wind pressure and wind suction. The first, influences the wind-facing side of the building and the second on the side opposite to the wind. The wind loading can be enormous, but there are particularly robust solar PV panels, which are designed for large wind and snow load and adverse weather conditions. In this connection, the frame and cover are decidedly constructed, and of course, the used PV mounting system should withstand high stress.

2. CAD MODELLING

The CAD model of solar panel support structure is developed using Creo 2.0 software which is sketch based, feature based, parametric 3d modelling software developed by PTC and has properties of parent child relationship and bidirectional associativity. The CAD model is developed using extrude, revolve, sweep and pattern tool. The blades developed after extrusion is assembled using coincident constraint, axis pattern and angle offset. This CAD model is saved and converted into. Iges format to be exported in ANSYS software.

Table 1. Dimensions of solar panel support structure [1]

B	2.48m
W	7.29m
H	1.65m

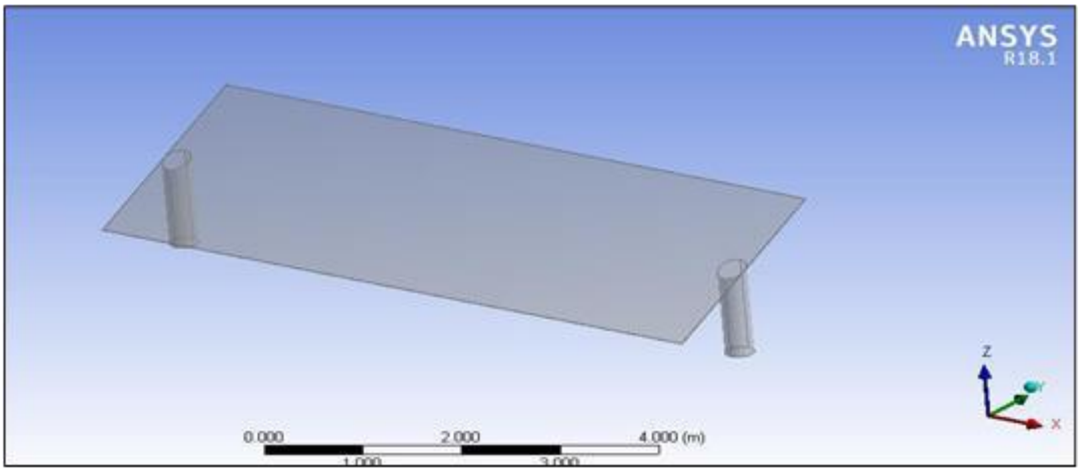

Figure 1. Imported CAD model of solar panel in ANSYS design modeler

3. LOADS AND BOUNDARY CONDITION

Domain is defined as fluid with isothermal energy condition and reference pressure set to 1 atm. Standard k-epsilon turbulence model is set for analysis which is 2 equation model and helps in fast computation and useful in prediction of simpler fluid flows. The inlet boundary conditions are defined as per meteorological data of India. The air inlet velocity is 55m/s for all CAD models. The top face and 2 side faces are applied with opening boundary conditions as shown below.

