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Design and Build of Electric Car Frame SULA Evolution

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ABSTRACT

This research is research and development. The purpose of this research is to make an electric car design drawing according to the national electric car race standards that have better dimensions and turbulence than the previous design. The method in designing an electric car frame is by observing and studying the literature. The results of data collection are selected and reviewed and a design is made according to standards. Supervise and evaluate so that design and manufacture are not much different. The results obtained in the design are (1) The design results in the manufacture of the Sula evolution electric car frame, there are two parts, namely the mainframe and the suspension frame. The frame is divided into several parts, namely the seat holder, battery holder, controller holder, and rollbar. While the suspension frame is the front arm and rear arm; (2) In the design of the Sula evolution electric car frame, the calculations carried out are using the Autodesk Inventor application and the formula in analyzing the results of the mainframe design for the Sula Evolution electric car, namely the calculation of the weight of the material based on the data taken from the design drawings made.

Keywords: Design, Electric Car, Frame

INTRODUCTION

The development of electric cars is increasing rapidly in following up on increasing air pollution. Electric cars are one of the vehicles without emissions which is an alternative to reduce air pollution [1].Added by [2] that electric cars have advantages and efficiency compared to fuel cars. Like cars that use fuel oil, electric cars are equipped with indicator panels that are used for information facilities for drivers to know the condition of the vehicle directly while driving so that the driver feels safe and comfortable and can take action correctly when something happens with his vehicle. Some of the advantages of an electric car with a car running on liquid fuel are the sound that is smooth, odorless, and free of smoke [3]. The current development of electric car technology causes experts to continue researching electric-based vehicles. One of the triggers for making electric cars is environmentally friendly and does not cause pollution and can reduce the use of oil (BBM) which is currently running low. The view of A. Guizani et all [4] that electric cars are cars of the future.

Electric car vehicles in Indonesia are experiencing rapid development, especially among college students, with the competition to make marketable vehicles. Added by Efendi and Azhis [5], one of the competitions held in Indonesia is the Shell Eco Marathon (SEM) Contest for the international level of higher education competitions, the Indonesia Energy Marathon Challenge (IEMC) for the National level, Indonesian Electric Car (KMLI), and Cars Energy Saving (KMHE).

Several studies regarding the design of an electric car show that the process of designing an electric car requires a car frame that functions as a support for all loads on the vehicle, for a frame construction itself must have a standard of strength, lightness and flexibility value [6]. Added by Anang [7] that electric cars must be effective and be the main solution in an effort to prevent environmental damage from vehicles using liquid fuel. That the world automotive market responds well to large-scale electric car manufacturing, this is because electric cars are more environmentally friendly than cars running on gasoline [8]. Added by Lilis [9] electric cars must also pay attention to and build an environmentally friendly concept.

Electric cars have become cars that have been developed with the concept of future vehicles [10]. Added by [11] Un-Noor et all that electric vehicles will replace vehicles that use a combustion motor. The use of electric vehicles prioritizes efficiency compared to vehicles using gasoline [12]. Manufacturers in various countries from time to time continue to develop electric cars [13]. Carley [14] explained that the development of electric cars must be

designed with a good planning system. Another aspect that needs to be developed in the future of electric cars is the battery source used [15]. Many universities have developed electric cars in order to develop environmentally friendly cars [16].

Several studies were performed to improve and optimize models of electric vehicles in order to obtain a more reliable and more efficient vehicle [17]. Burridge and Alahakoon [18] added that the design of car vehicles in either a kart or an electric car requires a construction that meets efficiency and safety standards. These design standards generally follow the category of the race that will be followed, for the sula car the standard evolution that will be followed is the Indonesian electric car competition from the Bandung State Polytechnic. The design must also pay attention to the placement parameters of the main components of an electric vehicle [19].

Based on the results of the 2019 KMLI competition, there are still a number of things that must be developed for the SULA'16 electric car, one of which is the vehicle frame. In the electric car frame SULA'16 has excessive capacity so that the vehicle speed is reduced. Therefore, the authors are interested in making second generation electric cars as a form of development of the SULA'16 electric car. The manufacture of SULA Evolution electric cars requires good planning including material selection and development of frame designs. The author takes the topic of a final project regarding the design of the design with the title "Order to Build an Electric Car Frame SULA Evolution in Subang State Polytechnic". The purpose of this research is to make an electric car design drawing according to the national electric car race standards that have better dimensions and turbulence than the previous design.

