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Analisis Bentuk Kontruksi *Chassis* Mobil Listrik *Prototype* Tipe *Hollow* Alumunium 6061 Menggunakan *Software* Inventor 2016

Analysis of Prototype Electric Car Chassis Construction using Aluminum Hollow 6061 Profiles using Inventor Software 2016

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Abstract

Vehicles are a means of transportation. Most vehicles use fossil fuels as an energy source. Fossil fuels will run out, so electricity is used as a substitute. Electric fuel is environmentally friendly and does not emit pollution. Making a prototype electric car, one of which is preparing a design and simulating it using software. This study aims to find the best 6061 hollow aluminum chassis model through static analysis using Autodesk Inventor software with the finite element analysis (FEA) method. This study compares three chassis models, namely chassis patterns H, X, and Y, which will be subjected to a static load test of 900 N, including the driver's load of 600 N. The values obtained are von Mises stress, displacement, and the safety factor. The dimensions of the chassis are 2,160 mm by 750 mm by 500 mm, with a thickness of 2 mm. The results can be concluded: the H-pattern chassis is the best and easier to design compared to the X and Y chassis. This chassis has a von Mises stress value of 84.47 MPa, a displacement value of 0.89 mm, and a safety factor of 3.20. Based on these results, the model H chassis is safe.

Keywords*: prototype, von mises stress, displacement, safety factor, Inventor.*

SDGs**:**

Abstrak

Kendaraan adalah sarana transportasi. Umumnya kendaraan menggunakan bahan bakar fosil sebagai sumber energi. Bahan bakar fosil akan habis, maka dijadikan bahan bakar listrik sebagai pengganti. Bahan bakar listrik ramah lingkungan dan tidak mengeluarkan polusi. Pembuatan mobil listrik prototype salah satunya menyiapkan desain dan disimulasikan menggunakan software. Penelitian ini bertujuan untuk menemukan model chassis berbahan aluminium hollow 6061 yang terbaik melalui analisis statik menggunakan software Autodesk Inventor dengan metode finite element analysis (FEA). Penelitian ini membandingkan tiga model chassis, yaitu chassis pola H, X, dan Y yang akan diberikan pengujian beban statis sebesar 900 N termasuk beban pengemudi yaitu 600 N. Nilai yang didapatkan, yaitu von mises stress, displacement dan safety factor. Dimensi chassis yang dibuat adalah 2.160 mm x 750 mm x 500 mm dengan ketebalannya adalah 2 mm. Hasilnya dapat disimpulkan, chassis pola H yang terbaik dan lebih mudah dalam proses perancangannya dibandingkan chassis X dan Y. Chassis ini memiliki nilai von misses stress 84,47 MPa, nilai displacement 0,89 mm dan safety factornya adalah 3,20. Berdasarkan hasil tersebut chassis model H aman.

Kata Kunci: prototipe, *von mises stress*, *displacement*, faktor keamanan, Inventor.

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1. INTRODUCTION

Vehicle is a means of transportation that is very necessary for everyday life. At this time the development and innovation of a vehicle is quite rapid, with the technologies that have been realized as well as the newly discovered technologies (Keliky, 2014; Setiawan, Sujana and Taufiqurrahman, 2021). Vehicles now use innovation that is different from before, namely the renewal of energy from Ignition Combustion Engine Vehicles (ICEVs) to vehicles that use electric energy or Electric Vehicles (Evs). This development is very important to develop, because of that in Indonesia also held an Indonesian Electric Car Contest for students for a research development (Toteles and Alhaffis, 2021).

The electric car is an innovative vehicle, because it has an electric motor that moves to generate power, then the electric power is stored in the battery (Daryanto and Tyassmadi, 2016). In addition, the purpose of replacing fossil fuels into electric fuel is to reduce air pollution in order to create environmentally friendly vehicles and also efforts to reduce the percentage of the greenhouse effect that occurs in Indonesia by 26% (Mulyadi *et al.*, 2022).

The material used in several previous studies uses carbon steel because it has strong properties and is more economical in the manufacturing process, but the disadvantages are that it is susceptible to rust, prone to fracture and difficult to weld (Dwinanto and Muhammad, 2015; Hasanuddin *et al.*, 2019; Efendi, 2020).

Chassis is the main component in a car. The chassis itself has several types, namely ladder frame, tubular space frame, aluminum space frame, monocoque and backbone chassis (Shantika, Firmansjah and Naufan, 2017; Syinta, Aprizal and Suripto, 2021). On the other hand, the chassis must have a light weight and be strong as a support for the engine, car body, suspension system, electrical system and driver (Ellianto and Nurcahyo, 2020). This study uses a type of ladder frame chassis called two long bars that support the vehicle and provide strong support from the weight of the load and are generally based on a transport design, and are generally called ladder frames.

This study has a formulation of the problem, namely, what are the results of Von Mises Stress, displacement and safety factor from the three existing chassis patterns and which model is the best chassis pattern theoretically and analytically (Toteles and Alhaffis, 2021; Dudescu, Bere and Neamțu, 2022; Weriono and Siregar, 2023). This study aims to determine the comparative analysis value of 3 different chassis constructions with the same material and using the same aluminum hollow. This can be used as a reference before starting the embodiment of a prototype electric car. The analysis carried out in this study uses the Autodesk Inventor 2016 software with a basis so that it can be computationally adjusted to achieve a high level of accuracy. Analyzing a chassis shape in which there are three shapes, namely, X, H and Y shapes. The results of the three patterns will later look for the Von Mises Stress, displacement and safety factor values.

2. METHODOLOGY

The research method carried out has 5 stages, namely literature review, data collection, ladder frame chassis design modeling, frame design simulation and analysis, and analysis results.

The literature review is intended to obtain numerical results that will be used as a reference for the framework feasibility test. In this case the type of frame used is the ladder frame. This frame has many advantages and harmony in the design of electric car prototypes. This research uses Finite Element Analysis through Autodesk Inventor 2016 software.

Then data collection was carried out, data collection techniques were carried out by systematic observation, namely observation within the boundaries of a study, the values needed in the research. The author discusses the analysis which is limited only to basic research on three chassis patterns, analyzing Von Mises stress, displacement, and safety factor with Aluminum Hollow 6061 material. Chassis analysis is given a load of 900 N with these parts, the driver's foot load is 100N, the driver's back load 300N, driver waist load 200N, engine component load 200N and front wheel drive component load 100N.

Next is to model the staircase frame chassis design which is done by making a model with the initial stages of drawing a chassis sketch and then entering the type of material into the sketch according to the material to be used, then do it until the actual chassis model is formed. After that, do a double check so that the results can be maximized. Furthermore, the simulation must have completed the chassis design modeling stage.

