Design and Analysis of Solar Smartflower Simulation by Solidwork Program

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Abstract. The potential of solar energy that is so large in Indonesia can be a driving force for the use of renewable energy as a solution for energy needs. Government with the community can utilize and optimize this technology to increase the electrification ratio up to 100% in all corners of Indonesia. Because of its modular and practical nature, making this technology easy to apply. One of the latest imported products that have started to be offered and sold in Indonesia but not yet widely used for solar power generation is the kind of smartflower. Before using the product, it is of course very important and immediately to undertake an in-depth study of the utilization, use, maintenance, repair, component supply and fabrication. The best way to know the above is through a review of the design and simulation. To meet this need, this paper presents a solar-smartflower design and then simulated using the facilities available in the solidwork program. Solid simulation express is a tool that serves to create power simulation of a design part modelling. With the simulation is very helpful at all to reduce errors in making design. Accurate or not a design created is also influenced by several other factors such as material objects, the silent part of the part, and the load given. The simulation is static simulation and body battery drop test, and based on the results of this simulation is known that the design results have been very satisfactory.
Keywords: design, analysis, simulation, solar, smartflower, solidwork.

1. Introduction

The last few years are intensively promoted through various electronic media sales of solar smartflower, but not many are interested. This may be due to the very expensive price and unavailability of service. To anticipate if it will be widely used but knowledge about it is not adequate then for the solution is to design and analyse through simulation program. This paper presents some research that tries to develop the design of solar smartflower and then analyse it through simulation using solidwork before made the process of its fabrication. The smartflower is an all-in-one ground mounted solar system with a tracker that follows the sun. It name comes from its design – the solar cells are arranged on individual "petals" that open at the beginning of each day. After the sun goes down, the smartflower petals fold up and a self-cleaning process kicks in. In addition to solar cells, the smartflower system contains a dual-axis tracker that makes it possible for its "petals" to follow the sun across the sky throughout the day. Thanks to this tracking capability, the smartflower can produce significantly more electricity than a similarly-sized rooftop solar panel system – up to 51 percent more, according to smartflower website. The 12-petal, 194 square-foot structure comes with 2.5 kilowatts (kW) of electricity production, which is equivalent to a 4 kW fixed rooftop array. There are two versions of the smartflower available in the U.S., both of which is manufactured in Austria: the smartflower and the smartflower-plus. The smartflower-plus offers energy storage capabilities via an integrated battery in addition to the standard solar electricity generation that the smartflower offers.

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According to press coverage about the product, the smartflower is priced at approximately $16,900. The smartflower-plus, which has includes batteries for energy storage, is not yet available in the U.S., but will be priced around $22,000 when it comes to market. Strategies and approaches related to the design method can be seen from the Montgomery literature [1] while some papers that have applied it can be found in Haris [2, 3]. Paper presents digital control design in [4], and for concept and theory of automation applied to production system can be found in Groover literature [5].

2. Methodology

Static studies provide tools for the linear stress analysis of parts and assemblies loaded by static loads and drop test studies are used to analyse the stress of moving parts or assemblies impacting an obstacle [6]. The step-by-step instructions are following given:
Step 1: Creating a Study
Step 2: Assigning Material
Step 3: Applying Fixtures
Step 4: Applying Loads
Step 5: Meshing the Assembly
Step 6: Running the Analysis
Step 7: Visualizing the Results
Step 8: Save Your Work and Exit SolidWorks

3. Result and Discussion

Solar smartflower is designed to have six main parts consist of fin diesel nine units, body battery, hinge buffer, base, hinge base, and fin with hinge 1 unit. This Smartflower can open and close focus horizontally 360 degrees, you can move up and down vertically 270 degrees vertically. Figure 1 shows parts designed of the solar smartflower, and Figure 2 shows designed full assembly of the solar smartflower.

