AIR INFLATED STAGE ROOF STRUCTURE WITH INDEPENDENT ENERGY FOR SMES EXHIBITION

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ABSTRACT

Applied Research with objects of the SME Exhibition Stage in the form of portable stag buildings with inflatable structure roofs using PVC Tarpaulin fabric material. These faciliti can be built, dismantled and moved to other locations easily, safely, quickly and lightly wi independent energy sources (photovoltaic solar energy systems). The research objective is develop stage facilities as a means of exhibiting SME products that fulfill aesthetic aspect strength, speed, effectiveness, comfort and energy saving so as to encourage the developme of creative economy SMEs. The research method used the Experimental Method and Actio Research, beginning with the development of design, manufacture and testing of portab stage models with pneumatic air inflated stage roofs of Independent Energy, including: (speed test of the manufacture, transport, assembly, installation, dismantling of pneumatic a inflated structures and solar energy modules, (2) strength testing of Air Inflated materials (thermal comfort tests under the roof of the stage of Air Inflated pneumatic structures, (testing the effectiveness of using photovoltaic solar energy to drive inflatable stage ro blowers. The tests were carried out at the University of Merdeka Malang Lab and Field Tes in Malang City and Regency, proved to provide reliable and satisfying results, including: speed of installation and demolition installations (23 minutes portable stage, 6 minut inflatable roof, solar panel installation 15 minutes) , b) the required air pressure is only 0.7 p to set up an inflatable roof, c) the tensile strength of PVC tarpaulin material reaches 312 kg cm2, d) 4 solar panels each with a capacity of 100 wp with energy storage in the form of a 1(AH battery 12 V and 1000 W converter in bright conditions produce a minimum of 11.6 Am 18.8 V can provide energy needs to drive inflatable stage roof blowers and portable sour systems, and f) comfort under the inflatable roof maximum temperature of 350C. The portab stage and the practical and fast-build inflatable stage roof are expected to become a prototyp of stage facilities for SME Exhibition on a national scale.

Keywords: portable stage, pneumatic structure, air inflated, solar energy, SME exhibition.

1. INTRODUCTION

Small and Medium Enterprises (SMEs) have a very important role in Indonesia economic development. This is because in addition to contributing to the growth and absorption of labor, it also plays a role in the distribution of development

results. Small companies can absorb 51% of the national labors (Manurung, 2006). In Indonesia, the quantity of SMEs is also superior, this is based on the fact that most businesses in Indonesia are more than 99% in the form of small and medium scale businesses. Even SMEs made a very significant contribution especially when the crisis was experienced in the period 1998-2000. In a crisis, where large-scale businesses appear to have stagnated and even stopped their activities, the SME sector shows the potential to continue to survive and develop so that a creative industry SME development program in Indonesia is always needed. In terms of marketing, the SME product exhibition is an effective marketing method for creative economic SMEs that need to be supported by the role of universities (Budiyanto, Hery & Rofieq, Mochammad. 2018). One of the most important parts of the SME product exhibition is the entertainment stage which is an attraction for visitors to come and be in the exhibition area. This research focuses on the design and manufacture of portable stage and stage roof structure of independent energy air inflated as a means of exhibiting SME products, using tarpaulin PVC-coated fabric so that it is lighter and compact and quick to install and dismantle.

Previous research on Pneumatic Air Inflated Structure for disaster tents proves that this structure can be used in restricted areas, lightweight structural materials, easily moved, folded or transported to other locations only by truck / pickup. (Budiyanto, Hery, at.al. 2014; 2015). The novelty of this research is the use of electrical energy to drive a blower that will inflate the pneumatic structure of inflated water as an environmentally friendly energy source as its power is photovoltaic solar energy

There are 5 main aspects that are a problem in this study, namely:

a. The design and manufacture of portable stages and the air inflated structure roof stage with independent energy for SME exhibitions.
b. Speed and effectiveness in the process of transporting, assembling, installing and dismantling portable stages and the air inflated structure roof stage with independent energy
c. The level of thermal comfort in a portable stages and the air inflated structure roof stage with independent energy
d. The efficiency of photovoltaic solar energy in providing energy for the roof of an air inflated structure