The simulation will get visual results of the strength of the chassis construction and the numerical results that will be obtained from this simulation. Then the analysis of the simulation results is an analysis that will bring up detailed numerical results and an explanation of the simulation results. The simulation results will get three values, namely Von Mises Stress, displacement and safety factor related to the research, the results of the analysis of the ladder frame type electric car chassis will be obtained.

2.1. The Equipment and Materials Spesifications for the Research

2.1.1. Hardware

The hardware used is a laptop with the following specifications, system model nya HP Laptop 15s-fq2xx, RAM 8GB, operating system Windows 11 Home Single Language 64-bit.

2.1.2. Software

The software to be used is Autodesk Inventor 2016 software, this software can meet the needs of a static analysis simulation to be carried out to get the best results from the three chassis models.

Figure 1. Software Autodesk Inventor 2016

2.2. Chassis Modeling and Design

2.2.1. Chassis Modeling

This study examines 3 types of models on the middle side of the chassis, especially the driver's support section. With these 3 types designed using the Inventor software using Aluminum 6061 material and having an alloy of hollow material shapes. The estimated size of the chassis to be used is 2, 160 mm x 250 mm x 651 mm. The pattern on the chassis will use three patterns namely H, X and Y which will be varied in the middle position of the chassis, as shown in Figure 2, Figure 3 and Figure 4.

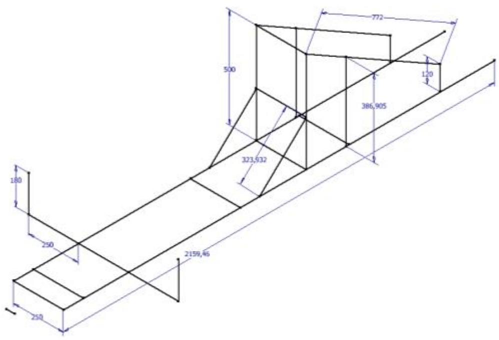

Figure 2. Chassis H

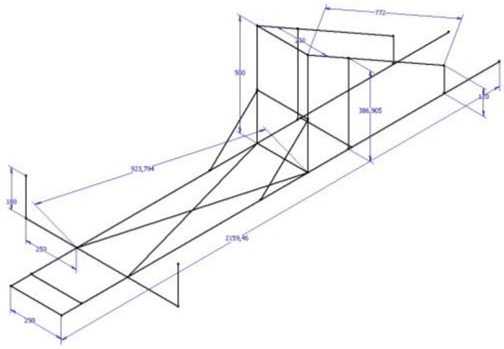

Figure 3. Chassis X

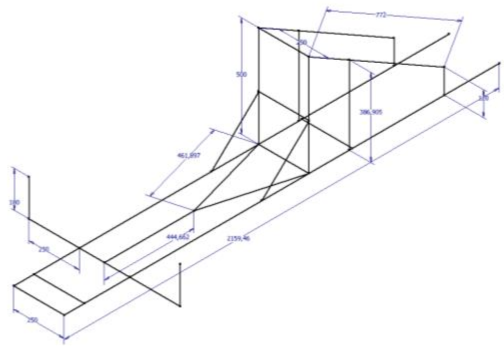

Figure 4. Chassis Y

2.2.2. Material Data Input

This stage includes the required material data in accordance with the research. Material data entry can be arranged in the Autodesk Inventor 2016 software in the material tool. It is necessary to determine the constraints area as a seat that will be related to the suspension. Then it is necessary to assume that the seat is rigid with the suspension and does not experience displacement because of loading.

To facilitate a calculation, loading groups are needed which must be adjusted to the desired loading point. Loading on the chassis requires a unit change from kg to N, so it takes a multiplication of gravity to the loading of kg.

Loading points are an attempt to group a load so that it can be properly assumed to get maximum results from the results of the testing process. This loading must be adjusted according to its position, each chassis pattern is given the same loading value, which only calculates the weight of the driver as an effort to get static chassis simulation results. The loading is given the same value so that the best chassis can be determined for the same loading variable. The following is the loading that applies to the 6061 aluminum chassis.

- **Load point on Chassis H**

The driver's foot loading point is 10 kg, then multiplied by the gravity value of 10 m/s^2. The following is Figure 5 of the loading point on the chassis.

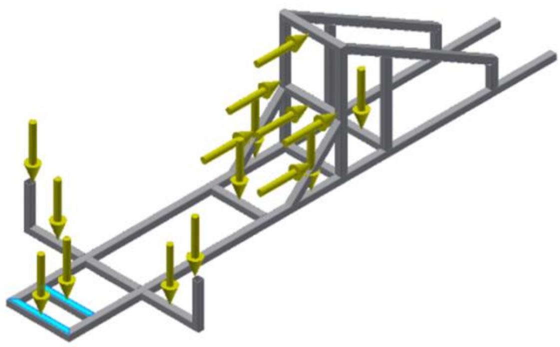

Figure 5. Foot load point on chassis H

The following is the calculation:

$$\text{F1} = \text{Foot load x g}$$

$$\text{F1} = 10\ \text{kg x}\ 10\ \text{m/s}^2$$

$$\text{F1} = 100\ \text{N}$$

The driver's waist loading point is 20 kg, then multiplied by the gravity value of 10 m/s^2. Here is Figure 6 of the loading points on the chassis.

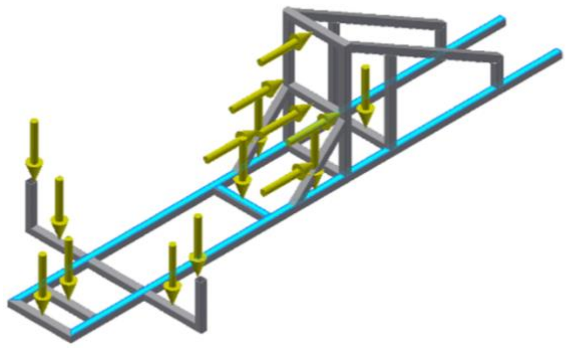

Figure 6. Waist point on chassis H

The following is the calculation:

$$\text{F2} = \text{Waist load x g}$$

$$\text{F2} = 20\ kg\ x\ 10\ m/s^2$$

$$\text{F2} = 200\ \text{N}$$

The driver's back loading point is 30 kg, then multiplied by the gravity value of 10 m/s^2. Here is Figure 7 of the loading points on the chassis.

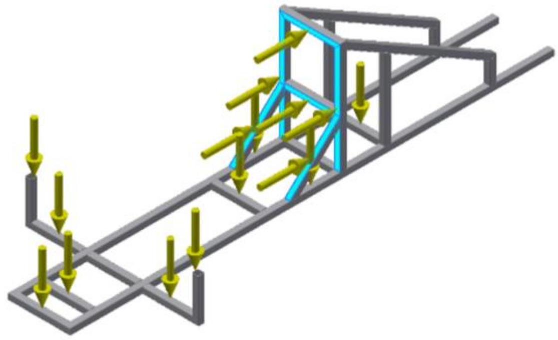

Figure 7. Back load point on chassis H

The following is the calculation:

$$\text{F3} = \text{Back load x g}$$

$$\text{F3} = 30\ \text{kg x}\ 10\ m/s^2$$

$$\text{F3} = 300\ \text{N}$$

The machine loading point is 20 kg, then multiplied by the gravity value of 10 m/s^2. Here is Figure 8 of the loading points on the chassis.