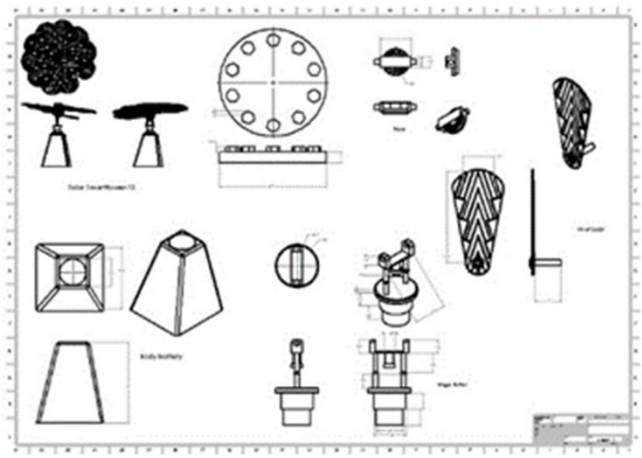


Figure 1. Design of parts of the solar smartflower.

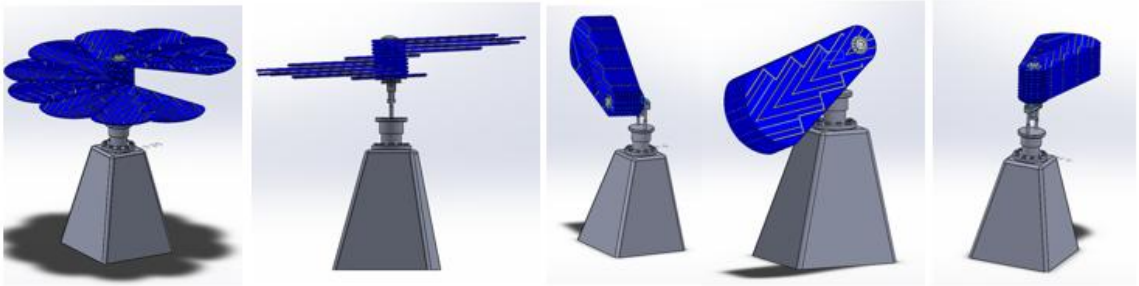
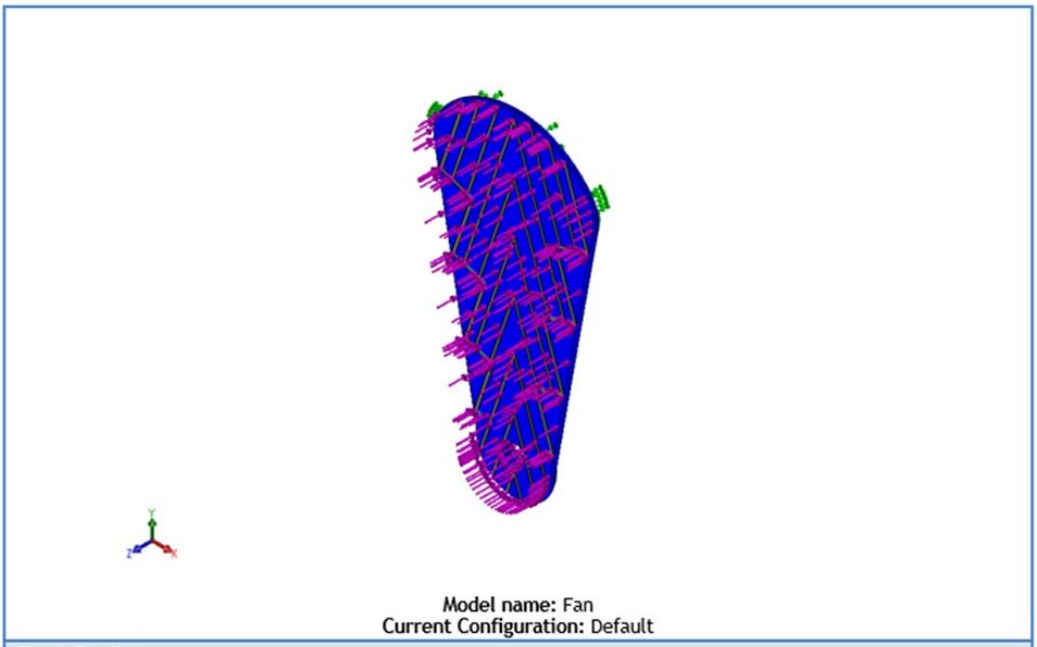


Figure 2. Designed full assembly of the solar smartflower.

