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Manufacturing and Testing Static of Rear Suspension System KMLI Car

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Abstract. The manufacture of the electric car rear suspension KMLI (Indonesian electric car competition) aims to make the suspension fit the regulations and suitable for use. The manufacture of suspension components from the suspension design uses solidwork software based on frame shapes and other components, then the engineering drawing process, the process plan, the preparation process, the manufacturing process, the component manufacturing process and the testing process. The test results for ground clearance without load are 230 mm and ground clearance testing for 125 kg load is 134 mm with a standard ground clearance of 100-170 mm. suspension. From the test results, the electric car rear suspension system can be said to be good and feasible to use.

INTRODUCTION

Kompetisi Mobil Listrik Indonesia (KMLI) is an activity held to test students' competence in designing and manufacturing safe, economical, and environmentally friendly vehicles. At KMLI, the vehicle design refers to the current four-wheeled vehicle design. The dimensions of the vehicle must comply with the established regulations which have a width of 120140 cm and a minimum weight of a vehicle without a driver of 125 kg. For the vehicle to be safe and comfortable, there are several aspects that the designer must pay attention to. Vehicles experience vibrations and shocks both due to the engine and due to bumpy and uneven road surface contours. To reduce vibration or shock, every vehicle must have a suspension system. The suspension system is a mechanism that is between the vehicle body and the wheels that serves to dampen vibrations, the suspension system must be strong enough to withstand static and dynamic loads from the passenger, chassis, and engine. Suspension system design is an important part of the overall vehicle design, it's determines the car's performance [1]. The suspension system on a vehicle is one of the important components of an active suspension system which is divided into 2 types, namely series and parallel types. The ideal suspension system can minimize deflection and vertical acceleration of the vehicle body which ensures safety and comfort in driving for a variety of road surface conditions [2]. In this research, the manufacture and testing of components of the rear suspension system of the KMLI car will be carried out. This study aims to obtain the physical form of the rear suspension system components and apply these components to the KMLI vehicle and to determine the feasibility of the rear suspension system of the KMLI namely the large suspension deflection and ground clearance distance. With the scope of the study, make the existing suspension mechanism with an independent double wishbone model and test the performance of the suspension system, namely the large ground clearance and large spring deflection.

METHODOLOGY

Doing the literature study to find out about the double wishbone coil spring suspension and KMLI car. Also studying the design and manufacture of the KMLI car frame that has been made in previous research and KMLI regulations as a reference and reference for designing an electric car suspension, After determining the suspension then do the manufacture of a double wishbone suspension, after all components are made then all components are assembled and the ground clearance and large deflection spring testing process is carried out with various loadings to determine the feasibility of the suspension mechanism that has been made.

Suspension Design

KMLI rear suspension is made with reference to the design of the densest suspension model in a racing car [3]. The design of the suspension system mechanism that will be made in this study is shown in Figure 1. The process of designing the rear suspension system of the KMLI car was carried out using Solidwork 2017 software.

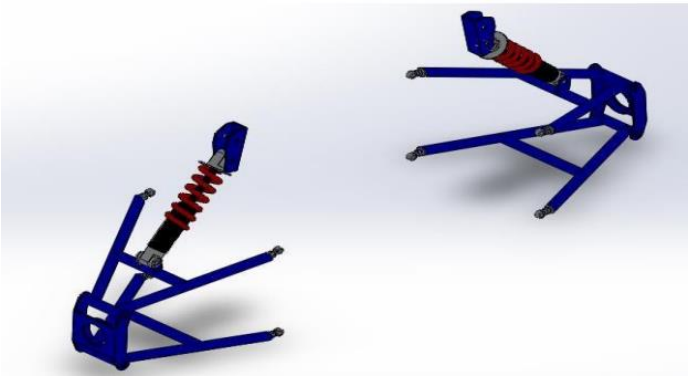

Figure 1. Racing Car Rear Suspension design

Modeling

The modeling is done with software to see if the designed mechanism can function properly. In addition, with the help of software, the size of each component also can be determined with an accurate modeling as shown in Figure 2.

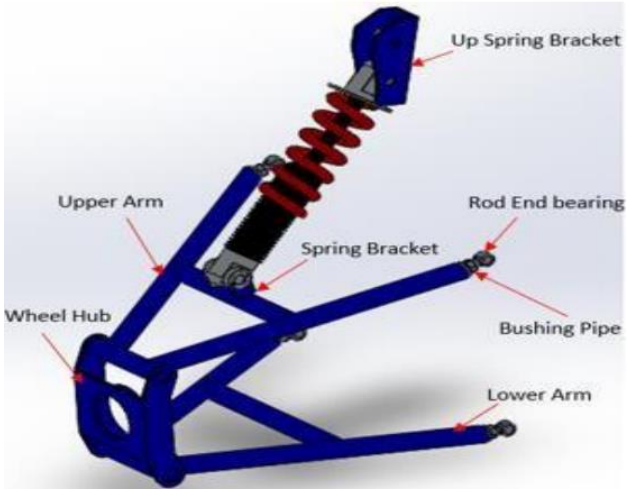

Figure 2. Components of The Rear Suspension

The modeling of the rear suspension system with this software is carried out by considering the use of standard components that available in the market so do not need to be made. Furthermore, the components that are designed and manufactured will follow and adjust to the dimensions of the standard components. This modeling is done with format of 3-dimensional images. The components of the rear suspension system of the KMLI and their assembly structure are shown in Figure 2. The rear suspension system of the KMLI car is composed of components; arm (lower and upper arm), bushing pipe arm, wheel hub, rod end bearing, spring bracket and shock absorber. Some of the components mentioned are already available in the market, while some other components are not available in the market. To get the components that are not yet available on the market, needs to do a manufacturing process.