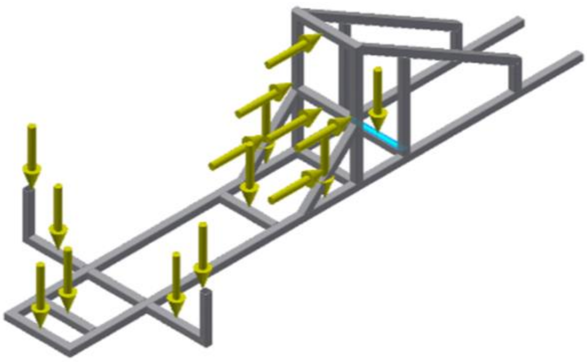

Figure 8. Machine load point on chassis H

The following is the calculation:

$$F4 = \text{Engine load x g}$$

$$F4 = 20\ \text{kg x } 10\ m/s^2$$

$$F4 = 200\ \text{N}$$

The loading point for the front wheel drive components is 10 kg, then multiplied by the gravity value of 10 m/s^2. Here is Figure 9 of the loading points on the chassis.

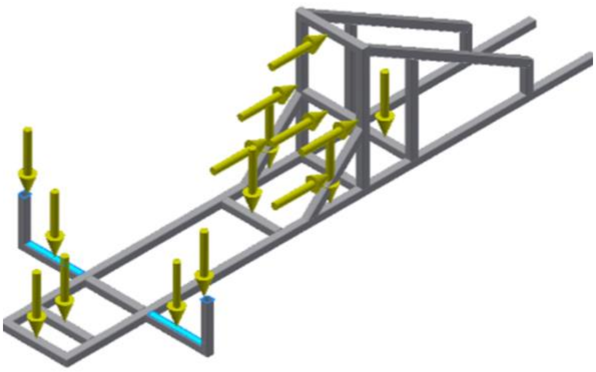

Figure 9. Wheel drive component load point on chassis H

The following is the calculation:

$$F5 = \text{Wheel drive components x g}$$

$$F5 = 10\ \text{kg x } 10\ m/s^2$$

$$F5 = 100\ \text{N}$$

- **Load Point on Chassis X**

The driver's foot loading point is 10 kg, then multiplied by the gravity value of 10 m/s^2. The following is Figure 10 of the loading point on the chassis.

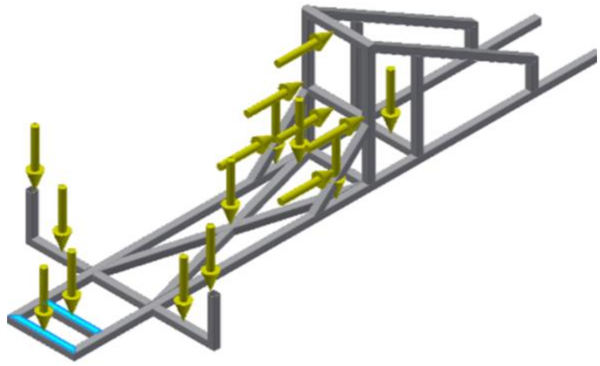

Figure 10. Foot load point on chassis X

The following is the calculation:

$$F1 = \text{Foot load x g}$$

$$F1 = 10\ \text{kg x } 10\ \text{m}/s^2$$

$$F1 = 100\ \text{N}$$

The driver's waist loading point is 20 kg, then multiplied by the gravity value of 10 m/s^2. Here is Figure 11 of the loading points on the chassis.

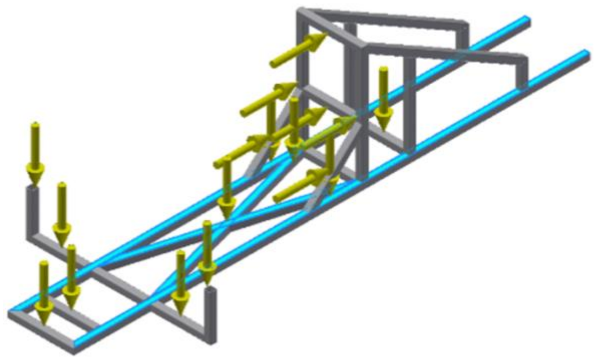

Figure 11. Waist point on chassis X

The following is the calculation:

$$F2 = \text{Waist load x g}$$

$$F2 = 20\ kg\ x\ 10\ m/s^2$$

$$F2 = 200\ \text{N}$$

The driver's back loading point is 30 kg, then multiplied by the gravity value of 10 m/s^2. Here is Figure 12 of the loading points on the chassis.

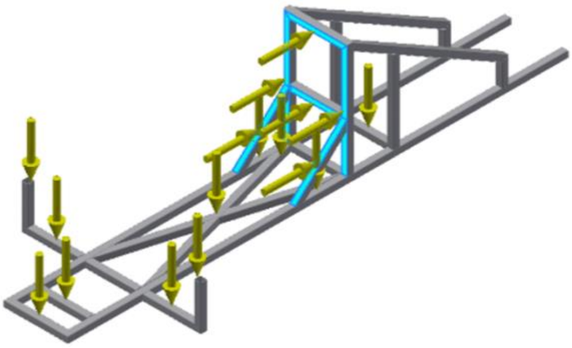

Figure 12. Back load point on chassis X

The following is the calculation:

$$F3 = \text{Back load x g}$$

$$F3 = 30\ \text{kg x } 10\ m/s^2$$

$$F3 = 300\ N$$

The machine loading point is 20 kg, then multiplied by the gravity value of 10 m/s^2. Here is Figure 13 of the loading points on the chassis.

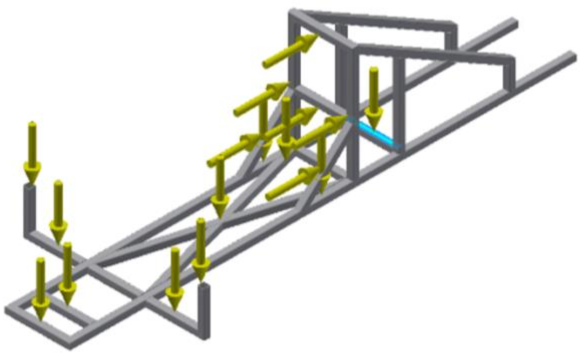

Figure 13. Machine load point on chassis X

The following is the calculation:

$$F4 = \text{Engine load x g}$$

$$F4 = 20\ \text{kg x } 10\ m/s^2$$

$$F4 = 200\ \text{N}$$

The loading point for the front wheel drive components is 10 kg, then multiplied by the gravity value of 10 m/s^2. Here is Figure 14 of the loading points on the chassis.