Figure 3 shows the static simulation performed on the full assembly of the fan part solar smartflower. Can be interpreted stress on all surfaces occurs in all directions. The occurrence of blue colour on the surface is due to receive a static minimum load permanently, and the part is not changed shape. Figure 4 shows silicon material properties, and Figure 5 shows load and fixtures.



Shell Bodies

Document Name and Reference	Formulation	Volumetric Properties	Document Path/Date Modified
ala panel solar_1-1-surface1	Thin	Thickness:20 mm Weight:52.1739 N Volume:0.00228492 m^3 Mass:5.32386 kg Density:2330kg/m^3	C:\Users\hp\Desktop\Solid \Fan.SLDPRT Aug 11 22:07:18 2017

Figure 3. The static simulation result of fan part of the solar smartflower.

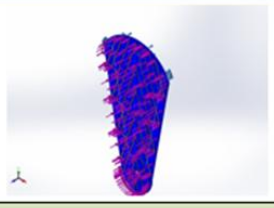
Material Properties

Model Reference	Properties	Components
	Name: Silicon Model type: Linear Elastic Isotropic Default failure criterion: Unknown Yield strength: 1.2e+008 N/m^2 Elastic modulus: 1.124e+011 N/m^2 Poisson's ratio: 0.28 Mass density: 2330 kg/m^3 Shear modulus: 4.9e+010 N/m^2	SurfaceBody 1(ala panel solar_1-1-surface1)(Fan)
Curve Data:N/A		

Figure 4. Material properties simulation result of the fan part solar smartflower.

Stress simulation result of the fan part solar smartflower designed is shown in Figure 6. Figure 7 and Figure 8 show displacement and strain simulation results of the fan part solar smartflower designed. If seen in the simulation results contained in Figure 6, shows the blue colour, meaning that the material used can withstand the stress load given, as well as the load displacement and strain. This can be seen in the simulation results shown in Figure 7 and Figure 8.

Loads and Fixtures

Fixture name	Fixture Image	Fixture Details
Fixed-1		Entities: 1 face(s) Type: Fixed Geometry

Resultant Forces

Components	X	Y	Z	Resultant
Reaction force(N)	-0.0913269	-0.1022	479.983	479.984
Reaction Moment(N.m)	-3.37168	-0.00342959	-0.000377144	3.37168

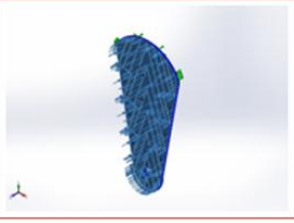
Load name	Load Image	Load Details
Force-1		Entities: 16 face(s) Type: Apply normal force Value: 30 N

Figure 5. Static simulation result of the fan part solar smartflower for load and fixtures.

Name	Type	Min	Max
Stress1	VON: von Mises Stress	0 N/m^2 Node: 65309	2.22317e+006 N/m^2 Node: 11137

