DESIGN AND ANALYSIS OF FRAME FOR MOBILE SOLAR POWER STATION

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ABSTRACT - *India is a sun-drenched nation, making it an ideal location for the use of solar energy for electricity production. The majority of solar panels manufactured now are stationary flat panels. As a result, they are only exposed to 4 - 5 hours of usable sunlight every day. The amount of solar energy incident on earth far exceeds the current and projected energy requirements of the world. This globally dispersed source has the potential to meet all future energy requirements if it can be harnessed effectively. Our objective is to develop and analyse the frame of a mobile power home station so that it can reach remote places in times of emergency. Our study pertains primarily to the construction of a vehicle structure that is capable of generating 3 kW of power using 11 solar panels. Solid works 2021 is used to create a 3D frame model. The design is analysed using the analytical programme ANSYS2021/R2 by applying all pertinent boundary conditions. Initially, the individual frames are designed to support the solar panels. The frame for eight solar panels is specifically constructed to accommodate rotating motion. Also, two solar panel frames are built to facilitate sliding. Solar panels are designed to be mounted on the columns. To mount eight solar panels, four columns of this type are created. The H-shaped foundation platform is intended to support the four columns. The finalized design is a bio-mimetic design, also known as the sunflower design. It has an 11:1 folding ratio. The fundamental framework must be meticulously designed. This design reduces the relative motion between components. It benefits from similarity and symmetry. The analysis, fabrication, integration, and testing of this design are performed. Numerous novel uses that were previously impractical are made possible by the flexibility of folding and unfolding*

***Key Words*: Solar power, solar panels, Design and analysis, Mobile frame, Modeling and simulation**

1. INTRODUCTION

Fossil fuels have a finite supply, and because of the industrial revolution and the exponential population growth, more energy is required. This leads to the development of renewable energy sources. Solar energy, wind energy, geothermal energy, hydro-power, and bio-energy are all examples of renewable energy. Solar technologies stagnated at the beginning of the 20th century. Solar energy systems that are inexpensive, non-exhaustible, and environmentally friendly will have enormous long-term benefits. Solar panels require greater room to create electricity, which is the primary drawback of solar power. The solar panels use the available area to generate electricity. Here is an innovative strategy whereby transportable solar panel frames might mitigate certain issues, such as the inability to transport solar panels to other regions where electricity is required. For solar panels to observe as much solar energy as possible when the time changes, a tilting motion is required. This helps the panels obtain additional energy so that more electricity is generated. This is of great assistance for remote application requirements. Agriculture needs energy for harvesting water throughout the year but some farmers feel this is a high investment as it is stationary and can't carry it to other places where electricity is needed. This disadvantage exists. This demonstrates that a solar water pumping system is a one-time investment that has both advantages and disadvantages in comparison to traditional systems in terms of operating and maintenance costs. The solar pumping system is self-sufficient since it generates its own energy using renewable resources without any external assistance. The pumping set is designed for a 3-horsepower pumping motor that is powered directly without the use of an energy storage device. According to the calculations, 11 solar panels are required to run the system under various loads, as each panel is anticipated to provide 330W. The frame is equipped with a tilting mechanism and a sufficient amount of clearance to accommodate seasonal variations in the amount of available solar energy.

2. DESIGN OF FRAME

A frame structure is a composition of beams, columns, and slabs that resists lateral and gravitational loads. Commonly, these structures are used to withstand the enormous moments generated by applied loads.

The rotational motion was chosen for eight solar panels, of which two are attached to each of four columns. The frame is designed to maintain the panel's position along its entire length. As the support rotates about a central axis, the frame and cross-section are designed to support the panel with minimal deflection under static and dynamic stress conditions.

The sliding motion was used for two solar panels, since both panels slide under the fixed panel. A C-channel member is used as a guide to retract the panel in a specific direction, with square members attached to both sides of the panel that slide into the C-groove. The cross section and thickness of the channel are dictated by the pull-out weight of the overhang of the panel.

2.1 MATERIALS SELECTION

The material is chosen based on its adaptability to several common production procedures that might be found in an educational institute, as it must be fabricated there. Generally, alloy steels and plain carbon steels were preferred. Mild steel EN3B is chosen based on availability.

Table - 3.1

Carbon	Silicon	Potassium	Magnesium	Sulphur	Iron
0.16 - 0.24	0.35 max	0.05 max	0.50-0.90	0.05 max	Balance

Table - 3.2

Mechanical Property	Value
Yield Strength	200-240 N/mm^2
Tensile Strength	400-560 N/mm^2
Shear Modulus	72 GPa
Vickers Hardness	124-241Vickers - HV
Elongation (in 200mm)	10-14 %

2.2 BASIC PARAMETERS

Each component and final assembly parameter is chosen in consideration of the characteristics that must be kept optimal in order to accommodate all components and achieve minimum space. Parameters for components are stated below.