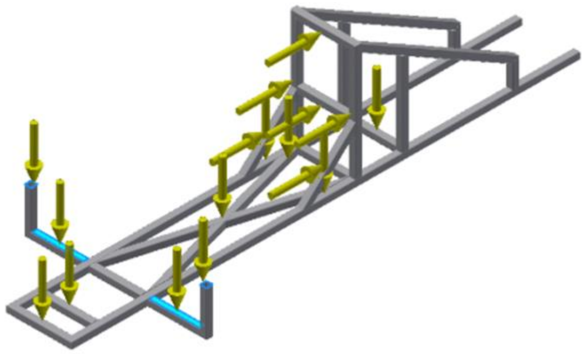

Figure 14. Wheel drive component load point on chassis X

The following is the calculation:

$$F5 = \text{Wheel drive components x g}$$

$$F5 = 10\ \text{kg x } 10\ m/s^2$$

$$F5 = 100\ \text{N}$$

- **Load Point on Chassis Y**

The driver's foot loading point is 10 kg, then multiplied by the gravity value of 10 m/s^2. The following is Figure 15 of the loading point on the chassis.

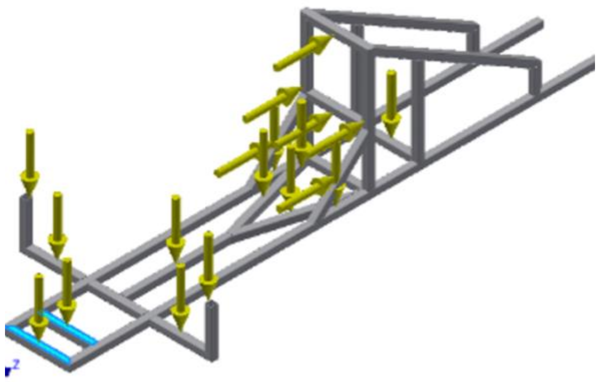

Figure 15. Foot load point on chassis Y

The following is the calculation:

$$F1 = \text{Foot load x g}$$

$$F1 = 10\ \text{kg x } 10\ \text{m/s}^2$$

$$F1 = 100\ \text{N}$$

The driver's waist loading point is 20 kg, then multiplied by the gravity value of 10 m/s^2. Here is Figure 16 of the loading points on the chassis.

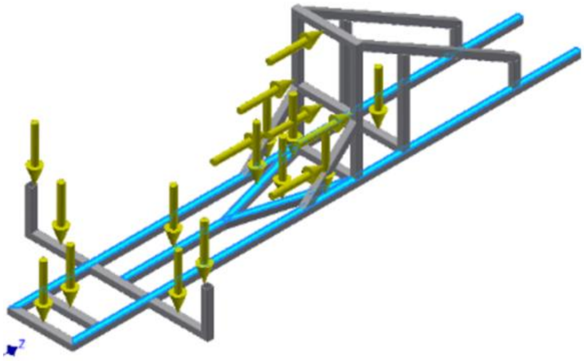

Figure 16. Waist point on chassis Y

The following is the calculation.

$$F2 = \text{Waist load x g}$$

$$F2 = 20\ kg\ x\ 10\ m/s^2$$

$$F2 = 200\ \text{N}$$

The driver's back loading point is 30 kg, then multiplied by the gravity value of 10 m/s^2. Here is Figure 17 of the loading points on the chassis.

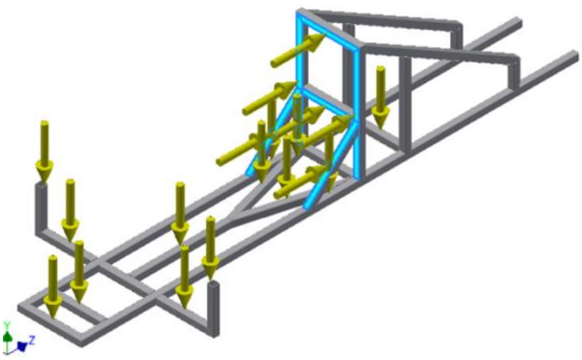

Figure 17. Back load point on chassis Y

The following is the calculation:

$$F3 = \text{Back load x g}$$

$$F3 = 30\ \text{kg x}\ 10\ m/s^2$$

$$F3 = 300\ N$$

The machine loading point is 20 kg, then multiplied by the gravity value of 10 m/s^2. Here is Figure 18 of the loading points on the chassis.

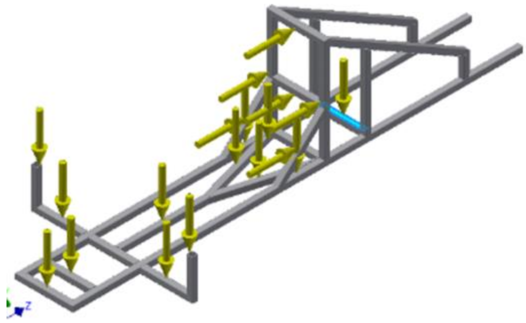

Figure 18. Machine load point on chassis Y

The following is the calculation:

$$F4 = \text{Engine load x g}$$

$$F4 = 20\ \text{kg x}\ 10\ m/s^2$$

$$F4 = 200\ \text{N}$$

The loading point for the front wheel drive components is 10 kg, then multiplied by the gravity value of 10 m/s^2. Here is a picture of the loading points on the chassis.

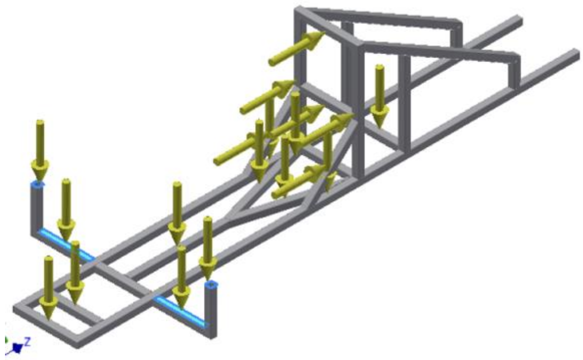

Figure 19. Wheel drive component load point on chassis Y

The following is the calculation:

$$F5 = \text{Wheel drive components x g}$$

$$F5 = 10\ \text{kg x}\ 10\ m/s^2$$

$$F5 = 100\ \text{N}$$

2.2.3. Static Analysis Simulation

After completing the 3-dimensional modeling of the ladder frame chassis with Aluminum 6061 material using the Inventor Software. This simulation produces the value of the maximum and minimum stress for the loading carried out at the points that have been determined to support the driver's load and the engine's load. It can be seen in the simulation that there are dark blue to red colors which affect the stress concentration. Deflection in the chassis is affected by a predetermined force against each side of the chassis (Sihombing, Jokosiworo and Adietya, 2019).