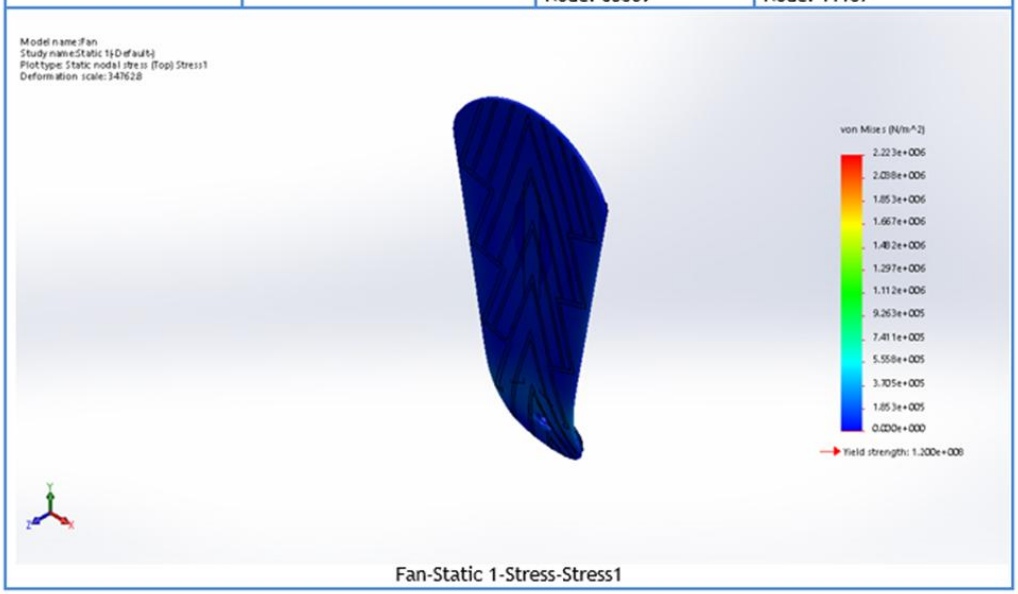


Figure 6. Stress simulation result of the fan part solar smartflower designed.

Figure 9 shows body battery of the solar smartflower designed, and the material properties is shown in Figure 10. Figure 11 shows stress simulation of the body battery solar smartflower designed while Figure 12 and Figure 13 show displacement and strain simulation results of the body battery solar smartflower designed.

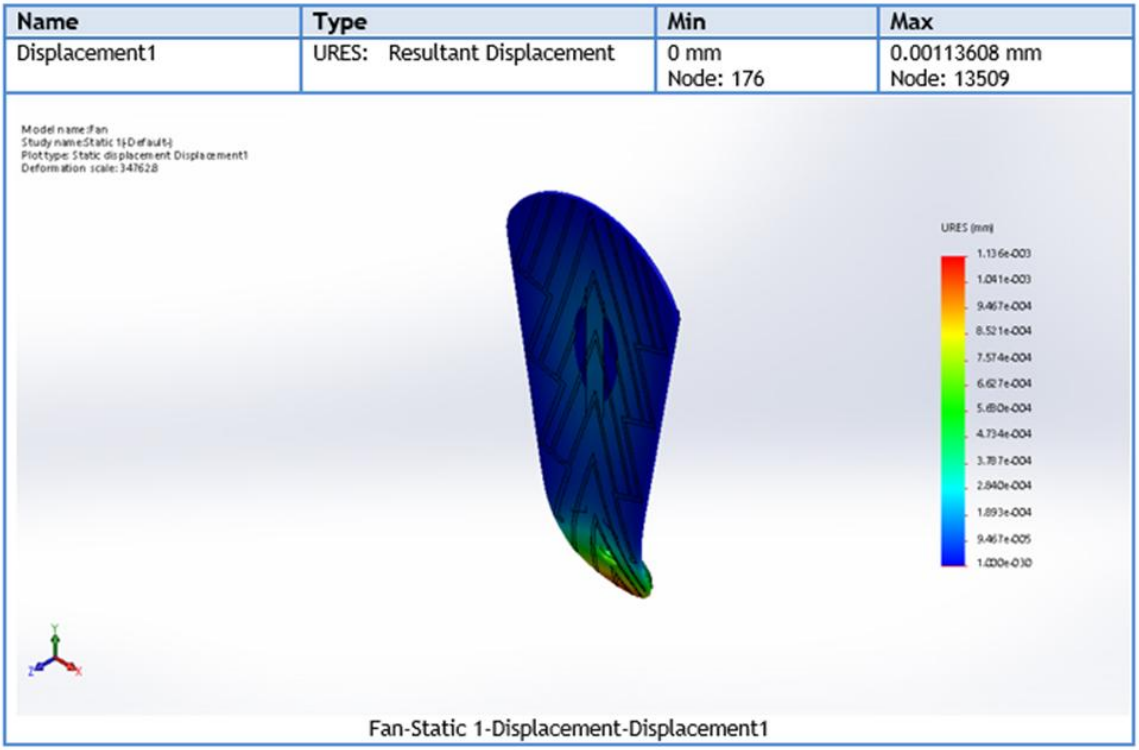


Figure 7. Displacement simulation results of the fan part solar smartflower designed.

