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STATIC STRESS AND DEFORMATION ANALYSIS OF GANESHA PORTABLE ELECTRIC SCOOTER (E-GASPOL) FRAME USING SOLIDWORKS SOFTWARE

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Abstract

This study aims to determine and minimise static stress and increase the safety factor on the Electric Ganesha Scooter Portable (E-GASPOL) vehicle frame. The type of development research used is the R2D2 type (Reflective, Recursive, Design and Development). The data analysis technique used is the finite element method, this method can solve static problems. From the data of the static stress analysis results on the four designs, the results of the modified vehicle frame design 3 have the best value, namely obtaining a maximum stress value of 1,255 x 10^6N/m conditions without rider load, this result has a decrease of 58.55% from the standard design and with a rider load of 7,699x 10^6N/m, this result has a decrease of 58.56% from the standard design. The maximum displacement value was 1,453 x 10^{-3}mm in the condition without rider load, this result decreased by 77.718% from the standard design and with rider load it was 8,791 x 10^{-3}mm, this result decreased by 78.10% from the standard design. In this study, the smaller the stress and displacement values, the better the frame strength, so it can be concluded that the modified frame is better and stronger than the standard frame.

INTRODUCTION

Technological development has progressed a lot, one of which is electric-powered vehicles, from here various communities and researchers have developed many electric vehicles such as electric-powered scooters, electric-powered cars, semi-electric bicycles, and electric-powered motorbikes [1]. Therefore, it is necessary to make efforts to develop an electric-powered vehicle more widely, including efforts to develop an electric-powered car frame in supporting the load of the vehicle, a driver, and engine parts. in a car or motorbike, one of the parts that has an important meaning is a frame. It is said to have an important role because the frame part in this vehicle has the function of supporting the engine part, supporting a system from the Suspense, and the system on the electrical part [2], from this explanation then on a frame to function perfectly as usually a frame is to be strong so that it can support the frame itself and from the driver, engine and all its parts without any damage and without any change in the shape of the frame. The development of the design of many vehicles has progressed, where one of them is the result of the design of a frame with the help of software [3]. It is desirable to minimise human error and save costs incurred in the design process. From this, it is not necessary to make the actual frame in order to know the strength of the frame design results to be made, but thanks to the software will get more accurate data results than testing data directly without using software. By using software in the research process, in addition to being facilitated and can be done anywhere, it also does not require additional costs in the analysis process to determine the strength of the frame to be researched.

Researchers and a team of students from the Undiksha Mechanical Engineering Education Study Programme class of 2019 designed a two-wheeled vehicle with the name E-GASPOL (Electric Ganesha Scooter Portable), which is a two-wheeled scooter type vehicle with electric power. E-GASPOL is designed in such a way that this vehicle can be folded which allows the rider to store it in the trunk of a car or at home which certainly does not require a large space. In the design of the E-GASPOL electric vehicle frame, it is done from the chassis team by this student, where in the frame design there are various scales of iron sizes made of Galvanized Steel then assembled in such a way as to form a frame or frame which is classified as a type of backbone frame where this type uses one strong iron rod like the concept of a backbone frame. This frame is directly connected to the suspension, crater mount on other components [4],

but it is not yet known whether the designed frame using material from Galvanized Steel is able to meet safety standards to support the weight of the rider, if it can be assumed that the average mass of an adult is 70 kg, therefore it is necessary to have a more in-depth study in order to find out the results of the maximum and minimum static stress and to make it possible to modify the design of the standard frame shape of the E-GASPOL electric powered vehicle if the resulting static stress is too large.

Therefore, researchers are interested in conducting static stress analysis of the E-GASPOL vehicle frame using software assistance. With the help of software, it is easier for researchers to know the strength of the frame in withstanding the load (the load of the frame itself and the load of the rider) under study. Some research related to the analysis of frame strength with the help of software is research conducted by Budarma [5] who analysed the Static Stress on the Frame of Ganesha Electric Vehicles 1.0 Generation 1 Based on Continous Variable Transmission (Cvt) Assisted by Ansys 14.5 Software. Then research conducted by Muhammad Taufiq [6] on Strength Analysis of Waste Glass Hammer Mill Machine Frame Using Solidworks 2021. Therefore, to find out the static stress of the frame, the researcher plans to conduct a static stress analysis on the frame of the E-GASPOL (Electric Ganesha Scooter Portable) electric powered vehicle using software, where the software to be used is Solidwork 2019 premium. Solidwork 2019 software is a software with a design programme, which is widely used in making a product design, design of a machine part, design in construction, or other engineering activities. Solidwork 2019 software is equipped with various tools that can be used in calculations and design analyses such as stress, strain, temperature effects, or on air flow rates and other analyses [7].

This study will analyse the frame design of a standard E-GASPOL electric vehicle, E-GASPOL modification 1 E-GASPOL modification 2 and E-GASPOL modification 3. The purpose of the modification and static stress analysis of the E-GASPOL vehicle is to strengthen and improve the safety of the frame on the vehicle. For this reason, after the analysis process of the four designs, it will be determined which of the frame designs is the safest and most consistent in experiencing changes in static stresses that occur and changes in frames that undergo deformation / displacement (changes in shape due to the force / force applied), therefore solidwork 2019 software is used.