RESEARCH METHODS

This research is a type of development research from research conducted by the Subang State Polytechnic research team. The data obtained were analyzed qualitatively descriptive.

Observations were made at the Bandung State Polytechnic during the KMLI competition regarding the performance of the SULA '16 electric car as a development model. Other supporting data uses relevant research related to the design of an electric car. In the design design process using computer software, namely CAD software (Computer Aided Design). The type of CAD software used is Autodesk Inventor Professional 2018 software. At this stage after the author designs a technical drawing of the SULA evolution electric car frame, the design results are adjusted to ISO standards to provide certainty that they are appropriate and unsuitable for image

makers and readers in using the rules image according to standard.

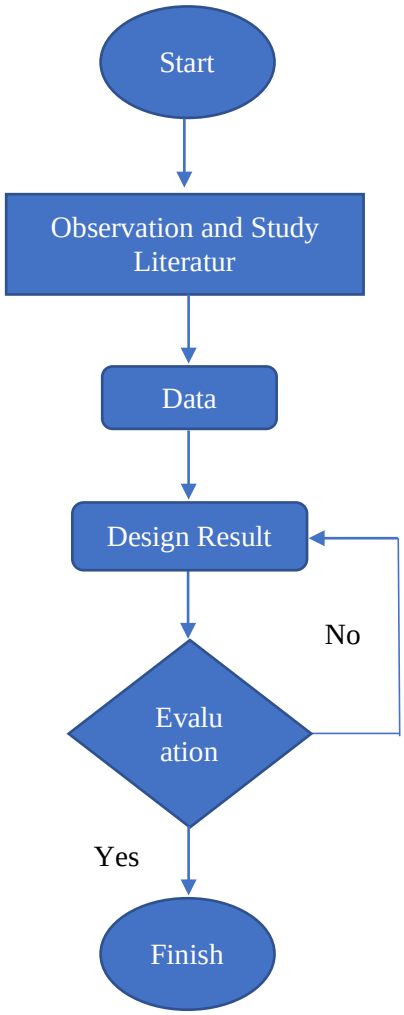


Figure 1. Flowchart of the design making process

The design results also conform to the KMLI Regulation model. After the design is in accordance with ISO standards and the design model is in accordance with KMLI, the design is given to the manufacturing department to manufacture the frame. The author oversees the production nets to match the designs that have been made if there is a change, then an evaluation is carried out. The evaluation process is very important to be carried out to help if there are errors in the manufacturing stage, for example the use of materials or materials that are different from the original plan and if adequate tools are not available. After making the design or making the outline of the car frame is complete, it is necessary to test the frame. This test is carried out for the purpose of knowing how much strength can be supported by the frame that has been made.

RESULT AND DISCUSSION

Observations

This observation was carried out to find information about electric cars. The initial method used was to study the entire SULA 16 electric car that had been previously made. This step was taken so that the authors know what things should be developed as the latest innovation for the Sula electric car. In addition, the observation method was also carried out when participating in the Indonesian Electric Car Competition which was held at the Bandung State Polytechnic by conducting a comparative study between SULA 16 cars and electric cars for KMLI participants from other educational institutions. Many observational data obtained, one of which is the design of an efficient and lightweight frame and is in accordance with the regulations for the 2019 KMLI competition at the Bandung State Polytechnic.

Figure 2. Research observation

Study Literature

The first step in the literature study process carried out by the author is to study the results of the final project report on the electric car SULA 16 which is available, especially the main frame design section and search for data and information about the frame design system in the form of written documents, images, and electronic documents about the material. Related to the final project report that the author made about the design of the main frame of the electric car SULA evolution. The results of the data obtained are the car length 1975 mm and width 1300 mm with a weight of 64 kg.

Data

The author got an idea to make an efficient frame by taking into account the weight of the car and the aerodynamics of an electric car. The data taken is as in Figure 4, where the car has a pipe diameter for making a small but strong body.