2. LITERATURE REVIEW

2.1 Pneumatic Air Inflated Structure System

Pneumatic membrane structure is one of the soft shell structure systems, where the structure can stand due to differences in air pressure in pneumatic structures with air pressure outside the structure (Sukawi, 2011). Pneumatic structures are divided into 2 major groups namely air supported structure and air inflated structure (Schodek, 1980) .a) Air supported structures are referred to as single membrane structures because they only require one layer of membrane and require low air pressure (about 2-20 pounds per foot above atmospheric pressure). b) the inflated water structure is also called the double membrane structure (figure 1).

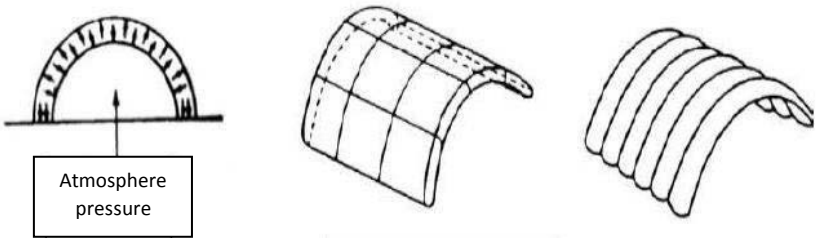


Figure 1: Air Inflated Pneumatic Structure
(Source: Schodek, 1980)

Membrane material made from fabric which are inflated by air are included in the category of structures that are stretched and have unique advantages in their use compared to traditional structures. These advantages include lightweight design, fast and easy to install, fast transport and small packing volume. Purwanto (2000) stated the possibility of applying and developing pneumatic structures in Indonesia, including climatic conditions in Indonesia, especially wind problems, is not a significant problem and can be calculated with the calculation of pressure in pneumatic structures. The things that need to be considered in the use of pneumatic structures in Indonesia, among others, behavior, social conditions of the Indonesian people need to be improved, especially in building maintenance. Alain Chassagnoux et.al. (2002) explained that to study contemporary architectural forms that use unconventional structures. The lecturers can invite students to conduct model experiments so that they get the experience of "forming" buildings using elements / components designed by students themselves.

Basic research and testing of the pneumatic structure system has been carried out by the research team, among others in the testing of pneumatic structure models (Budiyanto, Hery. 1992). Structural model experiments are needed to determine the behavior of the actual structure (prototype) by using a replica (model) of a smaller scale structure. Pneumatic structures have several advantages compared to conventional building structures, namely initial investment is cheaper, speed and ease of development, easy maintenance, structural elements can be folded (concise) so that it is easily stored (Budiyanto, Hery & Sukandar. 2007). Tent prototyping experiments pneumatic structures supported by air / water supported (Budiyanto, Hery & Suprapto, Agus, 2010). The membrane material of the Air Inflated Structure is proven to be reliable based on tensile testing> 200 kg / cm2, material durability> 70^0C, installation 3 minutes, installation of 3 minutes and dismantling 3 minutes and indoor temperature <35^0C (Setiawan, M. Ikhsan & Budiyanto, Hery. 2014) The Air Inflated Structure can be used in limited areas, lightweight structural materials (PVC Tarpaulin), easily moved, folded or transported to other locations only by truck / pickup (Budiyanto, Hery. 2015)

2.2 Photovoltaic Solar Energy System

The main components of a Photovoltaic Solar Energy System are photovoltaic cells that convert solar radiation into direct conversion captured by Solar Array, which requires Balance of System (BOS) to include charge controllers and inverters, battery storage units and other supporting equipment (Widayana, 2012). This energy system will support the electricity needs of the blower as an air source on the pneumatic structure of the air inflated roof stage.
Optimization is needed in the use of solar energy to prolong life and save battery power (Setiawan, 2012). In this research, optimization of the speed of air source blower on the pneumatic stage roof of air inflated will be done to the amount of power needed to obtain the efficiency of the use of electric power in the Photovoltaic Solar Energy System.