RESEARCH METHODS

The research conducted is classified into the type of research and development, or commonly called Research and Development (R&D) which is defined as a process or steps defined as a process or stages to develop new products or improve existing products. Products in this context do not necessarily mean hardware, but can also mean software [8]. R&D research is basic research that gathers information about user needs that is under development to make products and test their effectiveness. In this research using the R2D2 (Reflective, Recursive, Design and Development) type of development model in this type of development model is used in improving a function in an existing type of model with additional parts to get an increase in quality to achieve a goal [9].

In the research process, the data analysis technique used is the finite element method. The method is used because it can solve static, dynamic, linear and non-linear problems. What is meant by this type of method is a numerical method that has been used in solving a problem that includes engineering, structural analysis, stress analysis, heat transfer and mass, analysing data about changes in shape due to deformation, pressure and fluid velocity [10]. This research method is used in determining the problem of deflection problems and stress data that has been obtained to be held by the E-GASPOL electric vehicle frame and the strength of the materials used in the E-GASPOL electric vehicle frame.

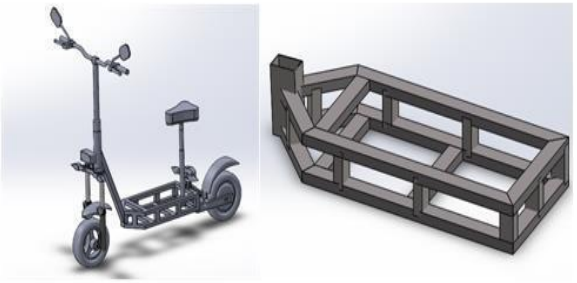


Figure 1. Frame Design (Elektric Ganesha ScooterPortable) E-GASPOL Standard Condition

In this study, a static stress analysis will be carried out which will determine the location of the maximum and minimum static stress distribution on the E-GASPOL frame (elektric ganesha scooter portable) where the material of the frame itself uses galvanized steel in solidworks 2019 Premium software so that it can be seen the static stress distribution that occurs on the standard modelling E-GASPOL electric vehicle frame and the modified modelling E-GASPOL electric vehicle frame with the addition of a predetermined load.

RESULT AND DISCUSSION

3.1 Data Analysis Results of E-GASPOL Vehicle Frame Design

3.1.1 Data from Simulation Analysis of Standard Frame Design Static Stresses in Unloaded Condition (Rider Load)

The static stress distribution process that occurs in the standard frame design conditions without being given loading (rider load, frame mass is taken into account) where the weight of the frame itself is 13.34 Kg. If converted to the amount of force (Newton), the force exerted is 130.82 N. The analysis results can be seen in Figure 2.

W = m x g----------(1)

= 13,340 kg x 9,8 m/s^2

= 130,82 N

Description :

W = weight of the object (N)

m = mass of the object (kg)

g = gravitational acceleration (m/s^2)

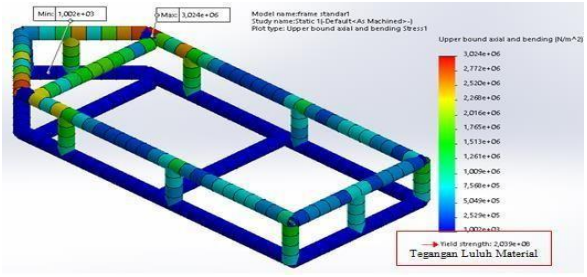


Figure 2. Results of the Distribution of Standard FrameDesign Static Stress Values in the Unloaded Condition (Rider Load)

The results of the maximum static stress simulation data for conditions without a rider load (shown in red) weighing 130,82 N are 3,024 x 10^6 N/m^2, for the minimum static stress shown in blue, namely with the analysis results of 1,002 x 10^3 N/m^2. Based on the yield stress value of the material used, namely Galvanized Steel of 2,039 x 10^8 N/m^2, therefore the results obtained that the structure is confirmed to be able to withstand the load given.

From the results of the static analysis of the standard frame without rider load, the maximum displacement or deformation (change in shape of the object subjected to force) value is 6,521 x 10^{-3} mm. The analysis results can be seen in Figure 3.

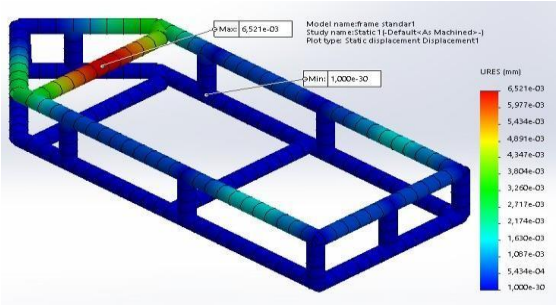


Figure 3. Deformation/Displacement Value of StandardFrame without Rider Load Condition

3.1.2 Data from simulation analysis of static stress of standard frame design under loading condition (rider load)

The static stress distribution process that occurs in the standard frame due to the rider load. Which means the force exerted on the frame is the mass of the frame of 13.34 kg plus the rider load of 70 kg. Thus the total load exerted on the standard frame is 83.34 kg or if converted into the amount of force (Newton) then the mass exerted is 817.28 N. The analysis results can be seen in Figure 4.