The components that are already available in the market are rod end bearings (Figure 3) and shock absorbers (Figure 4), while the components that are not available in the market and must be manufactured are; wheel hub (Figure 5), bushing pipe arm (Figure 6), spring bracket (Figure 7), spring bracket (Figure 8), lower arm (Figure 9), and upper arm (Figure 10).

Figure 3. Road and Bearing

Figure 4. Shock Absorber

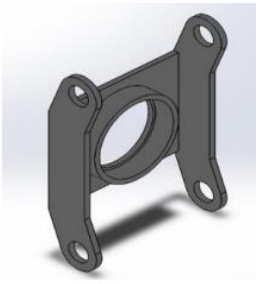

Figure 5. Wheel Hub

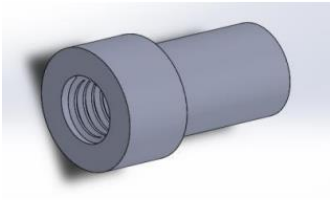

Figure 6. Bushing Pipe

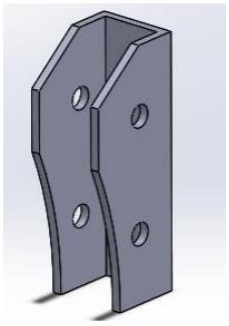

Figure 7. Spring Bracket

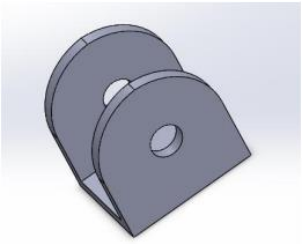

Figure 8. Spring Bracket

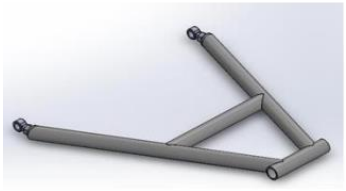

Figure 9. Lower Arm

Figure 10. Upper Arm

Component Manufacturing and Assembly

The manufacture of components that can't find on the market, begins with the manufacture of technical drawings. Then process planning for each component. At this stage, detailed preparation of the process stages is carried out, complete with process parameters, tools, and other necessary tools. The manufacture of components of the rear suspension system of KMLI cars, are arm wheel hub, bushing pipe arm, and spring bracket process that carried out between cutting, turning, perforating, threading, welding, and grinding processes. Together with the manufacturing process, a measurement process is also carried out to ensure that the finished components are of the correct size and do not cause problems during assembly. It can be seen in Figure 10 that is making the arm, Figure 11 is making the bushing pipes, Figure 12 is making the wheel hub, Figure 13 is making the spring bracket and Figure 14 is the pictures of the suspension that has been installed. The process of assembling or combining all components is carried out to get a rear suspension system device that can function according to its function as shown in Figure 14.

Figure 10. Making the Arm

Figure 11. Making the Brushing Pipe

Figure 12. Making the Wheel Hub

Figure 13. Making the Spring Bracket

Figure 14. Rear suspension that has been installed on the car frame

Testing Process

The process of making the rear suspension component on this KMLI electric car requires needs considerations and a careful working process so that the suspension can work optimally according to the function. To determine the performance and function of the suspension components, several tests were carried out to determine if the suspension components were feasible or not. Testing by applying a load to the chassis is shown in Figure 15 to obtain the vehicle's ground clearance (Figure 16) and the amount of spring deflection (Figure 17).

Figure 15. Loading Point

Figure 16. Ground Clearance Measurement

Figure 17. Spring Deflection Measurement

RESULTS AND DISCUSSION

Several parameters that need to be known to measure the performance of the rear suspension system of a KMLI car are ground clearance testing and spring deflection testing.

Ground Clearance Testing Results

After the testing, the results obtained ground clearance as shown in Figure 18. The results show the ground clearance at a maximum load of 125 kg is 134 mm, the results can be said to be feasible because the minimum ground clearance distance is 100170mm.