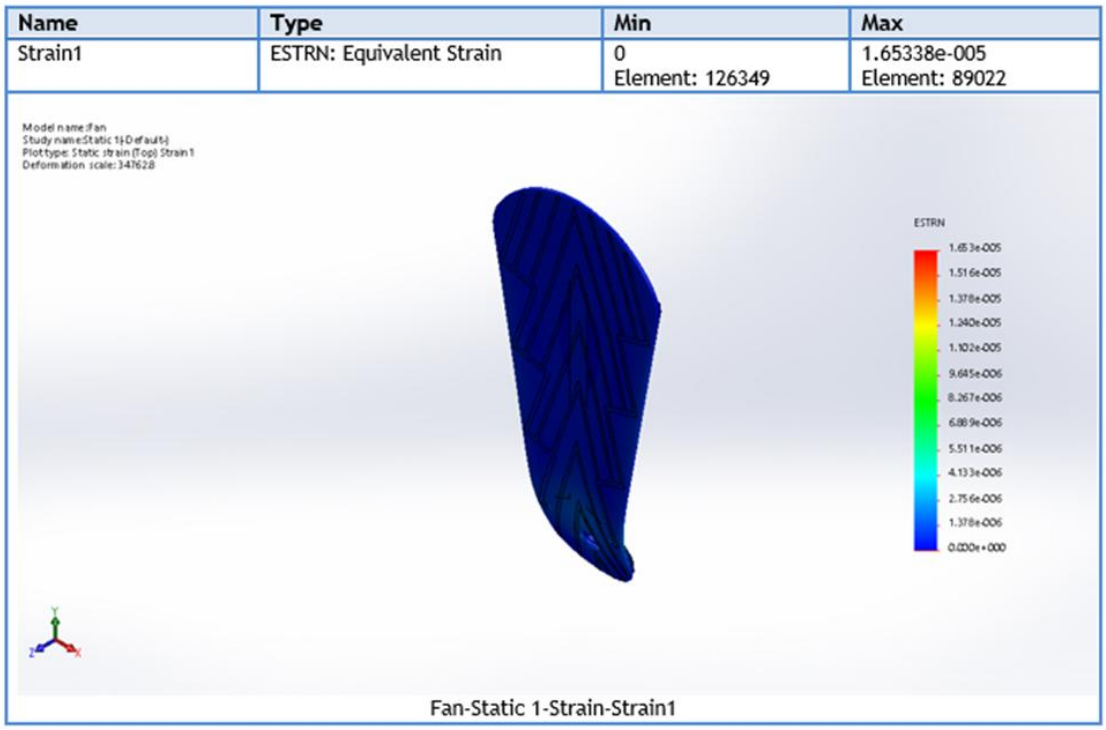
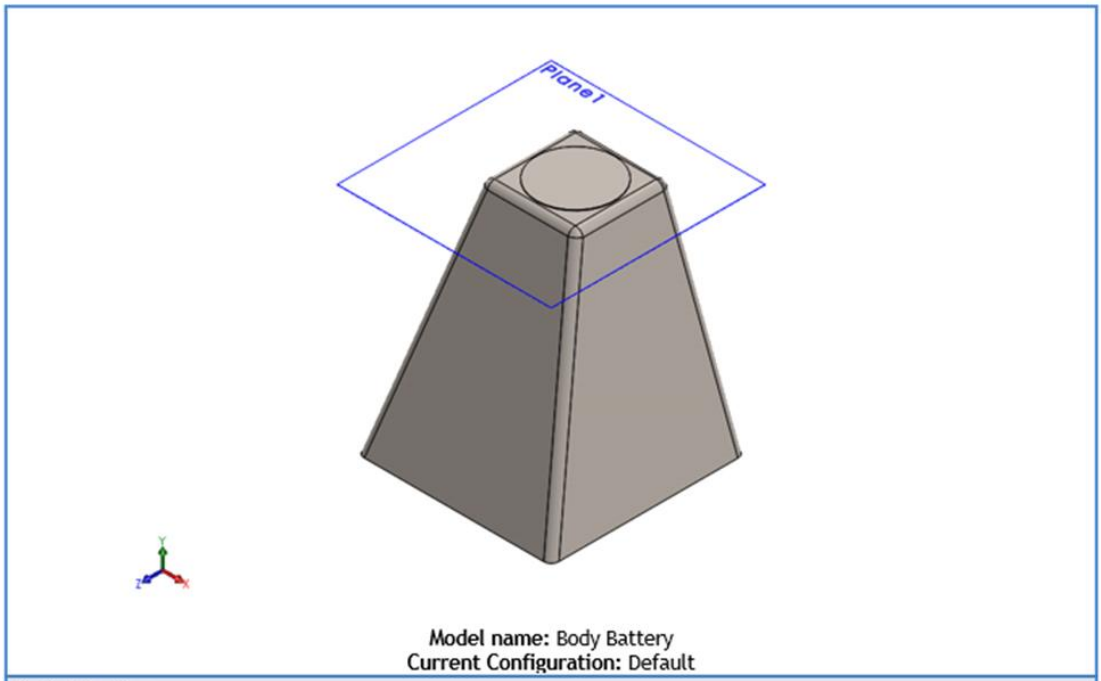