W = m x g

= 83,34 kg x 9,8 m

= 817,28 N

Description :

W = weight of the object (N)

m = mass of the object (kg)

g = gravitational acceleration (m/s^2)

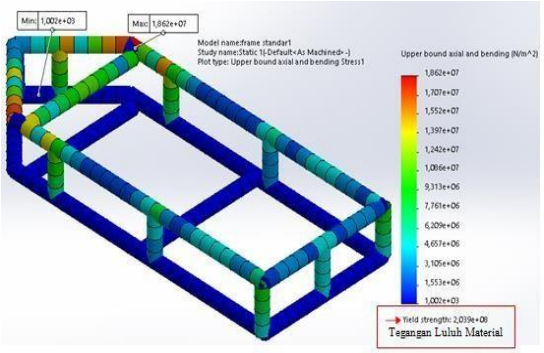


Figure 4. Results of the Distribution of Statical Stress Values of the Standard Frame Design Under Load (RiderLoad)

The results of the maximum static stress simulation data for conditions without a rider load (shown in red) weighing 817,28 N, which is 1,862 x 10^7 N/m^2, for the minimum static stress shown in blue, namely with the analysis results of 1,002 x 10^3 N/m^2. Based on the yield stress value of the material used, namely Galvanized Steel of 2,039 x 10^8 N/m^2, therefore the results obtained that the

structure is confirmed to be able to withstand the load given.

From the results of the static analysis simulation of the standard frame with a rider load, the displacement value is obtained or it can be said that the deformation (change in shape on an object subjected to force) is shown in red with a maximum of 4,015 x 10^{-2} mm. The analysis results can be seen in Figure 5.

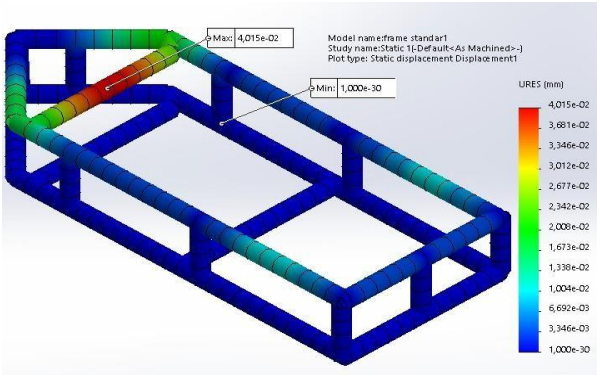


Figure 5. Displacement Value of Standard ConditionFrame Design with Rider Load

Table 1. Data from the Simulation Analysis of the Static Stresses of the Standard Frame Design Under No Load and With Rider Load Conditions

	Tegangan Maksimum	Tegangan Minimum	Deformasi / displacement
Tanpa Beban Pengendara	3,024 x 10^{7} N/m^2	1,002 x 10^{3} N/m^2	6,521 x 10^{-2} mm
Dengan Beban Pengendara	1,862 x 10^{7} N/m^2	1,002 x 10^{3} N/m^2	4,015 x 10^{-2} mm
Persentase peningkatan/ penurunan	Terjadi peningkatan tegangan maksimum sebesar 83,76% ketika diberi pembebanan (beban pengendara)	Tidak terjadi Peningkatan ketika diberi pembebanan (beban pengendara)	Terjadi Peningkatan Deformasi / displacement sebesar 83,76% ketika diberi pembebanan (beban pengendara)

3.1.3 Data from Simulation Results of Static Stress Analysis of Modified Frame Design 1 Condition without loading (Rider Load)

The static stress distribution process that occurs in the modified frame design 1 condition without being given loading (rider load, frame mass is taken into account) where the mass of the frame itself is 13.34 Kg. If converted to the amount of force (Newton), the force applied is 130.82 N. The analysis results can be seen in Figure 6.

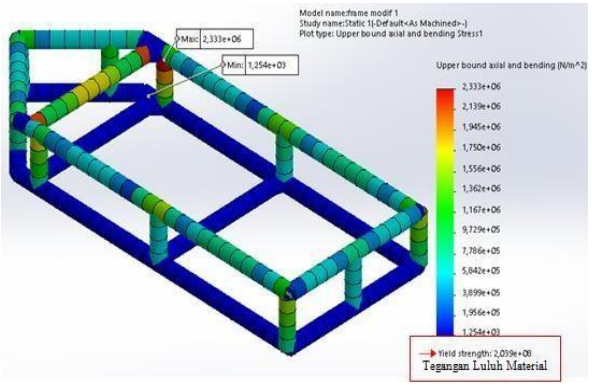


Figure 6. Results of the distribution of static stress valuesof Modified Frame Design 1 without loading (rider load)

The simulation data results of maximum static stress conditions without a rider load (shown in red) weighing 130,82 N are 2,333 x 10^{6} N/m^2, for the minimum static stress shown in blue, namely with the analysis results of 1,254 x 10^{3} N/m. Based on the yield stress value of the material used, namely Galvanized Steel of 2,039 x 10^{8} N/m^2, therefore the results obtained that the structure is certainly able to withstand the load given.

