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Analysis of Solar Panel Stability

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Abstract: Proper design of front solar panel and solar panel structure is essential in safeguarding PV panels subjected to high wind speeds. The panel structure should have adequate strength to support PV panels and should also withstand higher wind speeds. The current research studies the various analysis conducted on solar panel structures and PV systems using numerical and experimental techniques to determine the effect of various design configurations, temperature and other systems to improve efficiency and stability of the solar panel systems.
Key Words: Solar panel structure, PV cells, Wind load

I. INTRODUCTION

Sun is the ultimate source of energy, almost all forms of energy is either directly or indirectly related to it. It has been saying that the energy released from sun in one second is more than that what mankind had used since the dawn of civilization. The current impetus for alternative energy sources is increasing the demand for solar energy. Solar energy is a promising type sustainable energy which is inexhaustible and abundant. Till now, we were not able to tap the full potential of this “green energy.”

Figure 1: Solar panels damaged due to strong winds in Taiwan

Design of supporting structure is governed by wind load. As accurate designs are not available in design codes, possibility of unsafe design is very high. Evaluation of wind induced forces on solar panels is hence very important. Wind forces are governed by various factors like inclination angle, height, type of terrain etc. Researchers have made efforts to develop relations between different codes. Main objective of such studies is to analyze data and provide more safe and economical design. Due to poor design or non-availability of designs, many cases of damaged solar panels have been observed upon exposure to strong wind. The damaged solar panel due to high magnitude of air is shown in figure 1.

II. LITERATURE REVIEW

Alex Mathew et. al. [1] Worked on style and stability analysis of solar battery support structure created out from soft-cast steel. They conducted this work as a vicinity of project of Mahindra Reva Ltd. named as “solar 2 car”. The result shows that the solar panel support structure can able to sustain a wind load with velocity 55 km/hr. They calculated required amount of weight to withstand wind load for different wind zones without any holding arrangements and then after optimization can be done for easy assembly, dismantle and transportation

Georgeta Vasies et al. [2] given Numerical simulations for analysis of wind action on star panels settled on flat roofs with and while not parapets. Numerical simulations are performed in ANSYS CFX, for an incidence wind angle of 45°.They are watching that Oblique direction of wind generating high intensity of uplift forces in the corner areas of the flat roof, forces which bring an additional load on support systems of solar panels. Presence of the parapet facilitate mitigate the wind hundreds, and average pressure is up to 18.6% lower that for solar panels placed on flat roof without parapet.

Girma T. Bitsuamlaka et al. [3] presented the aerodynamic features of ground-mounted solar panels under atmospheric boundary layer. They did four different test cases to determine the wind effects on stand-alone ground mounted solar panels differing from one another by wind angle of attack and number of panels. They verified that there is reduction in wind loads on the adjacent solar panel when they are arranged in tandem. After that they were conclude that „the solar panels experienced the highest overall wind loads for wind angle of attack.

Vijay B. Sarode et.al. [4] delineated the planning and improvement of solar battery support structure that is formed up form steel. They proposed to introduce latest FEA knowledge and concepts to work on this sector to provide a detail optimized design. So, they had created the model in PRO-E software. They were doing after creating model of support structure they did analysis of structure by choosing different cross section and they got best structural design by optimization

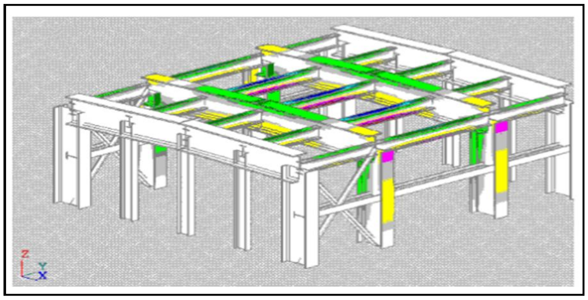

Fig 2: PRO-E model [4]

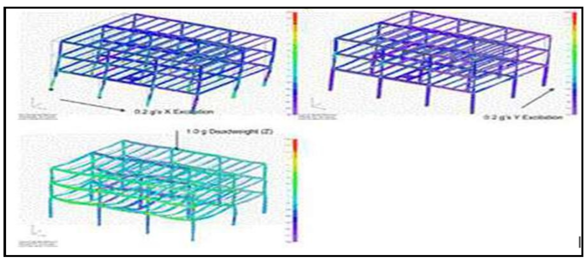

Fig 3: Deflection with different cross-section [4]

Study by Jones Westin, Sweden [5] suggested there is difference between wind actions in open range deployment and roof mounted because of turbulence and wind stream direction act by building. Uplift forces caused by wind action are balanced by attaching ballast to the photovoltaic mounting system. Such practice needs economical and safe guidelines so that uneconomical dimension doesn't cause construction infeasible.