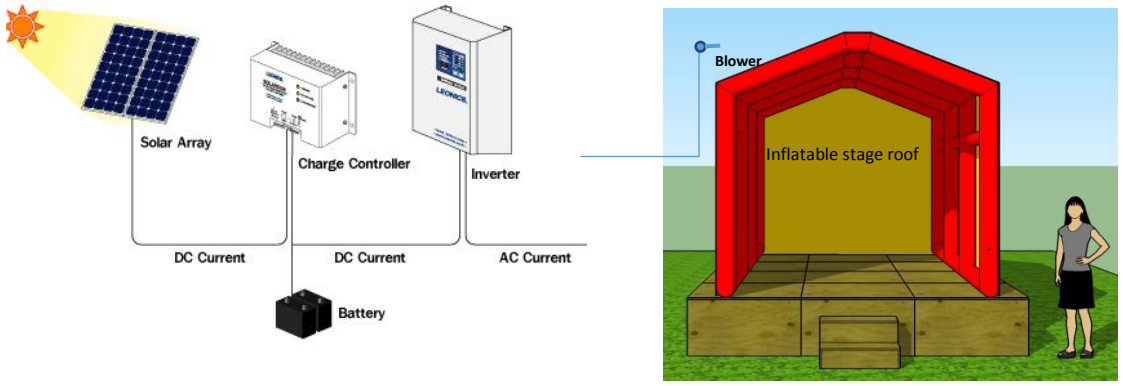


Figure 2: Schematic Design of Portable Stage Models and Inflatable Stage Roof

3. RESEARCH METHODS

This study uses experimental and action research methods in the form of modeling, conducting laboratory trials and field trials of various variables (Cowan, 1968). In this study various tests were carried out, namely: a) test flexibility, speed and effectiveness in the development process, b) testing the strength of inflated membrane water material, c) pressure testing in a membrane inflated membrane water, d) thermal comfort test under the roof of the inflated water membrane, e). material testing and f) effectiveness of solar power photovoltaic power systems.

4. RESEARCH RESULT

Figure 3: Portable Stage and Inflatable Stage Roof

The stage is made from a multiplex of 18 mm, designed to be portable and portable. Consists of 12 modules, each measuring 120x120x60 cm. For the stage roof, the inflatable tube frame is made of pvc coated tarpaulin fabric with a thickness of 0.5 mm, while the stage cover is made of water-resistant coated parasitic fabric. Solar panels as a source of electrical energy are 4 panels, every 2 panels are supported by a portable bracket.

Figure 4: Portable Stage Making (2 weeks)

Figure 5: Making an Inflatable Stage Roof (2 weeks)

Figure 6: Portable Stage Assembly (50 minutes)

Figure 7: Inflatable Stage Roof Installation (6 minutes)

Figure 8: Installation of Portable Bracket & Photovoltaic Energy Solar Panel (20 minutes)