From the data of the simulation results of the static analysis of the modified frame 1 condition without rider load, the maximum displacement value or deformation (change in shape on objects subjected to force) is shown in red as 3,627 x 10^{-3} mm. The analysis results can be seen in Figure 7.

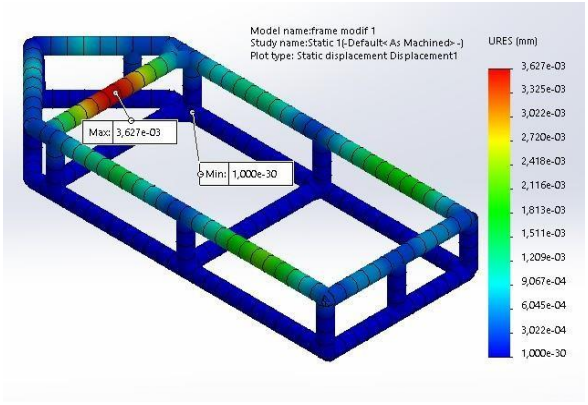


Figure 7. Deformation/Displacement Value of ModifiedFrame 1 No Rider Load Condition

3.1.4 Data from Simulation Results of Static Stress Analysis of Modified Frame Design 1 Condition Under Loading (Rider Load)

The static stress distribution process that occurs in the modified frame design 1 due to loading (rider load). Which means the force exerted on the frame is the mass of the frame of 13.34 kg plus the rider load of 70 kg. thus the total load exerted on the frame modification 1 is 83.34 kg or if converted into the amount of force (Newton) then the mass exerted is 817.28 N. The analysis results can be seen in Figure 7..

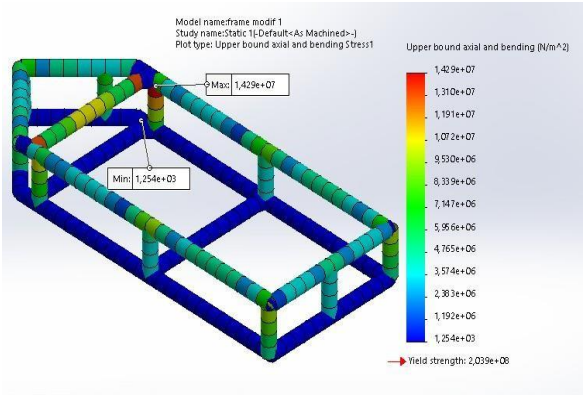


Figure 7. Results of Modified Frame 1 static stressvalue distribution with rider load

The results of the maximum static stress simulation data for conditions without a rider load (shown in red) weighing 817.28 N are 1,429 x 10^7 N/m^2, for the minimum static stress shown in blue, namely with the analysis results of 1,254 x 10^3 N/m^2. Based on the yield stress value of the material used, namely Galvanized Steel of 2,039 x 10^8 N/m^2, therefore the results obtained that the structure is certainly able to withstand the load given.

From the data of the simulation results of the static analysis of the modified frame 1 condition given a load (rider load), the maximum displacement or deformation (change in shape on objects subjected to force) value is 2,232 x 10^{-2} mm. The analysis results can be seen in Figure 8.

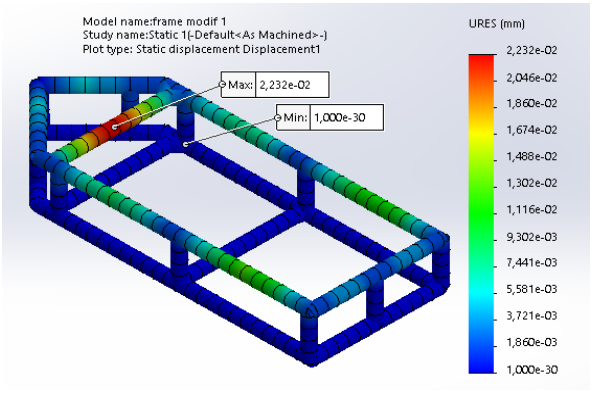


Figure 8. Deformation/Displacement Value of ModifiedFrame 1 Condition with Rider Load

Tabel 2. Simulation Result Data of Static Stress Analysis of Modified Frame Design 1 Without Load and With Rider Load

	Maximum Stress	Minimum Stress	Deformation / displacement
Unburdened Riders	2,333 x 10^6 N/m^2	1.254 x 10^3 N/m^2	3,627 x 10^{-3} mm
With Rider Load	1,429 x 10^7 N/m^2	1,254 x 10^3 N/m^2	2,232 x 10^{-2} mm
Percentage of increase/ decrease	There was a maximum stress increase of 83.67% when given loading (rider load)	No Increase when given loading (rider load)	Increased Deformation / displacement of 83.75% when given loading (rider load)