Study by A Mihailidis, K Panagiotidis and K Agouridas [6] suggested use of different approaches for supporting structure these helped in achieving the maximum overall efficiency. First was load calculation and to determine pressure distribution. Second was analysis of the structure.

In this particular paper from zeinub samani [7] reveals wind load govern the design of supporting structures of solar panels and constitutes about 50% of the total cost approximately.

Study by bitsuamlaka [8] demonstrated that sheltering effects is caused by upwind solar panels substantially reduced the wind load on the adjacent solar panel.

Mehrdal shademan [9] study carried simulations at different azimuth and inclination angle with Reynolds numbers equal to 2×106. It was observed drag coefficient for the downstream sets of panels reached a minimum.

Guideline from franke [10] provides us methodology for CFD simulation of flows in the urban environment. It focuses on two categories errors and uncertainties in modelling the physics and numerical errors.

M Mohamed Musthafa et al [11] discuss about the cooling of solar panel back side using water as the coolant. The results indicated that under cooling condition, the temperature can be reduced to effectively increase the photoelectric conversion efficiency of solar panel.

Naresh Kumar Malik et al [12] suggested about an Effective implementation of photovoltaics, focusing on semiconductor properties and overall photovoltaic system configuration. Photovoltaic advancements in the fields of thin film and nano crystalline materials continue to flourish and soon increase PV efficiency to over 50%. As efficiency increases, PV technology attracts a greater number of people, resulting in reduced cost.

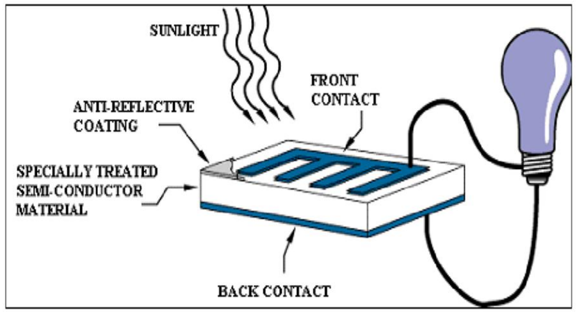

Figure 4: Basic component that make-up a PV cell [12]

P G Nikhil et al [13] analysed the performance of a 7W amorphous silicon photovoltaic module, with a quantity of silicone oil spread over its surface. The experimental results suggested a way to improve the performance of the module by cooling of the solar modules by silicone oil.

Li Zhu et all [14] studied about a DI water immersion cooling method which was applied to a dish high concentration PV system to keep a submerged cell module at a low working temperature. The pump for circulating the DI water is the model TE-4-MD-HC 582604 and is a totally enclosed and thermally protected type.

Mahesh Khatiwada et al [15] found that the Photovoltaic cell converts only about 15% of the solar energy falling into the useful electricity, rest is wasted as heat. The solar panel is cooled by passing air with the help of blower. He concluded that the power output and the electrical efficiency of the panel increase on cooling the panel.

Sayran A. Abdulgafar et [16] all discus to optimize the efficiency of a solar panel by submerged it in distillated water at different depths. The repeal of thermal drift increases the solar panel efficiency by about 11% at water depth 6 cm.

Yipping wang et al [17] carried out the experiment with three different dielectric liquid, silicon oil glycerol ethanol and found that the solar panel immersed in dielectric liquid had an increased operating efficiency. It was also observed that the absorption band almost the same but the silicon oil was turned yellow due to it's impurity after UV exposure while it remain colourless after the heat test.

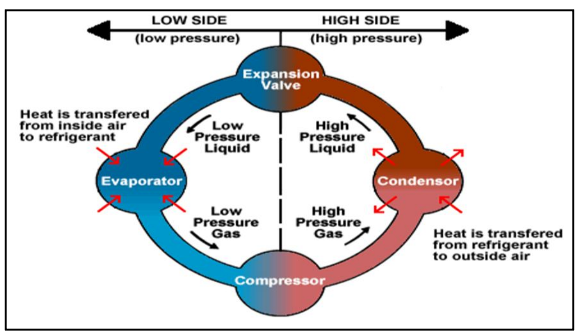

Figure 5: Four State Cycle [17]

Jacob Buehn et al [18] discuss to solve the problem of SAAR student design team which was in the process of developing an affordable refrigerator that is capable of operating on solar energy and alternative fuels such as small camp fires. The SAAR primarily charged utilizing the sun or other low-grade heat sources to drive the Ammonia Absorption Refrigeration Cycle.

Nasruddin et al [19] discuss the simulation of a two-bed silica gel-water adsorption chiller, utilizing solar energy based on climate of Indonesia. The adsorption chiller is being calculated numerically using MATLAB. The simulation results showed that during the maximum value of irradiation, the average value of COP could reach 0.26, while during the minimum value of irradiation the COP was found to be 0.15. At the same time, the cooling capacity is also varied which can reach up to the maximum value of 37.8 kW, whereas the minimum range of irradiation values was 5.3 kW.