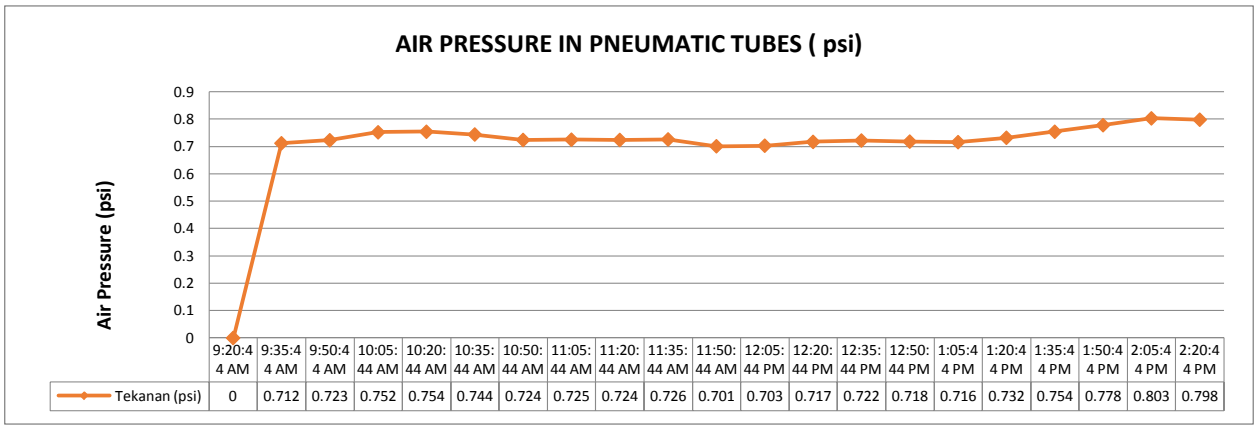
4.1. Process speed

The process of making a portable stage takes 2 weeks (figure 4), at the same time making an inflatable stage roof which also takes 2 weeks (figure 5). The portable stage assembly process takes 50 minutes (figure 6), while the inflatable stage roof inflating process takes only 6 minutes (figure 7). The series of electrical energy sources in the form of 4 photovoltaic panels are placed on 2 portable bracket which takes 20 minutes (figure 8).

4.2. System Efficiency and Structure Components

The stage roof consists of 2 components, namely: 1) inflatable tube material in the form of pvc tarpaulin cloth with a thickness of 0.5 mm, connecting this material using rubber glue specifically made for the material; 2) roof cover material in the form of coated parasitic fabric with a thickness of 0.2 mm, connecting using a sewing system.

4.3. Air pressure inside the inflatable membrane tube



	9:20:44 AM	9:35:44 AM	9:50:44 AM	10:05:44 AM	10:20:44 AM	10:35:44 AM	10:50:44 AM	11:05:44 AM	11:20:44 AM	11:35:44 AM	11:50:44 AM	12:05:44 PM	12:20:44 PM	12:35:44 PM	12:50:44 PM	1:05:44 PM	1:20:44 PM	1:35:44 PM	1:50:44 PM	2:05:44 PM	2:20:44 PM
Tekanan (psi)	0	0.712	0.723	0.752	0.754	0.744	0.724	0.725	0.724	0.726	0.701	0.703	0.717	0.722	0.718	0.716	0.732	0.754	0.778	0.803	0.798

Figure 8: Pressure Charts in Tubes of Inflatable Stage Roof Membrane

The minimum air pressure needed for the erection of the inflatable membrane tube is 0.7 psi, this pressure is achieved within 6 minutes from the start of the bubble. The air pressure in the inflatable tube can be reduced and increase with the outside temperature.

4.4. Thermal conditions inside and outside the roof of the inflatable stage

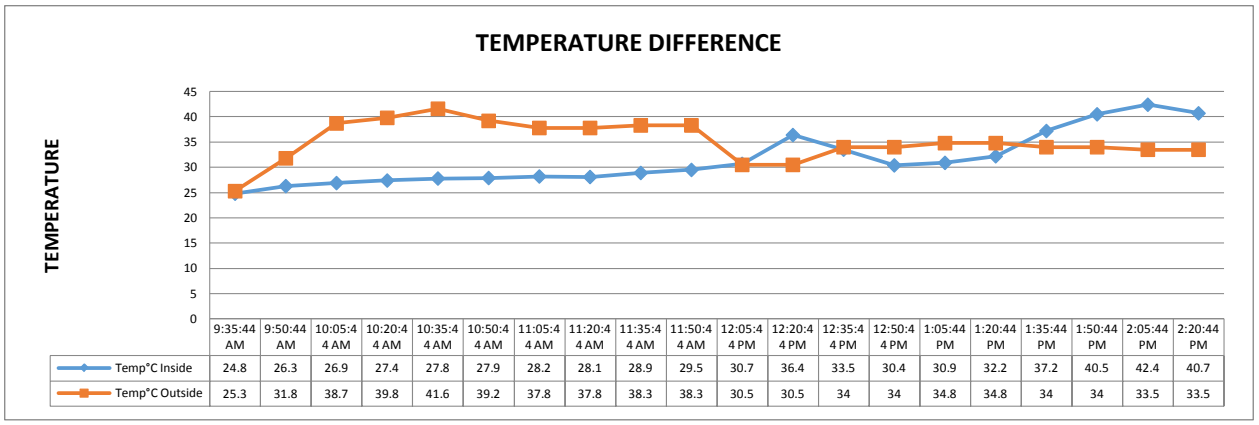


Figure 9: Chart of Thermal Conditions in and Out of Inflatable Stage Roofs

On the morning of 09.05 AM until 12.05 AM the air temperature inside the stage was lower than outside the stage. There are differences in air temperature inside and outside the stage between -4.9°C to 13.8°C.