3.1.5 Data from Simulation Results of Static Stress Analysis of Modified Frame Design 2 Condition without loading (Rider Load)

The static stress distribution process that occurs in the modified frame design 1 condition without being given loading (rider load, frame mass is taken into account) where the mass of the frame itself is 13.34 Kg. If converted to the amount of force (Newton), the force applied is

130.82 N.The analysis results can be seen in Figure 9.

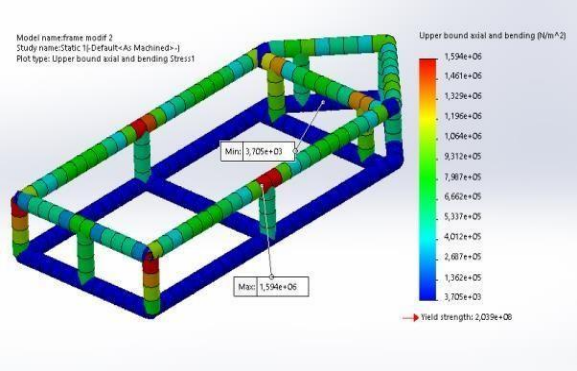


Figure 9. Results of the distribution of static stress valuesof Modified Frame Design 2 without loading (rider load)

The simulation data results of maximum static stress conditions without a rider load (shown in red) weighing 130,82 N are 1,594 x 10^6 N/m^2, for the minimum static stress shown in blue, namely with the analysis results of 3,705 x 10^3 N/m. Based on the yield stress value of the material used, namely Galvanized Steel of 2,039 x 10^8 N/m^2, therefore the results obtained that the structure is certainly able to withstand the load given.

From the data of the simulation results of the static analysis of the modified frame 2 condition without rider load, the maximum displacement value or deformation (change in shape on objects subjected to force) is shown in red as 2,214 x 10^{-3} mm. The analysis results can be seen in Figure 10.

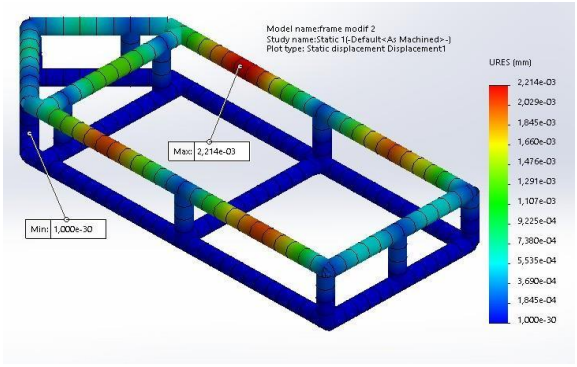


Figure 10. Deformation/Displacement Value of ModifiedFrame 2 No Rider Load Condition

3.1.6 Data from Simulation Results of Static Stress Analysis of Modified Frame Design 2 Condition Under Loading (Rider Load)

The static stress distribution process that occurs in the modified frame design 2 due to loading (rider load). Which means the force exerted on the frame is the mass of the frame of 13.34 kg plus the rider load of 70 kg. thus the total load exerted on the frame modification 1 is 83.34 kg or if converted into the amount of force (Newton) then the mass exerted is 817.28 N. The analysis results can be seen in Figure 11.

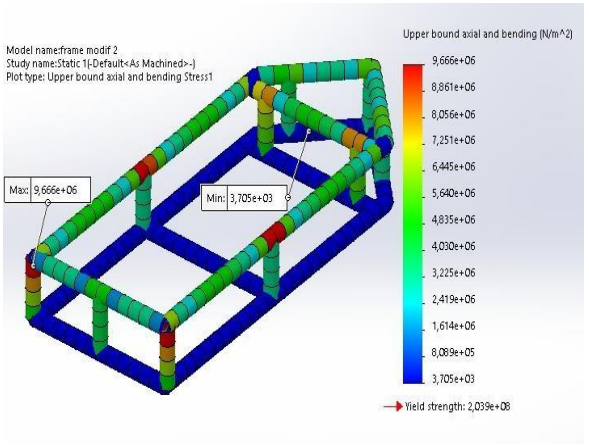


Figure 11. Results of Modified Frame 2 static stress value distribution with rider load

The results of the maximum static stress simulation data for conditions without a rider load (shown in red) weighing 817.28 N are 9,666 x 10^6 N/m^2, for the minimum static stress shown in blue, namely with the analysis results of 3,705 x 10^3 N/m^2. Based on the yield stress value of the material used, namely Galvanized Steel of 2,039 x 10^8 N/m^2, therefore the results obtained that the structure is certainly able to withstand the load given.

From the data of the simulation results of the static analysis of the modified frame 2 condition given a load (rider load), the maximum displacement or deformation (change in shape on objects subjected to force) value is 1,340 x 10^{-2} mm. The analysis results can be seen in Figure 12.