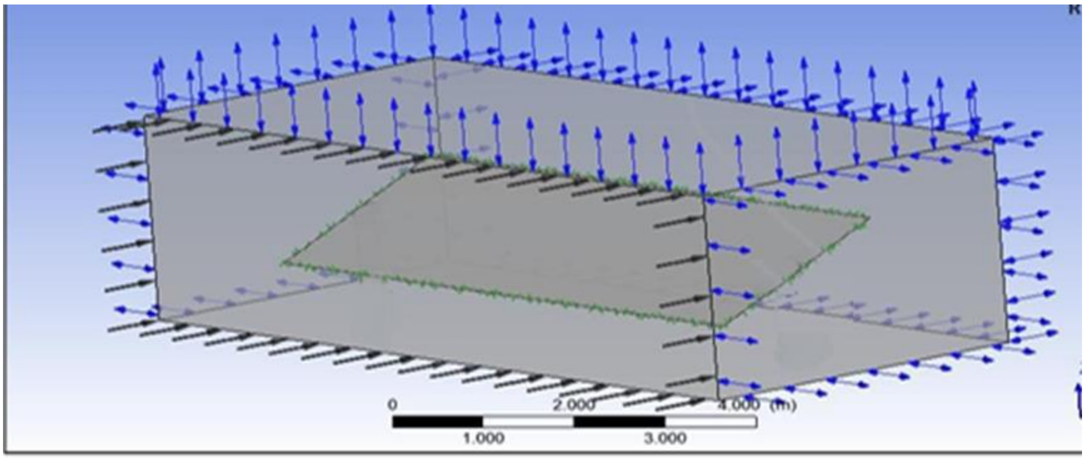

Figure 2. Loads and Boundary conditions

4. BASE DESIGN RESULTS AT 55 m/s WIND VELOCITY

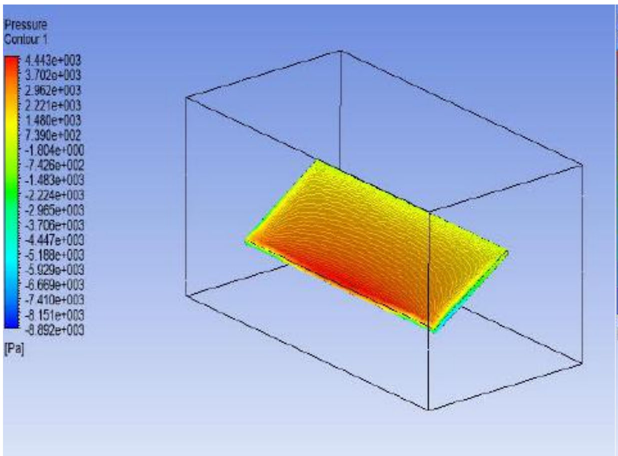

Figure 3. Pressure contour on solar panel at 55m/s

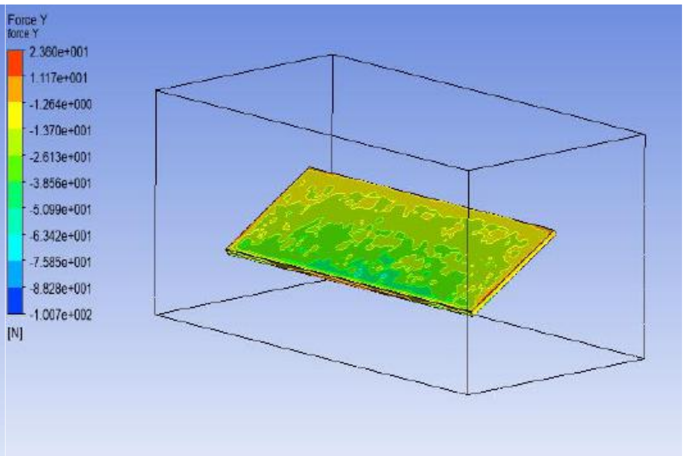

Figure 4. Drag force acting on solar panel

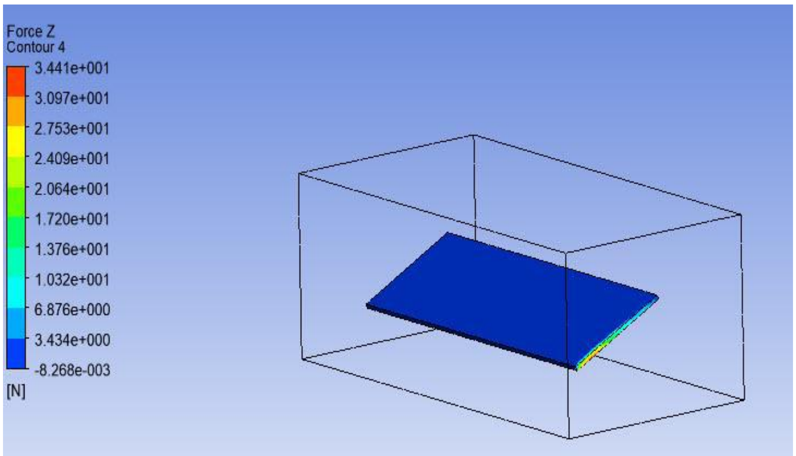

Figure 4. Lift force acting on solar panel

5. SOLAR PANEL WITH CIRCULAR DEFLECTOR AT 55m/s WIND VELOCITY

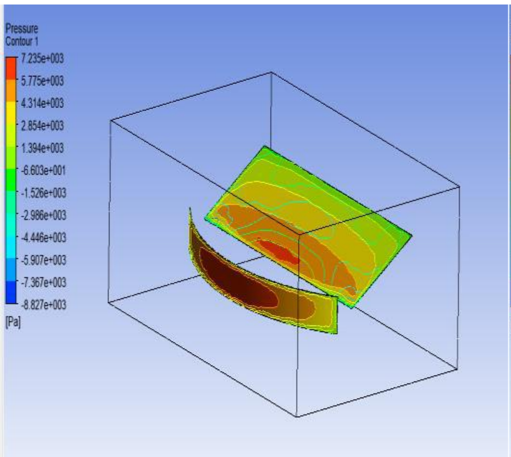

Figure 5. Pressure contour on solar panel

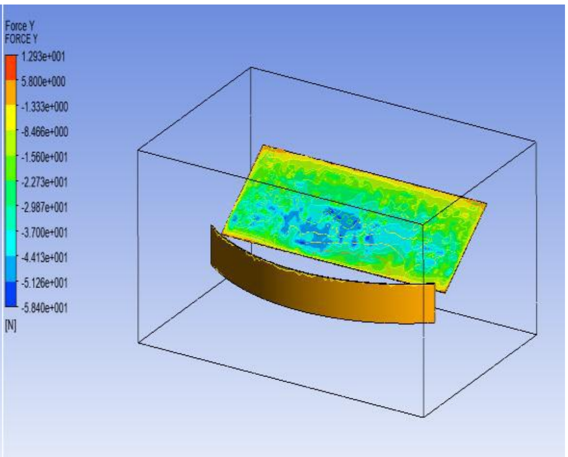

Figure 6. Drag force acting on solar panel

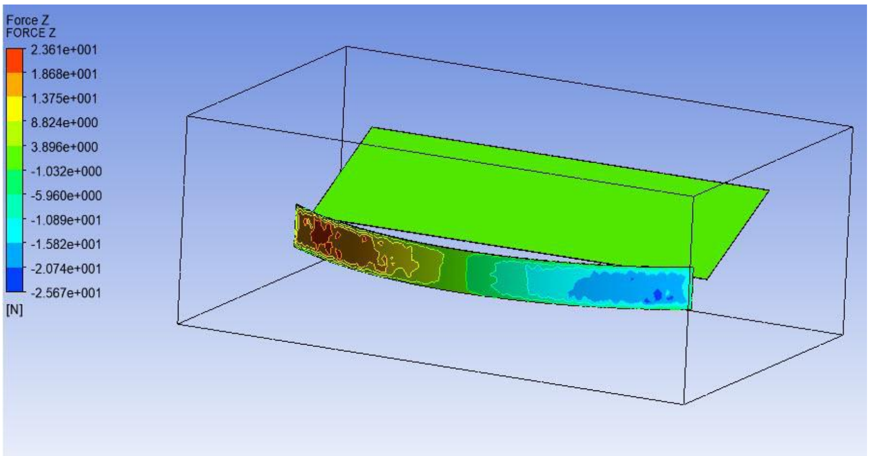