4.5. The strength of the inflatable roof stage membrane tube

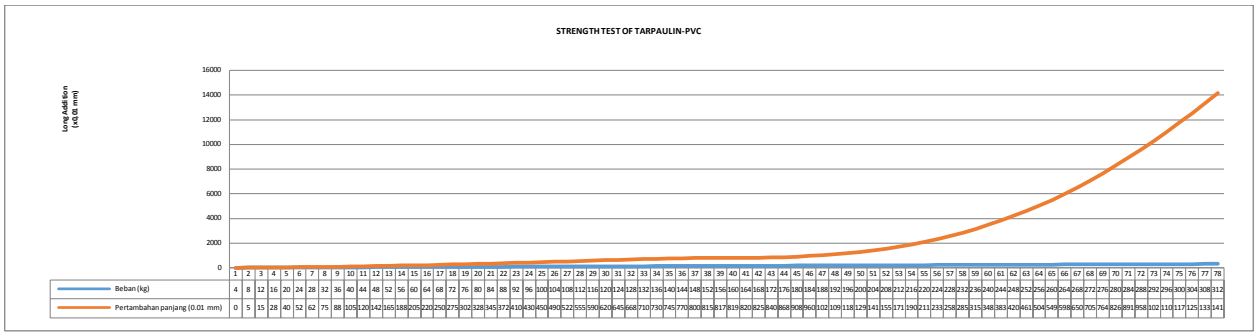


Figure 10: Load Test Graph for PVC Tarpaulin Fabric Material

The maximum strength of a tarpaulin pvc coated membrane with a thickness of 0.5 mm was achieved at a load of 312 kg for a surface area of 1 cm2

4.6. Testing solar photovoltaic energy

The test results of 4 solar panels each 100 wp are as follows:

Table 2: Testing the Current and Voltage of Photovoltaic Solar Panels Intensity

Time	Light (lux)	Weather	Current and Voltage of Solar Panel
09.00	73,000	Bright	13.2 A, 19.2 V
11.00	56,800	Bright	11.6 A, 18.8 V
13.00	60,700	Bright	12.8 A, 19 V
15.00	37,500	Cloudy	6.8 A, 17 V

In fine weather, 4 solar panels can produce a minimum of 11.6 Ampere 18 Volts, while when the weather is cloudy the current decreases to 6.8 Ampere 17 Volts. The electrical energy stored in the batterey can already be used to drive a

blower with a 550 Watt 220 volt voltage, this blower works to blow the inflatable stage roof for 6 minutes and empty the wind for 12 minutes.

5. CONCLUSION

The portable stage model and the independent energy inflatable stage roof are very suitable for the needs of the SME product marketing exhibition, this is due to the speed, ease and comfort of the building structure. Proven in Laboratory Tests and Field Tests, reliable results include tensile strength, roof material, tarpaulin, pvc coating, able to withstand up to 312 kg / cm2, portable stage installation 50 minutes, install inflatable roofs for 6 minutes and dismantling 10 minutes and reduce average temperature under a roof of 2.2^{o}C. Electrical energy needs for blowers and portable sound systems can be met by 4 panels of photovoltaic solar cells, in sunny weather it produces an electric current of 13.2 amperes, a voltage of 19.2 volts, so it does not require a generator or electricity. The portable stage building and the independent energy inflatable stage roof can become a broad model as a building that quickly builds independent energy. The use of tarpaulin and PVC materials is very flexible and strong so as to facilitate the process of transportation, installation and demolition, in a simple and easy to use packaging.

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