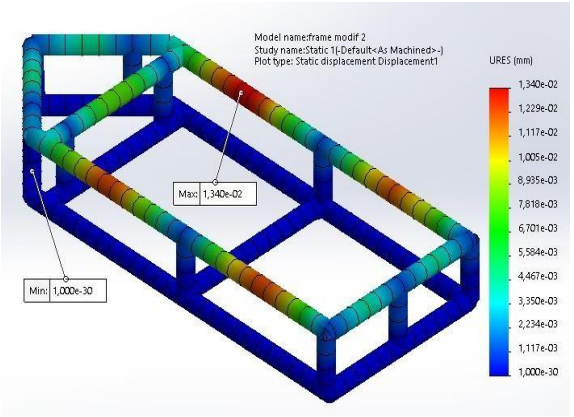


Figure 12. Deformation/Displacement Value of ModifiedFrame 2 Condition with Rider Load

Tabel 3
Simulation Result Data of Static Stress Analysis of Modified Frame Design 2 Without Load and With Rider Load

	Maximum Stress	Minimum Stress	Deformation/ displacement
Unburdened Riders	1,591 x 10^6 N/m^2	3,705 x 10^3 N/m^2	2,214 x 10^{-3} mm
With Rider Load	9,666 x 10^6 N/m^2	3,705 x 10^3 N/m^2	1,340 x 10^{-3} mm
Percentage of increase/ decrease	There was a maximum stress increase of 83,58% when given loading (rider load)	No Increase when given loading (rider load)	Increased Deformation /displacement of 81,57% when given loading (rider load)

3.1.7 Data from Simulation Results of Static Stress Analysis of Modified Frame Design 3 Condition without loading (Rider Load)

The static stress distribution process that occurs in the modified frame design 3 condition without being given loading (rider load, frame mass is taken into account) where the mass of the frame itself is 13.34 Kg. If converted to the amount of force (Newton), the force applied is 130.82 N. The analysis results can be seen in Figure 13.

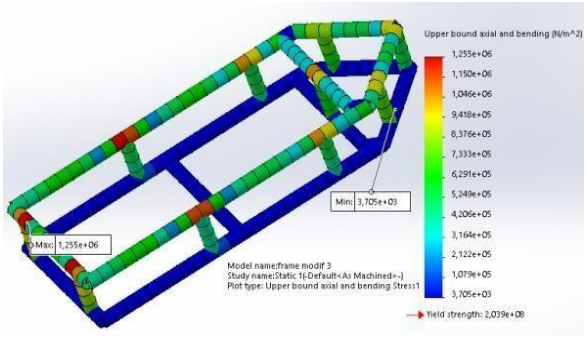


Figure 13. Results of the distribution of static stress values of Modified Frame Design 3 without loading (rider load)

The simulation data results of maximum static stress conditions without a rider load (shown in red) weighing 130,82 N are 1,255 x 10^6 N/m^2, for the minimum static stress shown in blue, namely with the analysis results of 3,705 x 10^3 N/m. Based on the yield stress value of the material used, namely Galvanized Steel of 2,039 x 10^8 N/m^2, therefore the results obtained that the structure is certainly able to withstand the load given.

From the data of the simulation results of the static analysis of the modified frame 3 condition without rider load, the maximum displacement value or deformation (change in shape on objects subjected to force) is shown in red as 1,453 x 10^{-3} mm. The analysis results can be seen in Figure 14.

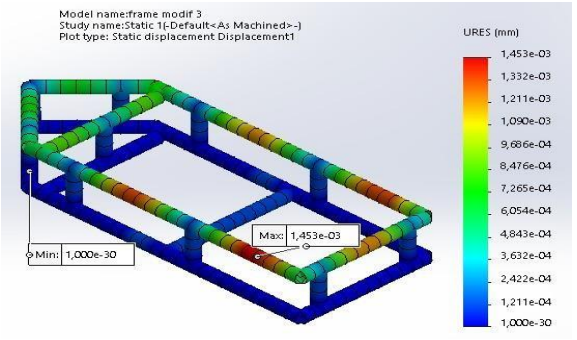


Figure 14. Deformation/Displacement Value of Modified Frame 1 No Rider Load Condition

3.1.8 Data from Simulation Results of Static Stress Analysis of Modified Frame Design 3 Condition Under Loading (Rider Load)

The static stress distribution process that occurs in the modified frame design 3 due to loading (rider load). Which means the force exerted on the frame is the mass of the frame of 13.34 kg plus the rider load of 70 kg. thus the total load exerted on the frame modification 1 is 83,34 kg or if converted into the amount of force (Newton) then the mass exerted is 817,28 N. The analysis results can be seen in Figure 15.