Figure 8. Strain simulation results of the fan part solar smartflower designed.



Model name: Body Battery
Current Configuration: Default

Solid Bodies

Document Name and Reference	Treated As	Volumetric Properties	Document Path/Date Modified
Boss-Extrude2 	Solid Body	Mass:85.6293 kg Volume:0.0106677 m^3 Density:8027 kg/m^3 Weight:839.168 N	C:\Users\hp\Desktop\Solid \Body Battery.SLDPRT Sep 13 01:18:31 2017

Figure 9. Body battery of the solar smartflower designed.

Material Properties

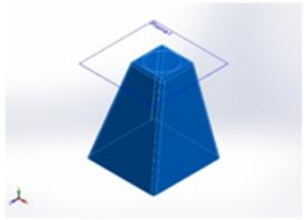
Model Reference	Properties		Components
	Name:	AISI Type 316L stainless steel	SolidBody 1(Boss-Extrude2)(Body Battery)
	Model type:	Linear Elastic Isotropic	
	Default failure criterion:	Unknown	
	Yield strength:	1.7e+008 N/m^2	
	Tensile strength:	4.85e+008 N/m^2	
	Elastic modulus:	2e+011 N/m^2	
	Poisson's ratio:	0.265	
	Mass density:	8027 kg/m^3	
	Shear modulus:	8.2e+010 N/m^2	
	Thermal expansion coefficient:	1.7e-005 /Kelvin	
Curve Data:N/A			

Figure 10. Body battery material properties of the solar smartflower designed.