This simulation will also obtain safety factor results for the chassis from a safety perspective. Static analysis on the chassis with three patterns H, X and Y can be seen which pattern is the best according to Von Mises Stress, the calculation of displacement and safety factor that has been obtained (Fauzi and Marsono, 2021).

Aluminum material has the basic properties of this material, in this study the value of the properties of the Aluminum material must be considered to get maximum results. The following are specifications for the Aluminum 6061 material shown in Table 1.

Table 1. Physical properties of aluminum 6061

Name	Aluminum 6061	
General	Mass Density	2.7 g/cm^3
	Yield Strength	275 MPa
	Ultimate Tensile Strength	310 MPa
Stress	Young's Modulus	68.9 GPa
	Poisson's Ratio	0.33 ul
	Shear Modulus	25.9023 GPa

2.3. Validation of Design Results

Validation of the design results is a reference to ensure that the data obtained from the design results is proven accurate with the help of Autodesk Inventor 2016 software. Validation is a standard form in a design so that the design results can be ensured that the design results are feasible or not according to predetermined standards.

The standard obtained as a reference in the calculation of the results of the von miss stress must be below the yield strength value and the safety factor must be adjusted to the standard.

2.3.1. Chassis Design Validation

The following are the steps taken in the stage of validating the prototype electric car chassis design using the Autodesk Inventor 2016 software, along with the stages:

1) Pre-Process Design

   The pre-design process is an effort to prepare a chassis shape that will be designed according to the needs and desires to maximize the results of chassis analysis using hollow 6061 aluminum.

2) Design Process

   The design process is divided into 3 stages to make it easier to understand the modeling process, this process uses Autodesk Inventor 2016 software. The following are the stages:

   a) Design Part Process

      The sketch results will be made in 3D by entering the type of frame needed according to the shape of the frame to be made. The three chassis patterns H, X and Y will be made according to ISO standard sizes. This chassis uses the same frame type with the same dimensions. the type of frame used is ISO 4019 (Square) - Structural steels - Cold-formed, welded, structural hollow sections with dimensions of 30mm x 30mm x 2mm. This information is contained in Figure 20 and Figure 21.

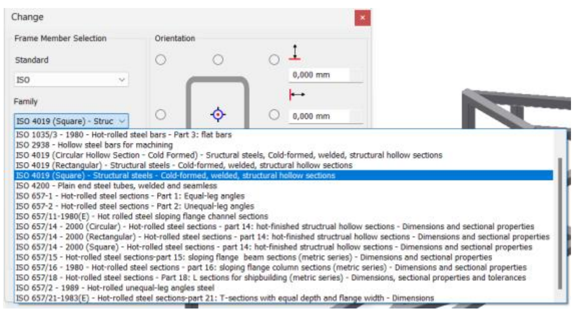

Figure 20. Material type

b) Chassis Design Process

The Chassis Design Process is something that must be done so that the chassis parts can be maintained to form one chassis component that is intact and strong in material structure.

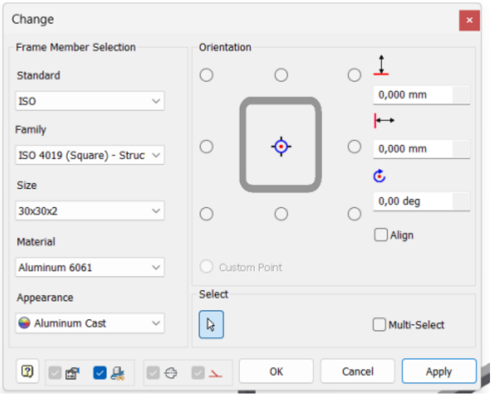

Figure 21. Material spesification

Here are the steps:

(1) Insert Frame

Insert frame is the process of inserting the type of material into the chassis (see Figure 22).

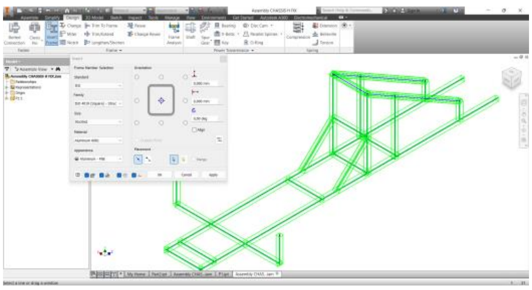

Figure 22. Insert frame

(2) Miter Process

The miter process is to thread the corners on an aluminum bar. Figure 23 is the process before the miter and in Figure 24 is the result after the miter.

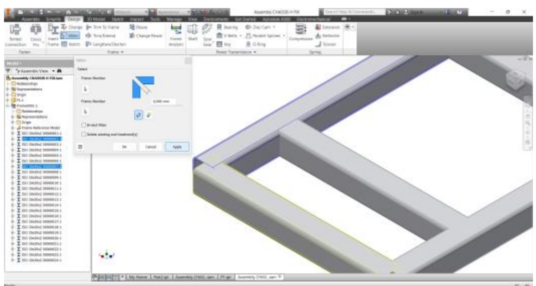

Figure 23. Before miter process

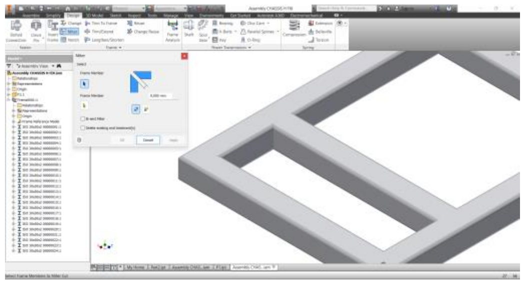

Figure 24. After miter process

(3) Trim/Extend

Trim/extend is the process of trimming and adding materials to make them fit perfectly (see Figure 25).

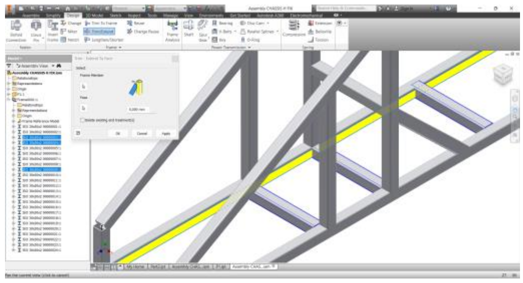

Figure 25. Trim/Extend Process

2.3.2. Validation of Chassis Analysis Results

This validation includes the pre-process analysis and the analysis process itself. validation analysis is carried out on the simulation that will be carried out on the ladder frame chassis.

a) Pre-process Analysis

The pre-process analysis procedure is the preparation for the chassis design analysis by verifying the material, setting constraints (support), constacts and determining the proper loading. Here are the steps:

(1) The first stage is to simplify a chassis model. The chassis is adjusted according to the type, the type of chassis used in this study is the ladder frame type (see Figure 26).