Solar panel: 77*39 inches

Primary Pole Diameter: 2.5*0.12 inches

Primary Pole height:78.74 inches

Secondary Pole Diameter:3.49*0.3 inches

Square Diagonal length :87.5 inches

Overall H-base dimensions:94.49*49.24 inches

Rectangle section: 4*2 inches

The aforementioned dimensions are fixed based on numerous iterations.

2.3 CAD MODEL

The retracted view of the entire assembly is shown below (Figure 2.1; 2.2)

Figure 3.1

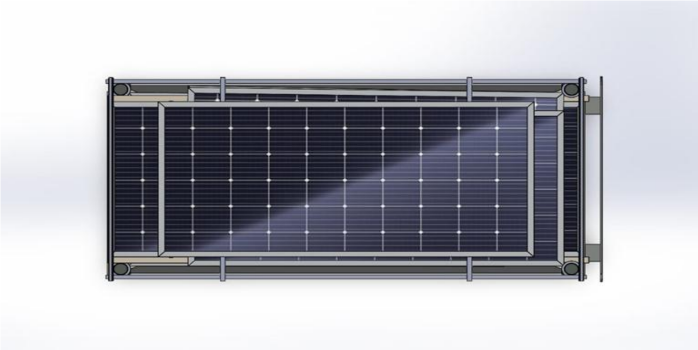

Figure 3.2

The deployed view of the entire assembly is shown below (Figure 2.3; 2.4)

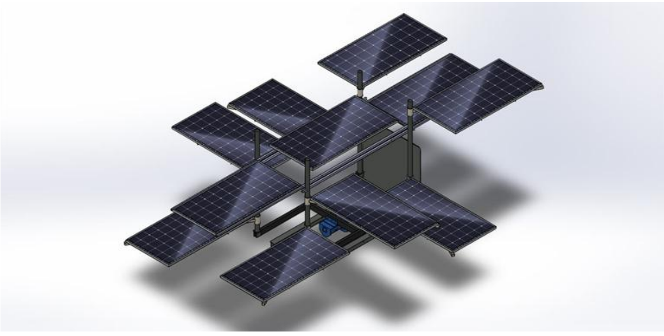

Figure 3.3

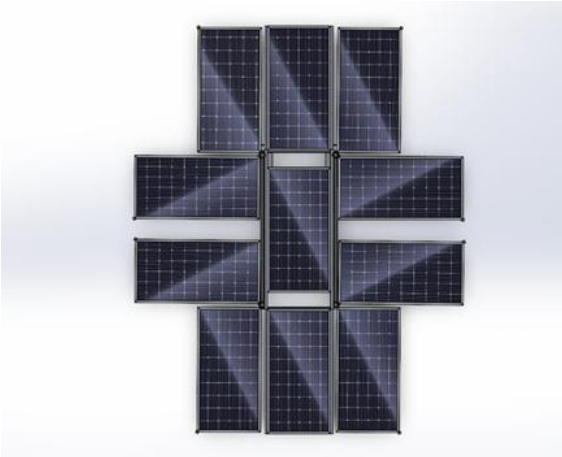

Figure 3.3

3. ANALYSIS SOFTWARE

To simplify complex and laborious problems, the model can be defined as finite elements and then its strength can be examined. There are numerous analysis tools, such as HYPERMESH, NASTRAN, and ANSYS. We chose ANSYS as our analysis tool.

3.1 ANSYS METHODOLOGY

The frame must be inspected for stress and strain generated by static forces, as well as bending moments caused by the weight of the solar panel and the self-weight of frame parts acting on the support point. These analyses will indicate the maximum permissible stress and responses at joints along the members of the frame, as well as provide insight into the weakest component of the design due to its geometric shape, thereby identifying those portions of the frame with the most stress and deformation.

This will also aid in determining the frame's stiffness while forces are being applied. Using ANSYS workbench, we performed a finite element analysis on the frame of our solar panel. The analysis was performed on several components of the solar panel such as Column, base and frame of the solar panel.