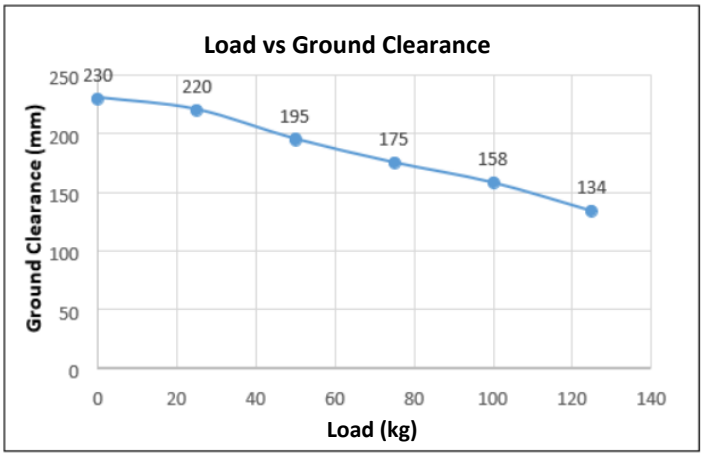

Figure 18. Graph of Ground Clearance Test Results vs Load

Spring Deflection Test and Shock Absorber Length Result

The deflection test on the suspension spring shows the results as shown in Figure 19. The results of testing the spring deflection on the rear suspension system when the load reaches 125 kg is 47 mm. In addition to testing to determine the spring deflection, the shock absorber on the rear suspension system of the KMLI car was also tested to determine the length of the shock absorber when it is under load. From the tests carried out, the results obtained as shown in Figure 20.

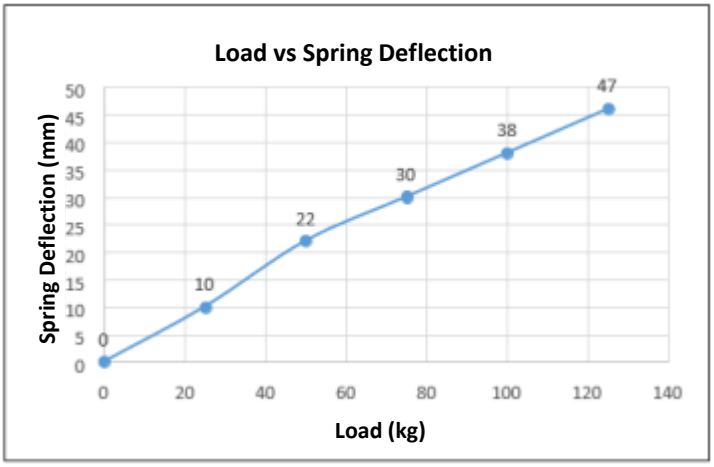

Figure 19. Graph of Spring Deflection Test Results vs Load

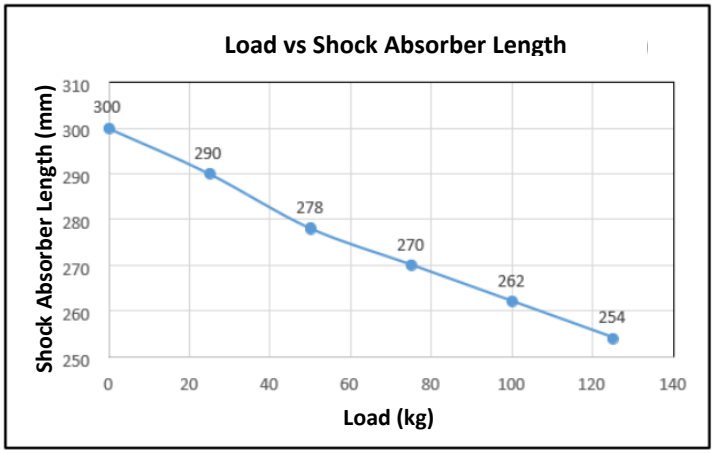

Figure 20. Shock Absorber Length Test Results

These results show that thef smallest shock absorber length that occurs at the time of maximum loading is 254 mm. The shock absorber used in this suspension system is a Yamaha mio shock absorber which has a maximum standard length of 310 mm, and a minimum standard length of 207 mm. From the tests that have been carried out on the spring at the beginning, when the condition is installed without a load, and when holding the maximum load, the data is obtained as shown in Table 1.

TABLE 1. Shock Absorber Comparison

No	Long (mm)	0.0	Minimum Length (mm)	Stroke (mm)
1	First	310		103
2	No Load	300	207	93
3	Full Load	254		47

From these data, it is known that the distance of the stroke at no load is 93 mm, while the distance of the stroke at full load is 47 mm. If you look at the standard working conditions of the Yamaha Mio shock absorber, where the minimum standard length is 207 mm, the shock absorber installed on the rear suspension system of the KMLI car can be said to be safe. It can be seen in table 1 that the minimum length of the shock absorber on the rear suspension system of a KMLI car when receiving a maximum load is 254 mm, still far from the standard minimum limit of 207 mm.

CONCLUSION

The conclusion that can be drawn from the results of the research is that the rear suspension system made for KMLI cars can function properly and is within safe limits. This can be seen from the ground clearance at no load and some loads and spring deflection tests at no load and some loads. The test results for ground clearance without a load are 230 mm, while ground clearance with a load of 125 kg is 134 mm. These results can be said to be feasible because of the standard ground clearance of 100-170 mm. The results of the spring deflection test without a load leave a step of 93 mm, while with a load of 125 kg it is 47 mm. These results are said to be feasible based on the Yamaha Mio shock absorber standard that is applied because it can work according to its function. So, it can be said that the suspension system made for this KMLI car is feasible to use.

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