(2) Then click environments - stress analysis - create simulations- static analysis - ok (see Figure 27).

(3) Determine the Assign material to enter the type or type of material used. The material used is aluminum 6061 (see Figure 28).

(4) Define constraints points (fulcrum) and define contacts automatically (see Figure 29).

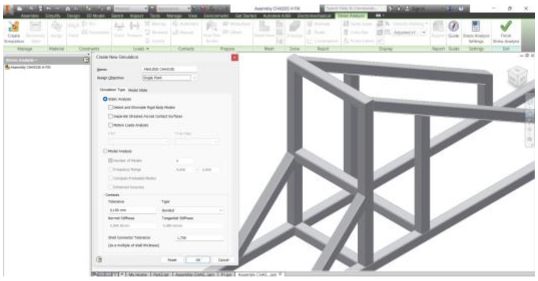

Figure 26. Create simulation

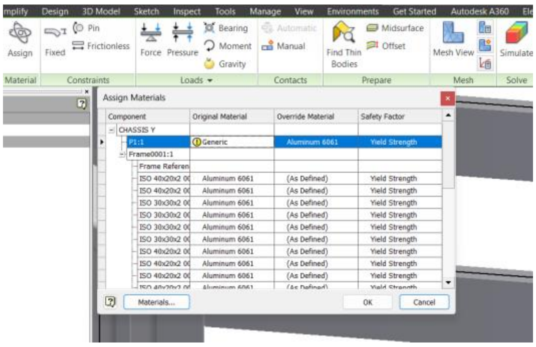

Figure 27. Enter materials

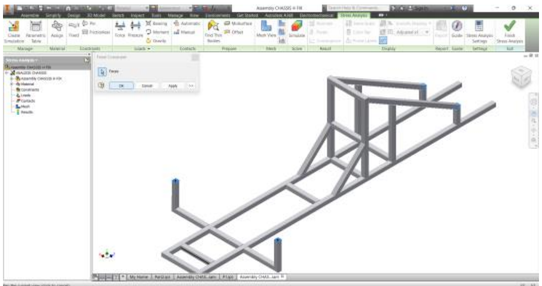

Figure 28. Constrains automatic

(5) Determine the gravity value in a design so that it can be adjusted to the results of research that has a real appropriate chassis placement (see Figure 29).

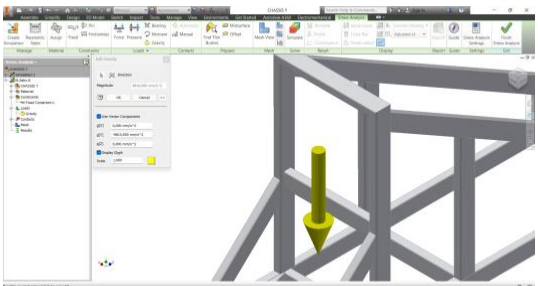

Figure 29. Enter the gravity value

(6) Determine the loads, namely the load of the driver, engine components and front wheel drive components of 900N with the points adjusted to the pattern of each chassis (see Figure 30).

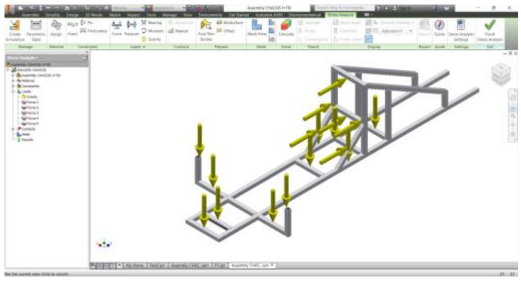

Figure 30. Load point

b) Process Analysis

The analysis process includes meshing view, simulate and simulation results.

(1) Meshing View, carry out a meshing process that is used as an observer of the flatness of a surface against the object to be analyzed (see Figure 31).

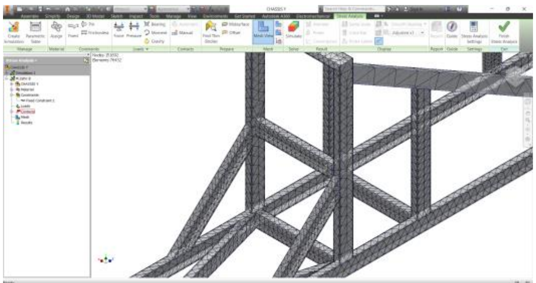

Figure 31. Meshing automatic

(2) Then click simulation to get the simulation process and click "Run" to start the simulation according to Figure 32.

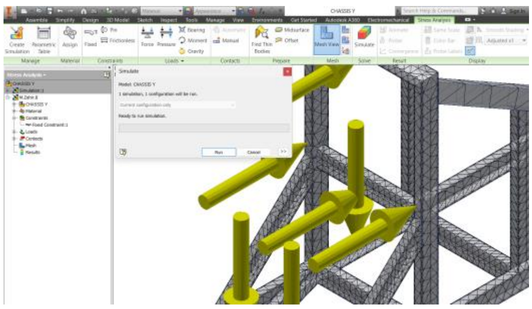

Figure 32. Start the simulating process

(3) The process that runs in the simulation is shown in the following Figure 33.

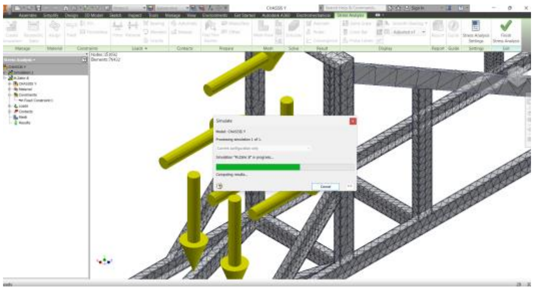

Figure 33. Simulation process

(4) The results obtained from the simulation are in the form of von misses stress, displacement and safety factor values (see Figure 34).

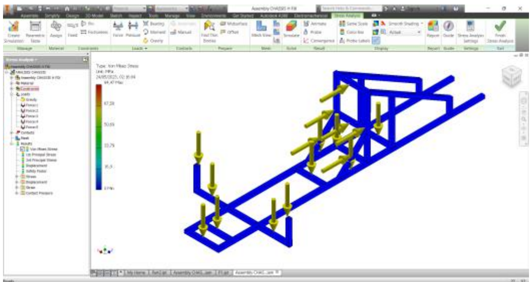

Figure 34. Simulation results

3. RESULT AND DISCUSSION

The design results obtained are based on the results of research by simulating chassis static analysis which is designed using a ladder frame type with a different model, namely the H model which is shown in Figure 35, then the X model which is shown in Figure 36 and the results of the Y model are shown in Figure 37. Design The ladder frame chassis uses ISO standard 6061 hollow aluminum.