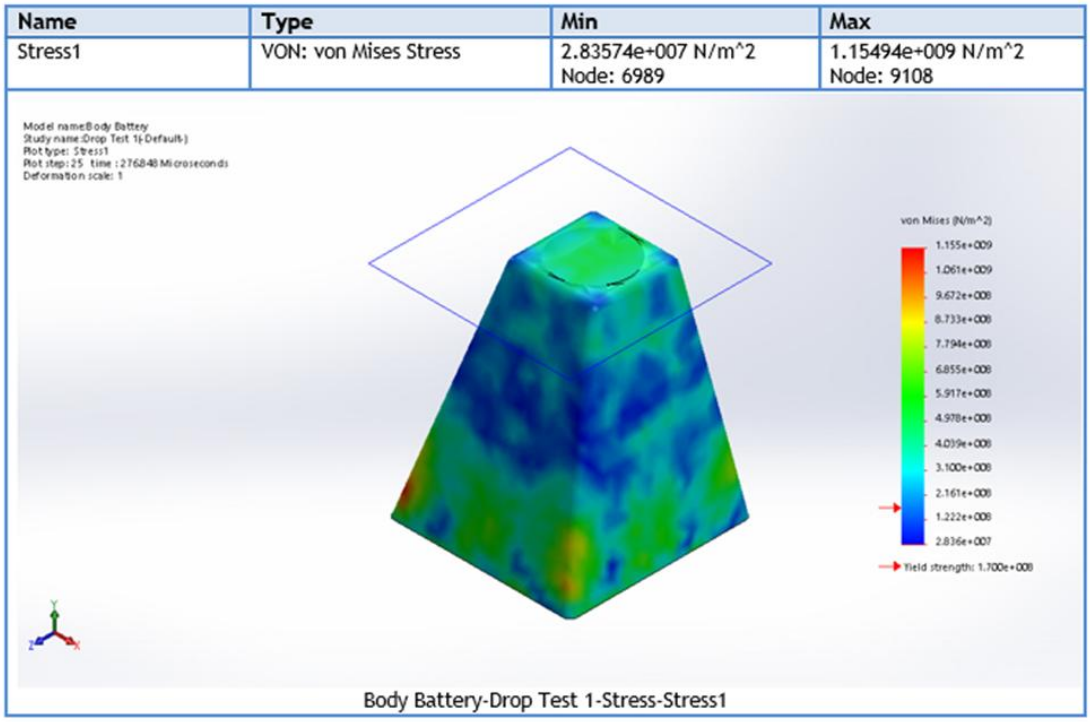


Figure 11. Stress simulation of the body battery solar smartflower designed.

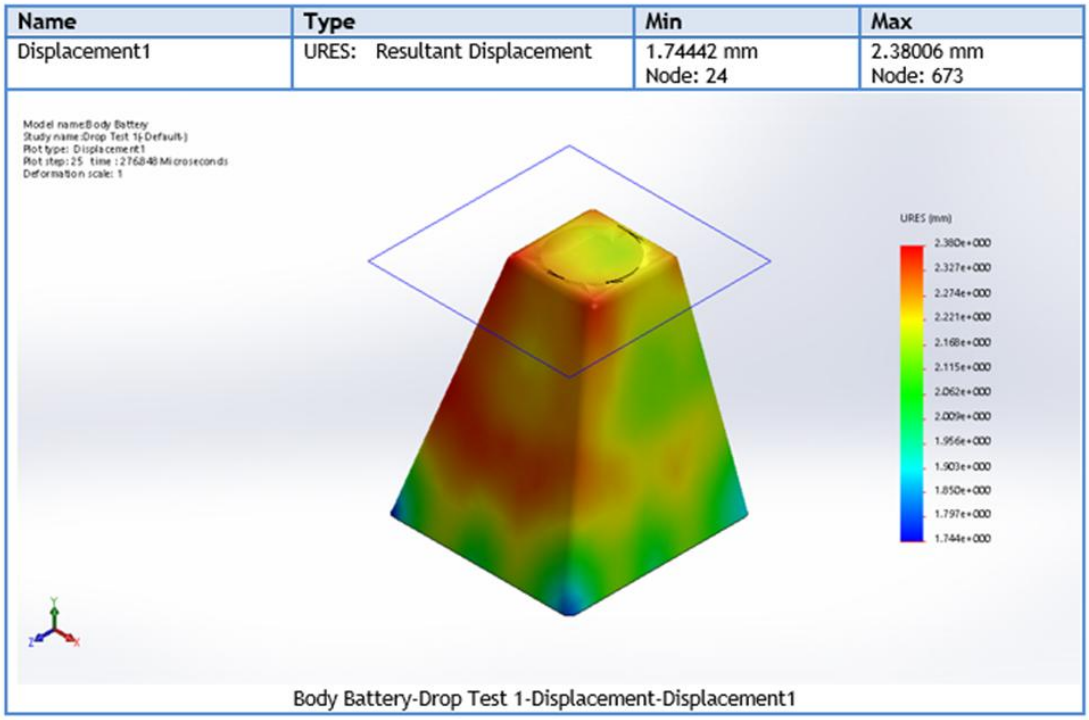


Figure 12. Displacement simulation of the body battery solar smartflower designed.