3.2 Boundary conditions of frame with rotary motion

Static structural analysis of a frame with rotary motion is performed by applying the boundary conditions illustrated in figure 1.5.2(a), which are:

1. A cylindrical support of 0 mm is provided at the cylindrical portion of the frame.

2. A remote load of 150N is applied through the centre of gravity to the entire frame.

3. The standard gravity of the earth is provided

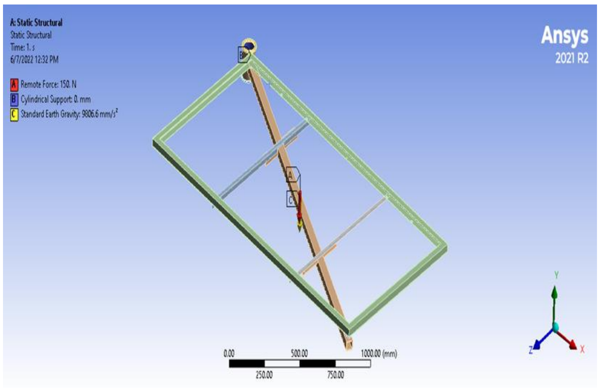

Figure 3.2.1

3.3 Boundary CONDITIONS OF frame with sliding motion

Static structural analysis for a frame with sliding motion is done by applying boundary conditions as shown in figure 1.5.3(a), which are

1. Fixed supports are given at four end faces of the frame.

2. A remote load of 200N is applied to the overall frame, acting through the center of gravity.

3. The standard earth gravity is given.

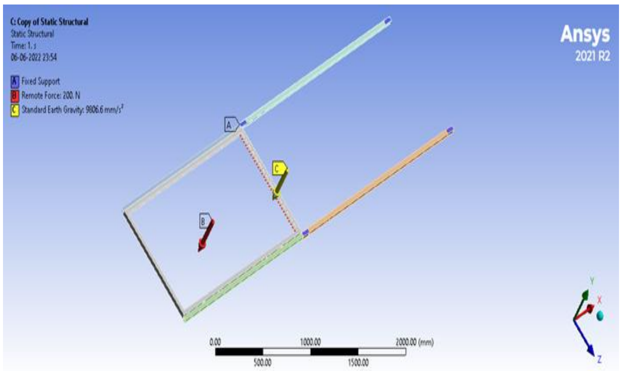

Figure 3.3.1

3.4 Boundary conditions for column

Static structural analysis for a column is done by applying boundary conditions as shown in figure 1.5.4(a), which are

1. Fixed supports are given at bottom of the column.

2. A remote load of 250N is applied to the column's two diagonal members that act through the center of gravity.

3. The standard earth gravity is given.

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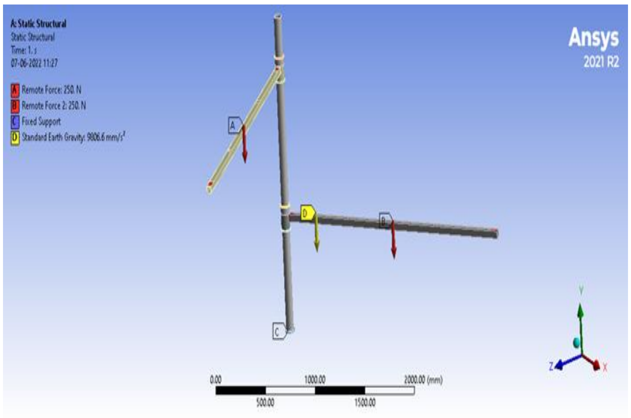

Figure 3.4.1

3.5 Boundary conditions for base platform

Static structural analysis for a base platform is done by applying boundary conditions as shown in figure 1.5.5(a), which are

1. Cylindrical support of 0 mm is given at four corners of the base platform.

2. A remote load of 4500N is applied to the base that acts through the centre of gravity.

3. The standard earth gravity is given.

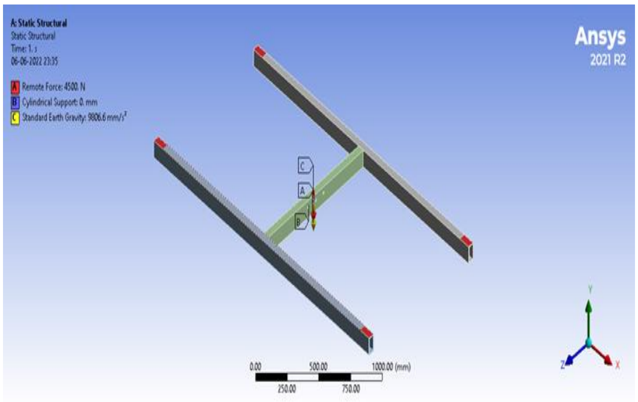

Figure 3.5.1

4. RESULTS

4.1 Frame with rotary motion:

The maximum stress obtained is shown in figure1.6.1(a) on the rectangular frame for rotary motion when a load of 150N is applied is 169.84MPa.

