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New Method of Electric Sports Car Body Manufacturing Using Spraying Elastic Frame Fabric

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----------***ABSTRACT***----------
This research discusses about the manufacturing method of electric sports car's body. The contents of this study include literatures, research methods, and results. Focus of this research is on the technique of manufacturing electric sports car's body by spraying the body frame that has been coated with elastic fabric. Two types of fabrics will be used in this study namely lycra and oscar. Mold ring is used as a body frame and the elastic fabric to form the surface is then sprayed by resin to make it harder. After the elastic fabric hardened then fiberglass will be added to strengthen the material. Then tensile test and stress analysis are perfomed to find out the strength and suitability of material. From the test obtained that oscar fabric specimen has better strength than lycra fabric specimen with tensile stress 5 [49] Kg/mm² [MPa], 2.26% elongation, and von misses 5.147e+007 N/m² while lycra fabric with 4 [39] Kg/mm² [MPa] for tensile stress, 2.24% elongation, and von misses 4.083e+007 N/m². According to the experiment it can be conluded that this method only needs the cost around IDR 902,500.00 with easier and even faster for a car body manufacturing process.
KEYWORDS *- Body frame, Elastic, Fiberglass, Lycra fabric, Oscar fabric*

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I INTRODUCTION

Transport plays a crucial role in urban development by providing access for people to education, markets, employment, recreation, health care and other key service[1]. This has an impact on the increasing number of vehicles in the world. According to the data from WHO (World Health Organisation), between 2010 and 2013 there was a 16% increase in the number of registered vehicles in the world[2].

Data from the Association of Indonesian Automotive Industries (Gaikindo) and the Indonesian Motorcycle Industry Association (AISI) showed that the total number of motorized vehicles in Indonesia up to 2010 reached 50,824,128 units[3].

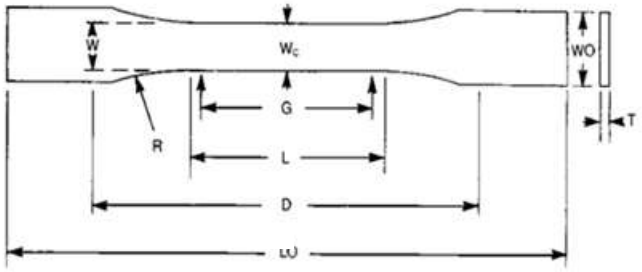
The continuous increase in vehicle volume will automatically affect air pollution. Global greenhouse gas emission is the main cause of global warming[4]. Decreased in air quality over the past few years shows us how important it is to promote emissions reductions by extension to industry and society or by conducting research for the implementation of emission reduction technologies[5].

One of the best ways to deal with this problem is to create cars with alternative fuels. The type of the alternative fuels can be electricity, gaseous energy carriers such as hydrogen and natural gas, liquid fuels such as ethanol, methanol, and biodiesel, and even solid energy carrier such as sugar[6]. The most interesting one is electric vehicle. In this modern era electric cars have become excellent in the automotive world for environmentally friendly and high engine efficiency, electric cars also have a lightweight and compact construction. Development of electric cars not only on the engine but on the body as well. Lightweight materials and efficient body manufacturing techniques will certainly be an important point in the development of the electric car itself. In the presidential regulation number 22 of 2017 set RUEN (Rencana Umum Energi Nasional) which was signed by President Jokowi on March 2, 2017 related to the national energy management planning. In appendix one of the RUEN at point (d) it reads, "increasing the efficiency of energy utilization". Therefore the researchers are interested to conduct the research of improving efficiency in the method of electric car body manufacturing.

The type of car chosen by the researchers is sportscar. This type of car is one of the most heavily customized types and is also usually made in limited number. Glass fibre is being used mostly for the sports car which includes Formula 1 cars. It is lighter than steel and aluminium, easy to be shaped and rust-proof. Furthermore, importantly, it is cheap to be produced in small quantity - it needs only simple tooling and a pair of hands[7].

II RESEARCH METHOD

Lightweight alternatives, however, have long been sought mainly to improve vehicle performance[8]. In this research the materials used are lycra fabric, oscar fabric, resin type polyester 157 BQTN commonly used in shipbuilding, matt fiber and catalyst *methyl ethyl ketone peroxide* (MEKP). Fabric materials and chemicas obtained from markets in Jakarta. Spray gun, compressor and mold ring are used to produce tensile test specimens. Spraying elastic frame is the method of this research. Two types of fabrics will be used in this study. Both have different characteristics that are lycra with water-absorbing properties and oscar with water-proof properties which is then be named lycra specimen and oscar specimen. Tensile test is one of the tests to determine the properties of a material. One of the most important goals of tensile testing is to determine the stress–strain curves of various materials[9]. Then stress analysis test is needed to determine the resistance of the material. Damage initiation and propagation in composite materials are of particular importance for the design, production, certification, and monitoring of an increasingly large variety of structures [10]. The manufacture of this tensile specimen will refer to ASTM D638 (specimen type III) and stress analysis will use Solidworks®.