Figure 7. Lift force acting on solar panel with circular deflector at 55m/s

6. SOLAR PANEL WITH CONICAL DEFLECTOR AT 55m/s WIND VELOCITY

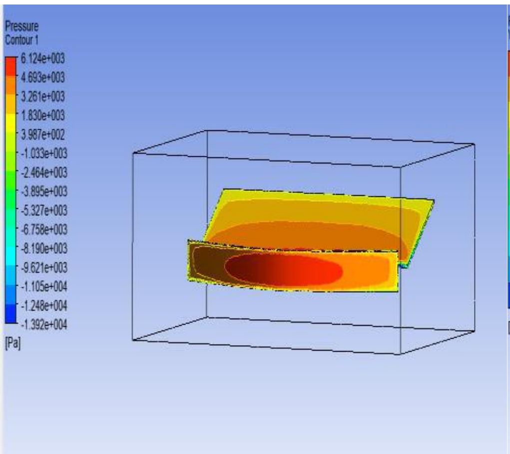

Figure 8. Pressure contour on solar panel

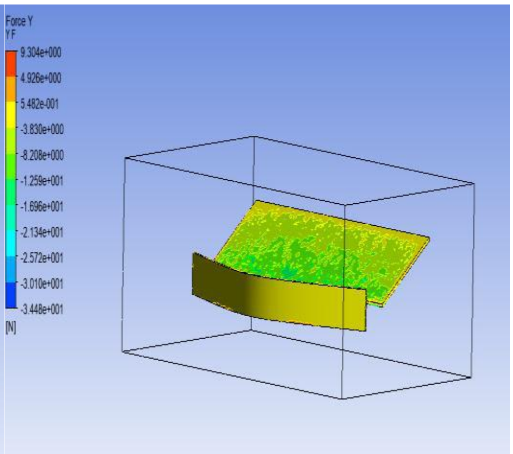

Figure 9. Drag force acting on solar panel

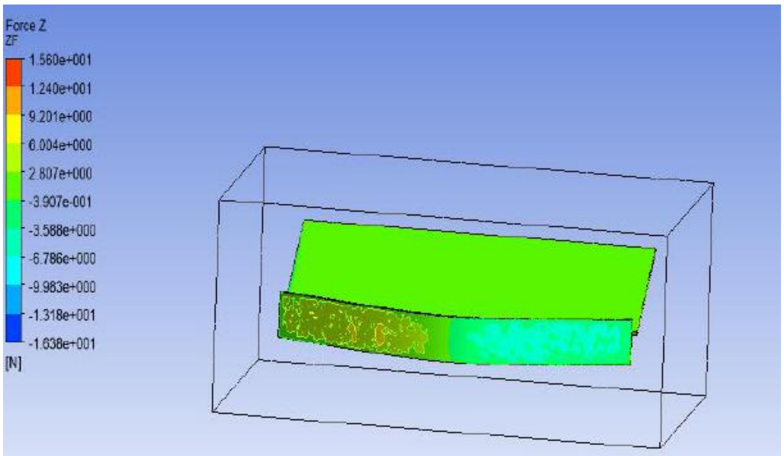

Figure 10. Lift force acting on solar panel with conical deflector

7. RESULTS AND CONCLUSIONS

The comparison between the existing and new design on basis of different parameters are shown in Table 2 below.

Table 2. Comparison between Existing and New Solar Panel Design with Wind velocity of 55m/s

Type of solar panel	Pressure field on solar panel (Pa)	Drag Force on solar panel (N)	Lift Force on solar panel (N)
Solar panel without deflector	4443	23.6	34.4
Solar panel with Circular Deflector	4314	5.8	3.8
Solar panel with Elliptical Deflector	4693	4.926	2.8

The CFD analysis is conducted on solar panel structure using k-ε turbulence model to determine the effect of wind flow on pressure, drag force and lift force generated

With reference to the Table 2 it is clear that the drag force and lift force is less and there is near about 78 % & 88% reduction in new design at 55m/s of wind velocity.

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