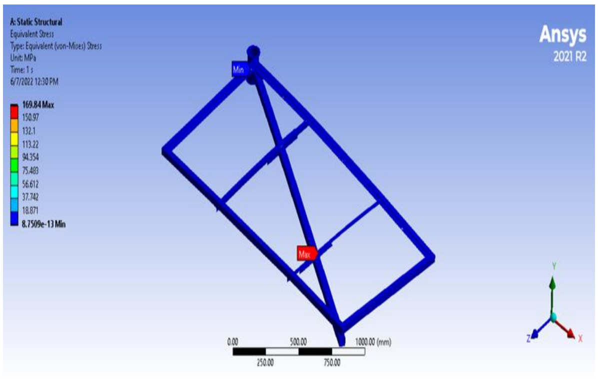

Figure 0.1

4.2. Frame with sliding motion

The maximum stress obtained on the rectangular frame is shown in figure1.6.2(a) for sliding motion when a load of 200N is applied is 100.86MPa

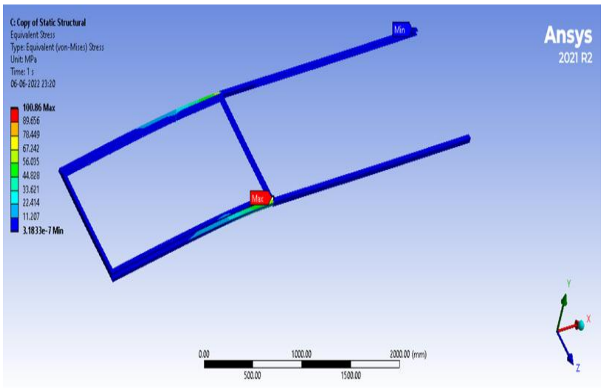

Figure 0.1

4.3 Base platform

The maximum stress obtained on the base platform is shown in figure 1.6.3(a) when a load of 4500N is applied is 151.36MPa

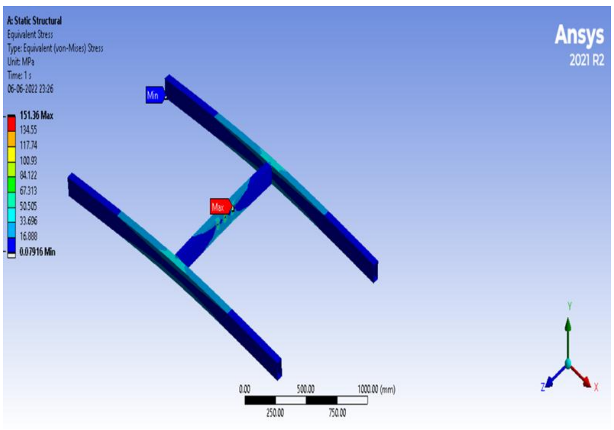

Figure 0.1

4.4 column

The maximum stress obtained on the column is shown in figure1.6.4(a) when a load of 250N is applied is 184.64MPa.

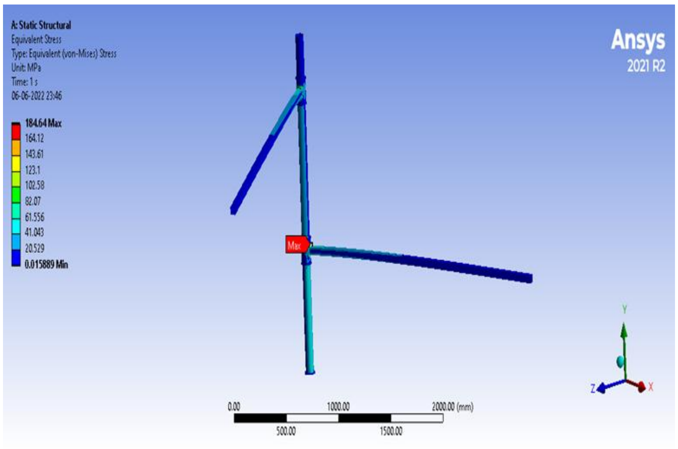

Figure 0.1

4.5 Results table

Table 0.1

Components	Maximum Stress (MPa)	Maximum Deformation (mm)	Factor of safety
Frame for rotary motion	169.84	2.931	1.472
Frame for sliding motion	100.86	16.954	2.876
Column	184.64	8.99 (X- axis) 3.24 (Z-axis)	1.354
Base frame	151.36	4.60	1.287

5. CONCLUSION

1. The Frame for rotary motion, sliding motion, column and base platform were designed and analysed.

2. The material selected was Mild Steel of EN3B grade with a yield strength of 240 MPa.

3. The static structural analysis was performed on different frames such as frame for rotary motion, frame for sliding motion, columns and base platform.

4. The design targets were reached by meticulous detailing in every aspect. The factor of safety was observed as 1.2 and above from results which is considered safe.

5. Parameters such as overall length of the frame is 106.69" inch, the maximum width of the Frame is 44" inch, Maximum height of the Frame is 106.66" inch and Weight of the frame is 550 kgs.

6. ACKNOWLEDGEMENT

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