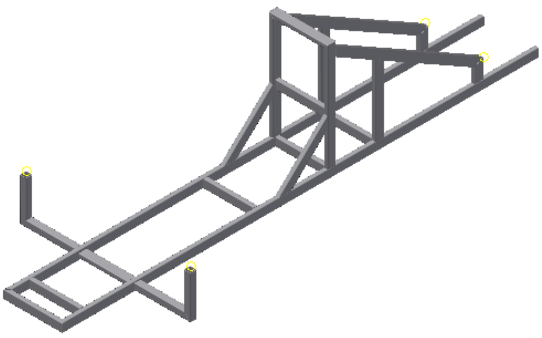

Figure 35. H chassis results

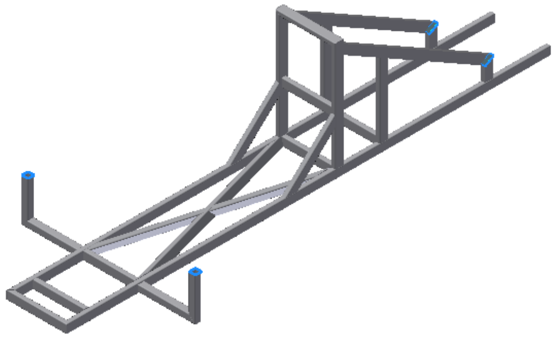

Figure 36. X chassis results

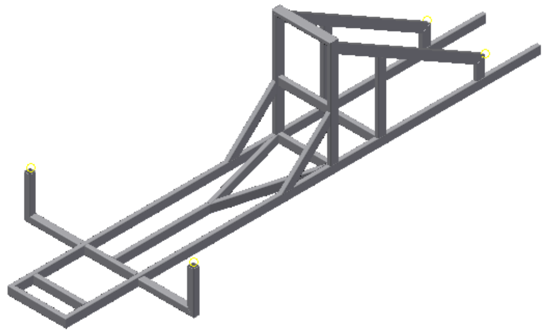

Figure 37. Y chassis results

The following is the result of testing the prototype electric car chassis using a ladder frame type with the help of Autodesk Inventor 2016 software:

- **H Pattern Chassis**

The following is the result of the analysis of the H chassis. The analysis is in the form of the results of the value of Von Misses Stress, Displacement value and Safety Factor value obtained from a static analysis simulation using the Autodesk Inventor 2016 software.

The values obtained from the simulation results show that the von misses stress value has a minimum value of 0 MPa and a maximum value of 84.47 MPa. The following is shown in Figure 38.

The values obtained from the simulation results show that the minimum displacement value is 0 mm and the maximum value is 0.8944 mm as shown in Figure 39.

The values obtained from the simulation results show a minimum safety factor value of 3.26 and a maximum value of 15 as shown in Figure 40.

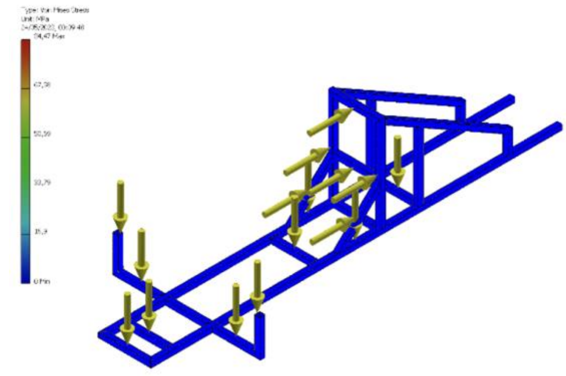

Figure 38. Result of von misses stress on H chassis

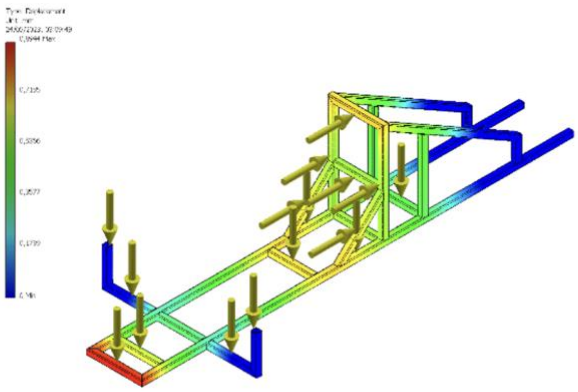

Figure 39. Results of displacement on H chassis

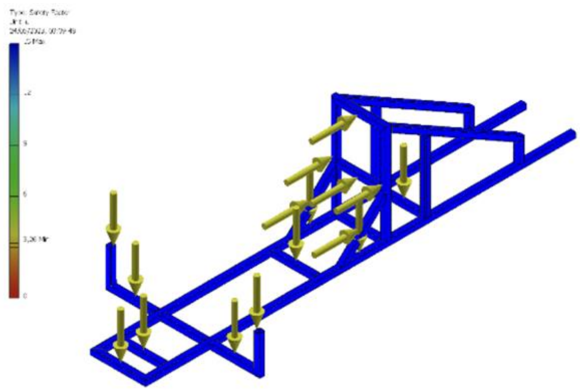

Figure 40. Results of safety factor on H chassis

- **X Pattern Chassis**

The following is the result of the analysis of the X chassis. The analysis is in the form of the results of the value of Von Misses Stress, Displacement value and Safety Factor value obtained from a static analysis simulation using the Autodesk Inventor 2016 software.

The values obtained from the simulation results show that the von misses stress value has a minimum value of 0 MPa and a maximum value of 86,5 MPa. The following is shown in Figure 41.

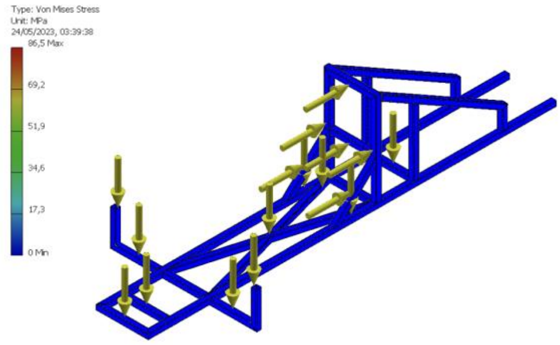

Figure 41. Result of von misses stress on X chassis

The values obtained from the simulation results show that the minimum displacement value is 0 mm and the maximum value is 0.8122 mm as shown in Figure 42.