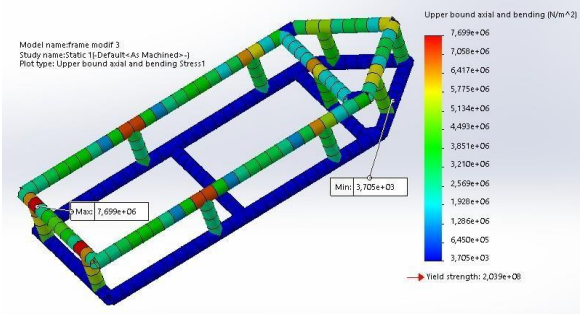


Figure 15. Results of Modified Frame 3 static stress value distribution with rider load

The results of the maximum static stress simulation data for conditions without a rider load

(shown in red) weighing 817.28 N are 7,699 x 10^6 N/m^2, for the minimum static stress shown in blue, namely with the analysis results of 3,705 x 10^3 N/m^2. Based on the yield stress value of the material used, namely Galvanized Steel of 2,039 x 10^8 N/m^2, therefore the results obtained that the structure is certainly able to withstand the load given

From the data of the simulation results of the static analysis of the modified frame 1 condition given a load (rider load), the maximum displacement or deformation (change in shape on objects subjected to force) value is 8,791x 10^{-3} mm. The analysis results can be seen in Figure 16.

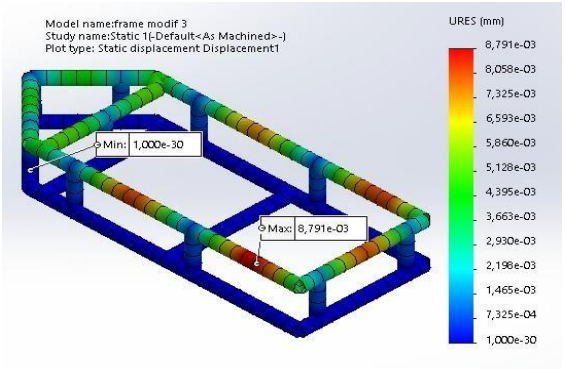


Figure 16. Deformation/Displacement Value of Modified Frame 3 Condition with Rider Load

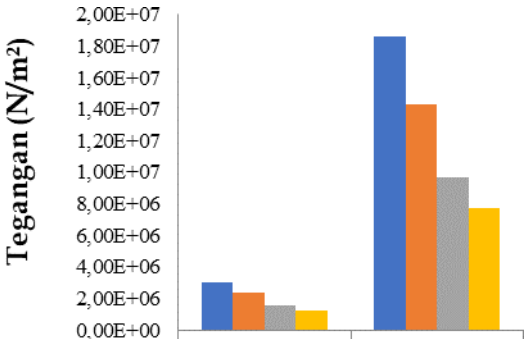
Tabel IV
Simulation Result Data of Static Stress Analysis of Modified Frame Design 1 Without Load and With Rider Load

	Maximum Stress	Minimum Stress	Deformation / displacement
Unburdened Riders	1,255 x 10^6 N/m^2	3,705 x 10^3 N/m^2	1,453 x 10^{-3} mm
With Rider Load	7,699 x 10^6 N/m^2	3,705 x 10^3 N/m^2	8,791 x 10^{-3} mm
Percentage of increase/ decrease	There was a maximum stress increase of 83,70% when given loading (rider load)	No Increase when given loading (rider load	Increased Deformation /displacement of 83.75% when given loading (rider load)

3.2 Comparison of Data Analysis Results of Standard and Modified E-GASPOL Vehicle Frames

3.2.1 Comparison of Maximum Static Stress Results of Standard Frame Design with Modifications 1, 2, and 3

The results that have been obtained from the static stress analysis simulation tests carried out on the standard and modified E-GASPOL vehicle frames, the maximum static stress values are obtained as follows:



	Tanpa Beban Pengendara	Dengan Beban Pengendara
Standar	3,02E+06	1,86E+07
Modifikasi 1	2,33E+06	1,43E+07
Modifikasi 2	1,59E+06	9,67E+06
Modifikasi 3	1,26E+06	7,70E+06

Figure17. Comparative Graph of Maximum Stress of Standard Frame, Modification 1, Modification 2, and Modification 3

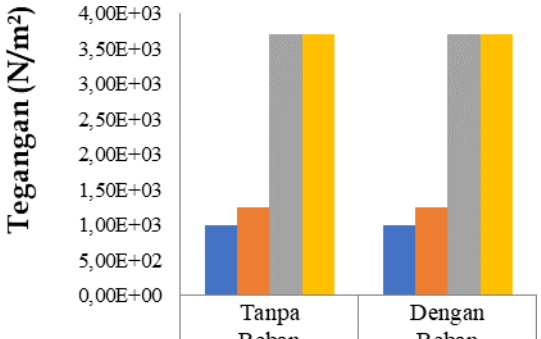
Seen in Figure 17, it is known that after analysing the 4 frames, namely the standard E-GASPOL frame, modifications 1, 2, and 3 with variations without rider load, as well as on the condition frame with rider load.

1. The maximum stress results on the modified frame 1 without rider load conditions decreased by 22,853% and with rider load conditions increased by 23,255% from the standard E-GASPOL frame.
2. The maximum stress results on the modified E-GASPOL frame 2 condition without rider load decreased by 47,457% and the condition with rider load by 47,954%.
3. The maximum stress result on the modified E-GASPOL frame 3 condition without rider load decreased by 58.554% and the condition with rider load by 58.562%.

This result we can conclude that the smaller the value of the stress result we get on a frame, the better the strength of a frame.