W	= 19 mm	G	= 50 mm
L	= 57 mm	D	= 115 mm
WO	= 29 mm	LO	= 246 mm
G	= 50 m		

Figure 2. Standardization size for type I, II, III based on ASTM D638 [11]

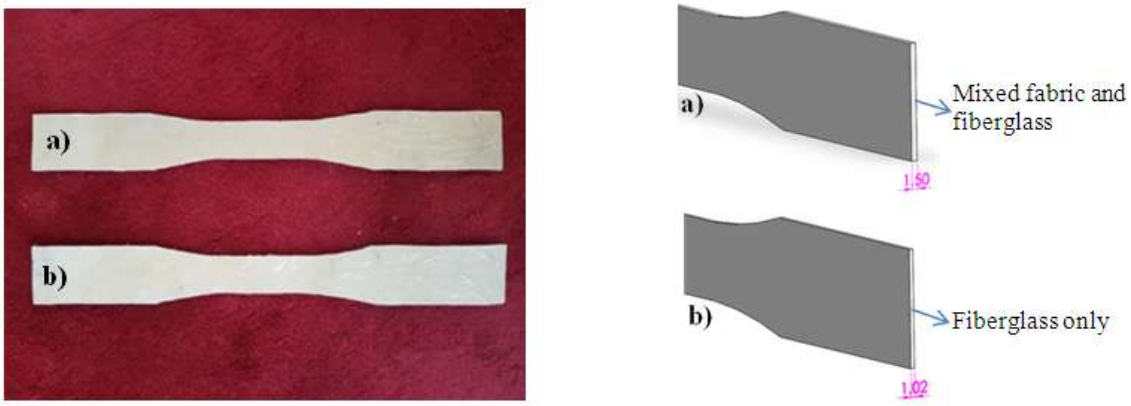


Figure 3. Manufacturing results lycra (a) and oscar specimen (b), Thickness of lycra (a) and oscar specimen (b)

Servopulser Shimadzu Ultimate Tensile Machine with tensile speed 0.05 mm/mm/ minute and capacity 20 ton is used for tensile test of this research. The test was performed at the Laboratory of tensile test of the Department of Metallurgical Engineering, Faculty of Engineering, University of Indonesia.

Stress analysis structural analysis is the corner stone of civil engineering and all students must obtain a thorough understanding of the techniques available to analyse and predict stress in any structure[12]. Stress analysis is essential to determine the material resistance. Researchers use Solidworks® application in order to find the result of this research.

III RESULT AND DISCUSSION

According to the purpose of this research that is to find the technique of manufacturing electric sports car body more efficient so it appears some result and discussion related to this research:

3.1 Which type of fabric is most appropriate for this research?

From the results of tensile tests that have been done on both specimens obtained results as shown in **Table 1** and **Fig. 4, 5 and 6**.

Table 1. Tensile test results of lycra and oscar specimen

Sample Code	Area (mm²)	Size Dimension (mm)	Gauge length (mm)	Tensile Stress (Kg/mm²) [Mpa]	Elongation (%)
Lycra Specimen	28.83	t = 1.50 w = 19.22	50	4[39]	2.24
Oscar Specimen	19.61	t = 1.02 w = 19.23	50	5[49]	2.26