Design Results

The main frame design for the Sula Evolution electric car has been completed. A good design must have a clear picture with various points of view [19]. The following is an electric car design drawing when viewed from several views (projections):

1. Top View

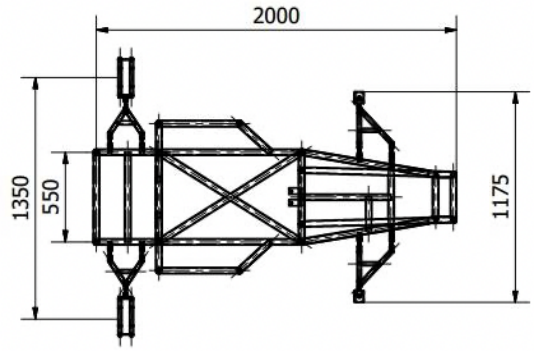


Figure 3. Top view

2. Right Side View

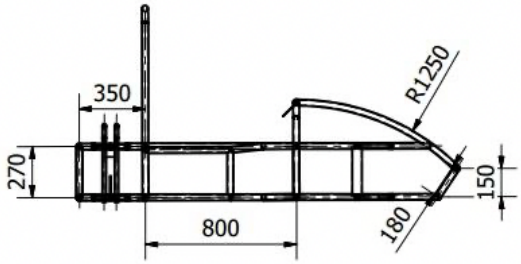


Figure 4. Right side view

3. Front Look

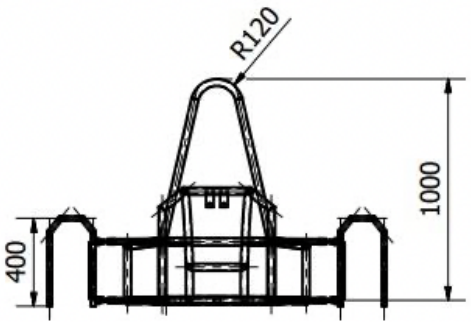


Figure 5. Front look

Electric Car Frame Comparison

Previously, electric cars were made by students of class 2016. Electric cars SULA'16 have a less efficient frame shape which affects the speed of the SULA'16 car. Therefore, in this final project the writer makes a more efficient frame design. Here's a comparison of the electric car Sula'16 and the electric car SULA evolution.

Table 1. Car frame comparison

SULA Electric Car'16	Evolutionary Sula Electric Car
Pipe diameter 25x2 mm	Pipe diameter 20x2mm
weight of the frame 64 kg	weight of the frame 24 kg
Manual Stering	Power Stering
Power 800 Watt	Power 1600 Watt

Table 2. Deficiency and advantages

Car Electric	Strengths	Weaknesses
Sula electric car'16	big maximum load wearing the body large steering angle	heavy frame heavy steering not ergonomic
evolutionary SULA electric car	faster light frame light steering ergonomic	bodiless small support load small steering angle

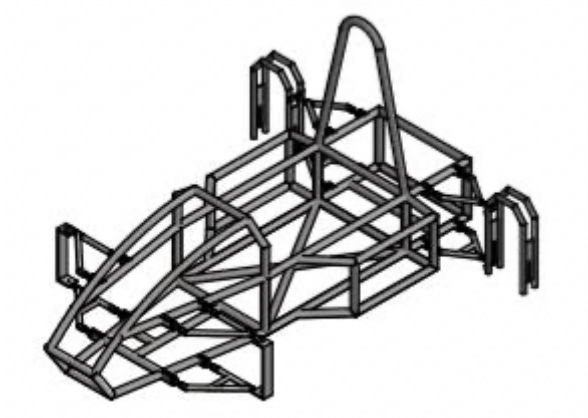


Figure 6. Projection skeleton

Main Frame

The main frame of this electric car is the main frame that will support the load from the driver and the components in an electric car, including: motor, battery, power stering, battery, and other electrical components. The main frame of the electric car is designed using a black iron type material with a size of 20 x 2 mm. added by Efendi [1] that in making the previous Sula car design, the car was too heavy so that it slows down the vehicle. On this basis, the second generation evolution sula design uses lighter dimensions and materials.

The main frame is designed with a length of 2000 mm and a width of 1350 mm. At several points, connections are made to add to the reinforcing structure of the frame with the aim of becoming stronger and stronger in accepting the load of the driver and the components in an electric car. The chassis of an electric vehicle greatly affects the performance of the vehicle [6].