3.2.2 Comparison of Minimum Static Stress Result Data of Standard Frame Design with Modification 1, 2, 3

The results that have been obtained from the static stress analysis simulation tests that have been carried out on the standard and modified E-GASPOL vehicle frames, the minimum static stress values are obtained as follows:



	Tanpa Beban Pengendara	Dengan Beban Pengendara
Standar	1,00E+03	1,00E+03
Modifikasi 1	1,25E+03	1,25E+03
Modifikasi 2	3,71E+03	3,71E+03
Modifikasi 3	3,71E+03	3,71E+03

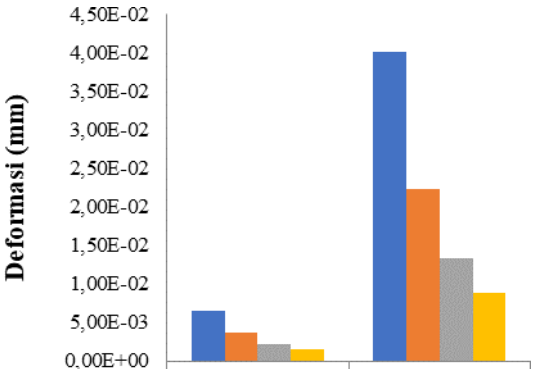
Figure 18. Comparative Graph of Minimum Stress of Standard Frame, Modification 1, Modification 2, and Modification 3

From Figure 18 above, it can be seen that after analysing the 4 frames, namely the standard E-GASPOL Frame, modifications 1, 2, and 3 with variations without rider load, and with rider load.

1. The minimum stress results in the modified frame 1 condition without rider load and the condition with rider load both increased by 25.150% from the standard E-GASPOL frame.
2. The minimum stress results on the modified E-GASPOL frame 2 condition without rider load and the condition with rider load both increased by 269.760%.
3. The minimum stress results on the modified E-GASPOL frame 3 in the condition without rider load and the condition with rider load both increased by 269.760.%.

3.2.3 Comparison of Maximum Deformation/Displacement Result Data of Standard Frame Design with Modification 1, 2, and 3

The results that have been obtained from the deformation/displacement analysis simulation test previously carried out on the standard E-GASPOL vehicle frame, modifications 1, 2, and 3, the maximum static stress values are obtained as follows:



	Tanpa Beban Pengendara	Dengan Beban Pengendara
Standar	6,52E-03	4,02E-02
Modifikasi 1	3,63E-03	2,23E-02
Modifikasi 2	2,21E-03	1,34E-02
Modifikasi 3	1,45E-03	8,79E-03

Figure 19. Comparative Graph of Deformation/Displacement of Standard Frame, Modification 1, Modification 2, and Modification 3

From Figure 19 above, it can be seen that after analysing the 4 frames, namely the standard E-GASPOL Frame, modifications 1, 2, and 3 with variations without rider load, and with rider load.

1. The maximum deformation/displacement results on the modified frame 1 condition without rider load decreased by 44.380% and the condition with rider load increased by 44.408% from the standard E-GASPOL frame.
2. The maximum deformation/displacement results on the modified E-GASPOL frame 2 condition without rider load decreased by 69.575% and the condition with rider load by 70.087%.

The maximum deformation/displacement results on the modified E-GASPOL frame 3 condition without rider load decreased by 77.718% and the condition with rider load by 78.105%.

CONCLUSIONS

Based on the results of static analysis research using solidworks 2019 software on standard E-GASPOL frames, modifications 1, 2, and 3 under conditions without rider loads and under conditions with rider loads, the conclusions are obtained, namely:

1. The static stress analysis process of the Electric Ganesha Scooter Portable (E-GASPOL) vehicle frame uses the R2D2 (Reflective, Recursive, Design and Development) development model which has three phases, namely defining, design and development and dissemination. Each stage of the development process has been successfully carried out and the feasibility of the E-GASPOL frame design has been tested.
2. The results of the static stress analysis of frame modifications 1, 2, and 3 of the Electric Ganesha Scooter Portable (E-GASPOL) vehicle got the results of the modified vehicle frame design 3 has the best value, namely obtaining a maximum stress value of 1,255 x N/m 10^6 conditions without rider load, This result has a decrease of 58.55% from the standard design and conditions with a rider load of 7,699x 10^6 N/m, this result has a decrease of 58.56% from the standard design, this result we can conclude that the smaller the value of the stress results we get on a frame, the strength of a frame is getting better.
3. Displacement/deformation analysis of frame modifications 1, 2, and 3 of the Electric Ganesha Scooter Portable (E-GASPOL) vehicle got the results of the modified vehicle frame design 3 has the best value, namely obtaining the maximum displacement/deformation value of 1,453 x 10^{-3} mm conditions without rider load, This result has a decrease of 77.718% from the standard design and the condition with a rider load of 8,791 x 10^{-3} mm, this result has a decrease of 78.10% from the standard design, these results we can conclude the smaller the value of the deformation results we get on a frame, the strength of a frame is getting better.

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