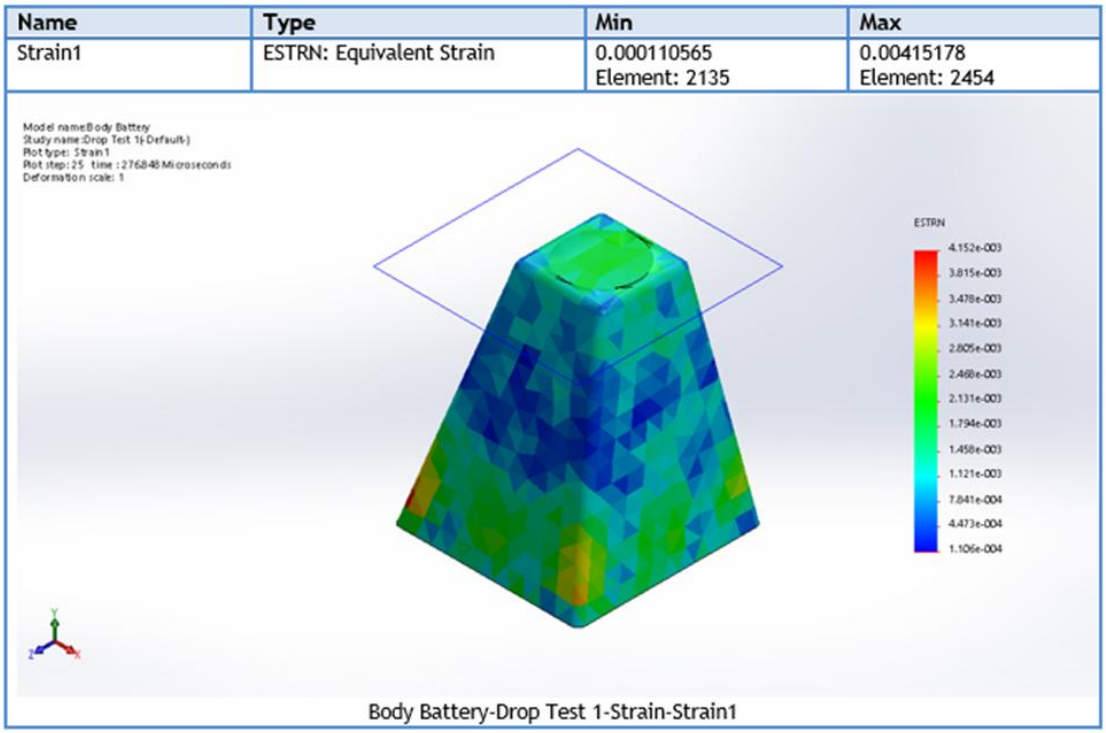


Figure 13. Strain simulation of the body battery solar smartflower designed.

4. Conclusion

Based on fan static and body battery drop test simulations it can be concluded that the solar smartflower designed can be forwarded to the fabrication stage. This fact is reinforced by the simulation results that show despite the static or drop test loads but parts of the solar smartflower designed does not change shape.

5. References

[1] Montgomery D.C 2013 *Design and Analysis of Experiments* (New York: John Wesley and Sons)
[2] Haris R, Rino Andias A and Tatang M 2015 EMS-SCADA Design of AC Usage on a Building (Proceeding 8th International Seminar on Industrial Engineering and Management 2015 (ISIEM 2015)) PS45-49.
[3] Haris R and Tatang M 2015 Website Design of EMS-SCADA for AC Usage on a Building (Proceedings of the 3rd International Conference on Information and Communication Technology 2015 (ICoICT 2015)) p 17-22
[4] Tatang M, Mohamad Nor M.T, Dirman Hanafi B, and Afrodi A 2010 Digital control design for the boiler drum BDT921 (Proceeding of Conf. on Industrial and Appl. Math., Indonesia) p 257-260
[5] Groover M.P 2001 *Automation, Production System, and Computer-Integrated Manufacturing* (New Jersey: Pearson)
[6] Solidworks 2010 *An Introduction to Stress Analysis Applications with SolidWorks Simulation, Student Guide* (Solidworks Education - Concord, Massachusetts 01742 USA)

Acknowledgments

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