Front Arm

The upper front arm is the main component of the Sula evolution electric car frame which functions as the main support for the knuckle mount. This component is made of galvanized pipe with a diameter of 20 with a semi triangular right angle. The size of the support pipe is 230 mm x 260 mm which is connected by the welding method

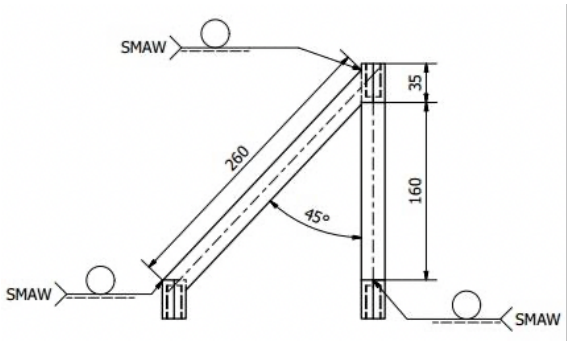


Figure 7. Front arm

Rear Arm

The lower rear arms are made of the same material and size as the upper front arms. The difference is added a support holder as a fulcrum for the shock absorber as a suspension component.

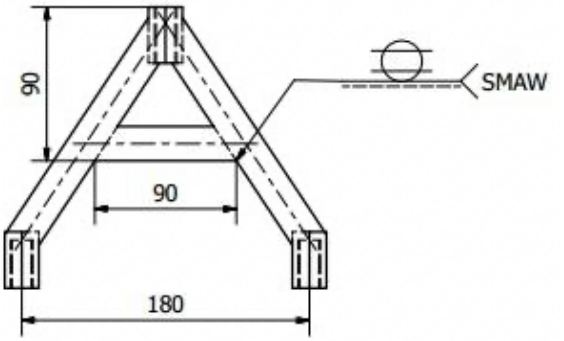


Figure 8. Rear arm

Design adjustments

At this stage, what the author is doing is making image adjustments by paying attention to ISO (International Organization for Standardization) standards. ISO standards that are considered include standard paper image sizes, line types, letter and number standards and writing of symbols. Adjustments were made to facilitate technical communication between the designer / image maker and the drawing user. In addition to adjusting ISO standards, the design results are also adjusted to the KMLI Regulation so that the design model created is the same as the KMLI regulations.

Table 3. Regulation of KMLI

Length	2200 mm
Wide	1250 mm
Weight	125 kg
Motor	2 KW
Brake	Hydraulic Disc
Steering Wheel	Tie Rods/Gear Box

Supervision of the Frame Making

Process supervision, the authors supervise the manufacturing process for making the frame related to design. If there are changes in the process of making the frame, the authors note the changes that occur. The changes are then evaluated by the authors so that the design and workmanship results.

Evaluation

In making the electric car frame the Sula evolution, there are several parts that have been changed from the design. Therefore, the authors evaluate the design to match the results of the framework that has been made. Here are some design changes to the Sula Evolution electric car.

In the battery holder there are changes in the construction of the Sula evolution electric car frame because the battery size is larger than the previous battery mount design. In the battery holder the position of the holder is forwarded 60mm with a length of 500mm, a champer length of 260mm with an angle of 45 °.

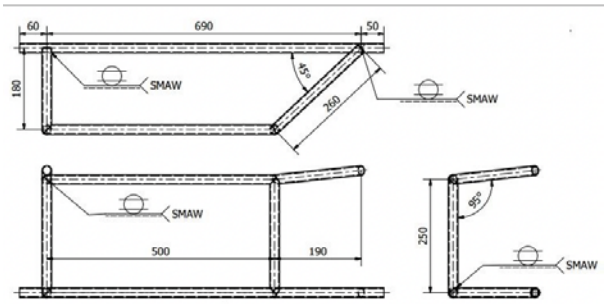


Figure 9. Evaluation of accu design

Material Weight Calculation

The calculation of the weight of the material is done by multiplying the volume of the material by the density of the material itself. In the electric car the Sula evolution material used is a 20 mm galvanized iron pipe. Iron has a requirement for its density of 7850 kg/m