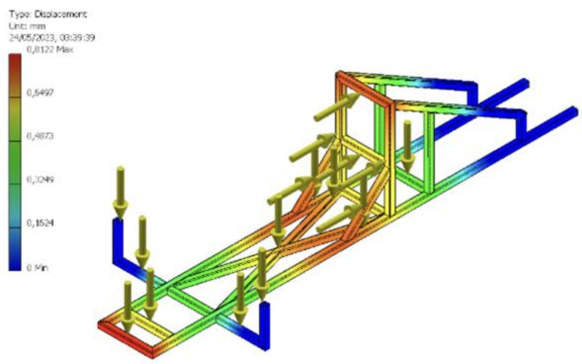

Figure 42. Results of displacement on X chassis

The values obtained from the simulation results show a minimum safety factor value of 3.18 and a maximum value of 15 as shown in Figure 43.

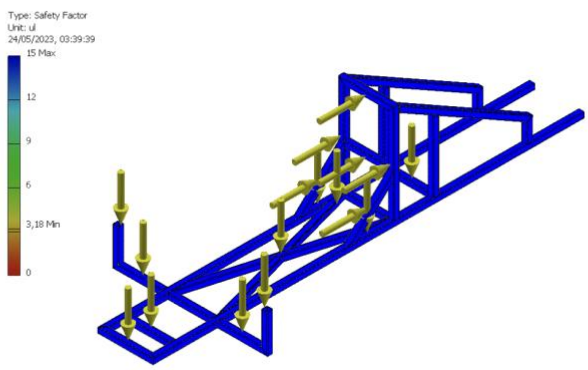

Figure 43. Results of safety factor on X chassis

- **Y Pattern Chassis**

The following is the result of the analysis of the H chassis. The analysis is in the form of the results of the value of Von Misses Stress, Displacement value and Safety Factor value obtained from a static analysis simulation using the Autodesk Inventor 2016 software.

The values obtained from the simulation results show that the von misses stress value has a minimum value of 0 MPa and a maximum value of 84.79 MPa. The following is shown in **Figure 44.**

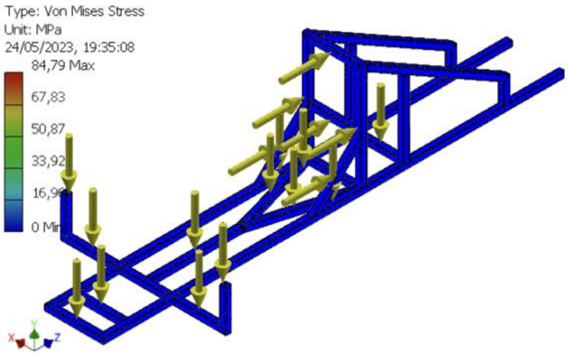

Figure 44. Results of von misses stress on Y chassis

The values obtained from the simulation results show that the minimum displacement value is 0 mm and the maximum value is 1.109 mm as shown in Figure 45.

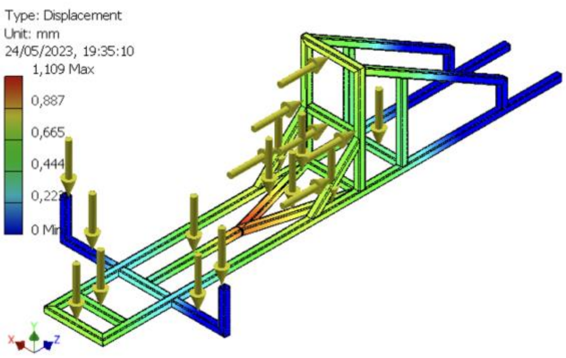

Figure 45. Results of displacement on Y chassis

The values obtained from the simulation results show a minimum safety factor value of 3.24 and a maximum value of 15 as shown in Figure 46.

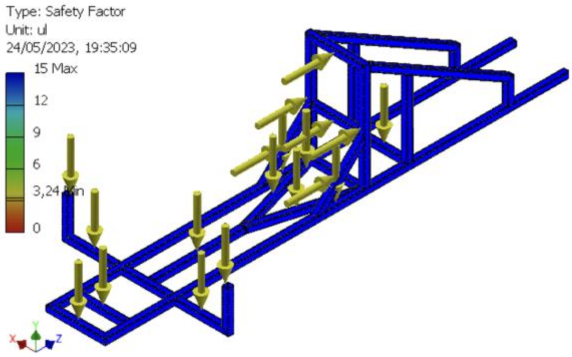

Figure 46. Results of safety factor on Y chassis

The results of the analysis of the pictures above are the aim of this study, these results will be compared in a table to make it easier to identify the values of the three chassis patterns. The following are in Table 2.

Table 2. Chassis pattern analysis results

Model	Classification	Result
Pattern Chassis H	*Von mises stress*	84,47 MPa
	Displacement	0,89 mm
	Safety factor	3,26 ul
	Massa	6,31 kg
Pattern Chassis X	*Von mises stress*	86,50 MPa
	Displacement	0,81 mm
	Safety factor	3,20 ul
	Massa	7,12 kg
Pattern Chassis Y	*Von mises stress*	84,79 MPa
	Displacement	1,11 mm
	Safety factor	3,24 ul
	Massa	6,70 kg

The discussion is based on the results of a simulation analysis of a prototype electric car chassis using hollow aluminum 6061 with the help of Inventor 2016 software, namely to find the values of von misses stress, displacement and safety factor in the three chassis patterns H, X and Y. The results of the analysis of Pattern H, namely the value of von misses stress of 84.47 MPa with a displacement value of 0.89 mm and a safety factor of 3.26 ul. Then the von misses stress value for the chassis pattern x is obtained, which is 86.50 MPa with a displacement value of 0.812 mm and a safety factor value of 3.20 ul. This analysis results in the von misses stress on the y pattern chassis of 84.79 MPa with a displacement value of 1.11 mm and a safety factor value of 3.24 ul.

This analysis also gets the results from the mass of the chassis, namely the chassis pattern H has a chassis mass of 6.31 kg, the x chassis has a mass of 7.19 kg and the y chassis has a chassis mass of 6.70 kg. The difference in the shape of the chassis on the prototype electric car results in a difference in the results of the static analysis simulation. The value of von misses stress with safety factor is inversely proportional.

4. CONCLUSION

Based on the results of research conducted using Autodesk Inventor 2016 software, with the aim of analyzing three chassis models made of hollow 6061 aluminum which have different patterns with loading at the same fulcrum. The 900N load on three chassis models can be well received according to the analysis results.

The results of the static analysis simulation stated that the three chassis models obtained close analysis results and the best was the H pattern chassis because it had a Von misses stress value of 84.47 MPa, a displacement value of 0.89 mm and a safety factor of 3.26 ul. The value of the von Mises stress is still relatively safe because it is still far below the yield stress value, which is 275 MPa. The value of the safety factor is above 1, so it is classified as safe in terms of safety and the displacement value is below number 1. This value is not much different from the pattern chassis Y but seen from other aspects, namely, modeling is easier to design, then the best category of the three chassis models is the chassis model H.

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