Y Dutil et al [20] reviewed on the state-of-the-art and potential of solar-assisted cooling and air conditioning technologies. They concluded that This technology needed moderate driving temperature (55-900C), which can be achieved by flat plate collector.

Shuang-Ying Wu et al [21] worked in order to solve the non-uniform cooling of solar PV cells and control the operating temperature of solar PV cells. Results showed that the overall thermal, electrical and energy efficiencies of the heat pipe PV/T hybrid system corresponding to 63.65%, 8.45% and 10.26%, respectively can be achieved.

III. CONCLUSION

The temperature of the solar cell has a huge impact on the efficiency of photovoltaic system. With the increase in surface temperature of solar cells or panels their efficiency decreases quite dramatically. The solar system is one of the most important alternative sources of energy. Cooling of solar cells depends upon five major considerations that are cell temperature, uniformity of temperature, reliability, simplicity and usability of thermal energy. The support structure with PV panels should have good aerodynamics to reduce effect of wind load and minimize damage caused to solar panel system.

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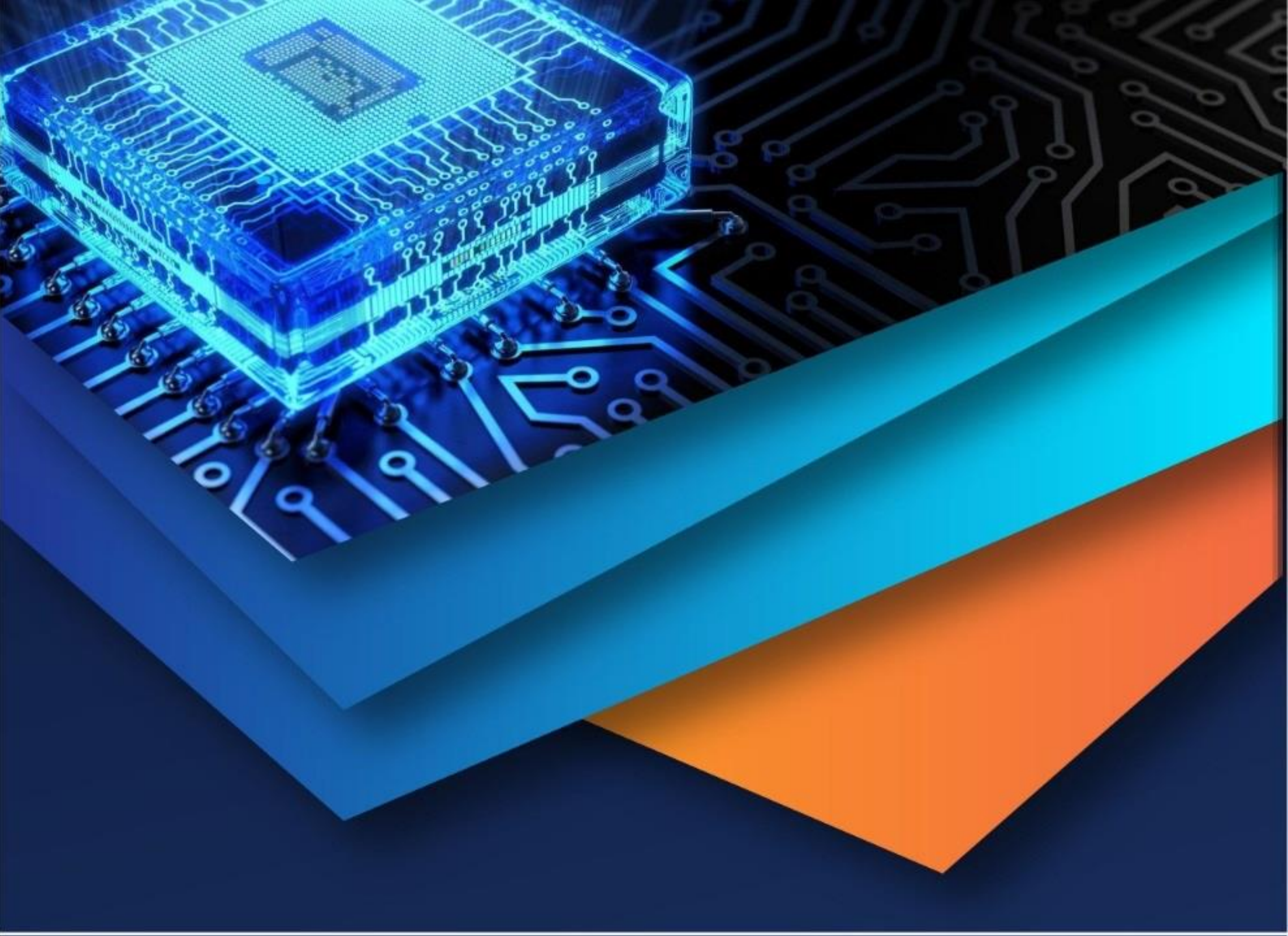

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