1. Underframe

m = v . mj

m = (((1/4 . π . D^2) . I) . m) - (((1/4 . π . d^2) . I) . mj)

m = (((1/4 .3,14.0,020^2) .9,947) .7850) - (((1/4.3,14.0,016^2) .9,947) .7850)

m = 24,518 -15,692

m = 8,826 kg

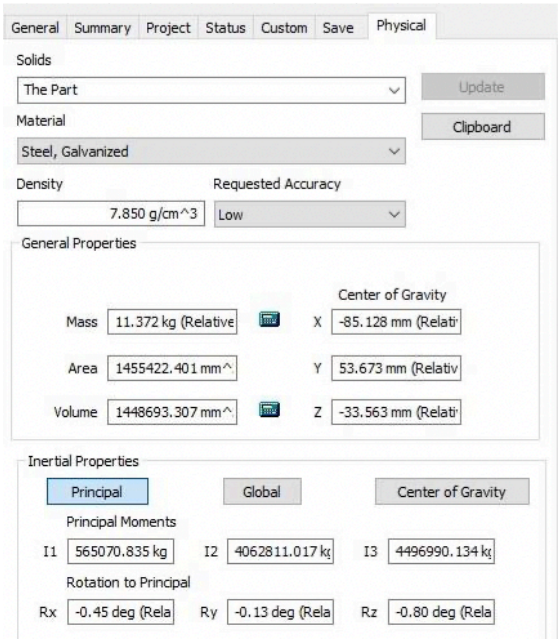
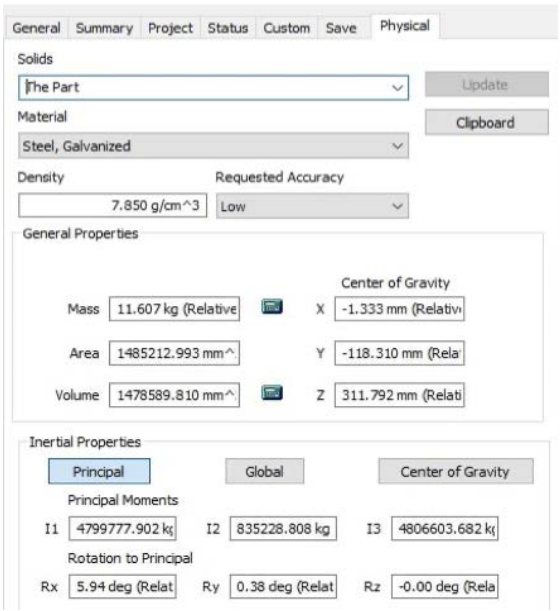


Figure 10. Underframe calculation

2. Top frame



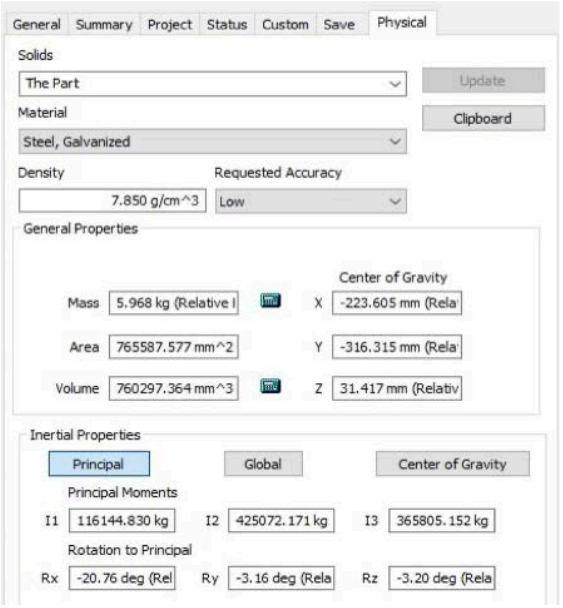


Figure 10. Top frame calculation

$m = v \cdot mj$

$m = (((1/4 \cdot \pi \cdot D^2) \cdot I) \cdot m) - (((1/4 \cdot \pi \cdot d^2) \cdot I) \cdot mj)$

$m = (((1/4 \cdot 3,14 \cdot 0,020^2) \cdot 9,868) \cdot 7850) - (((1/4.3,14.0,016^2) \cdot 9,868) \cdot 7850)$

$m = 24,324 - 15,567$

$m = 8,757$ kg

CONCLUSION

The conclusions obtained from the design of the Sula Evolution electric car are:

1. The design results in the manufacture of the Sula Evolution electric car frame have two parts, namely the main frame and the suspension frame. The frame is divided into several parts, namely the seat holder, battery holder, controller holder and rollbar. While the suspension frame is the front arm and rear arm.
2. In designing the Sula Evolution electric car frame, the calculations carried out are using the Autodesk Inventor application and the formula in analyzing the results of the main frame design for the Sula Evoution electric car, namely the calculation of the weight of the material based on the data taken from the design drawings made.

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