**uncertainty measurement estimated by 95% accuracy and coverage factor K=2*
**multiplied by 9.8*

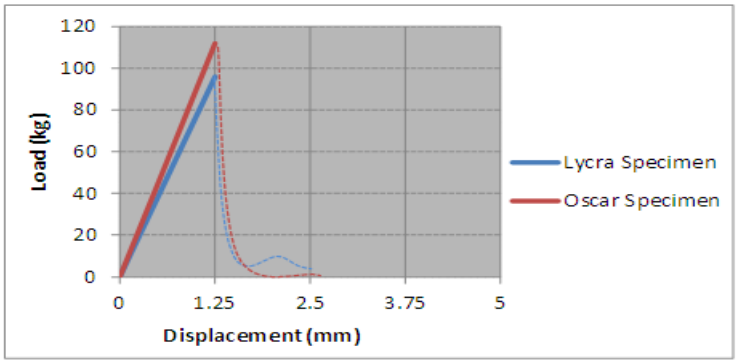


Figure 4. Tensile test graph of oscar and lycra specimen

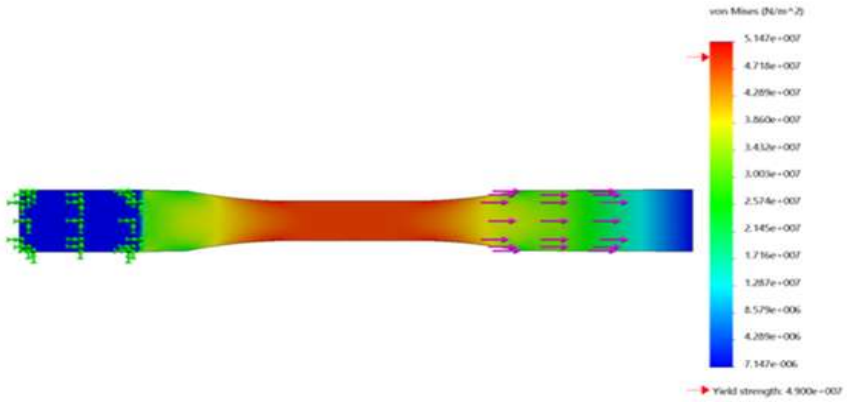


Figure 5. Stress analysis simulation of oscar specimen

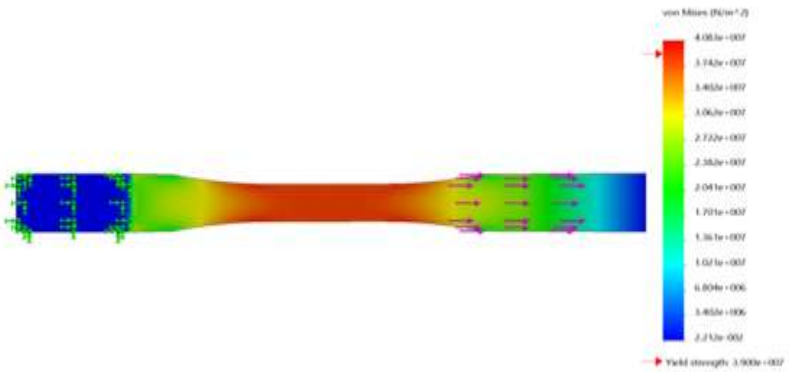


Figure 6. Stress analysis simulation of lycra specimen

From **Table 1** and **Fig. 5** of tensile test it can be seen that oscar spesimen has better strength than lycra specimen with tensile stress 5 [49] Kg/mm² [MPa] and 2.26% elongation while lycra fabric 4 [49] Kg/mm² [MPa] for tensile strees and 2.24% elongation. **Fig. 5** and **Fig. 6** show the results of von misses from stress analysis simulations for both specimens which are oscar 5.147e+007 N/m² and lycra 4.083e+007 N/m². This result shows that oscar with waterproof properties causes resin and fiberglass can be mixed perfectly then producing a stronger material and makes this fabric suitable for this research.

3.2 Is this method efficient in terms of time, cost and convenience?

Manufacturing proccess of electric sports car body by using this method becomes easier, cheaper and faster. From the results of the research showed that the process only takes less time including stretching the fabric to the frame, spraying, fiber installation and drying. The cost is also quite cheap because the average size of the car based on data from The CAIR Environmental Segmentation System (ESS) from Linda SE Opland's research about Size classification of passenger cars[13] is about 5x3m.

Table 2. Price forecasts for this method based on ESS data from Linda SE Opland

Materials	**Price per unit(Rp)**	**Quantity**	**Price (Rp)**
Oscar fabric	33.000/m	15 m	495,000
Matt Fiber	14.000/m	15 m	210.000
Resin 157 BQTN	32.000/kg	5 kg	160.000
Catalys	75.000/kg	0,5 kg	37.500
Total Price			**902.500**

According to **Table 2** achieved the total price for this research of electric sports car's body manufacturing process only need around IDR 902,500.00 for one electric car body with specification of tensile stress 5 [49] Kg/mm² [MPa], elongation 2.26%, 0.446 mm for max. total deformation and 16.75 MPa for max. equivalent stress.

IV CONCLUSION

Based on the results of this study can be concluded that the manufacture of electric sports car's body using this spraying elastic framework method becomes faster, easier and also cheaper. Oscar fabric is the best tool for this research because it's waterproof properties can make resin and catalys mixed perfectly to perform stronger material. The strength of the material can still be developed in the future.

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