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STRENGTH ANALYSIS OF SELIS BRAND ELECTRIC BIKE FRAME THUNDER TYPE BMX 350 WATT USING ANSYS V17 SOFTWARE

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Abstract
Frame is one important component of the electric bicycle because it serves as the supporting components are installed, so that it becomes a unity that makes electric bikes can run. For static stress analysis was performed on an electric bicycle frame brands Selis thunder type 350 watts using ANSYS software V17 with a maximum static load of 1,200 kg. The purpose of this study was to determine the strength that is capable detained by order so that an unknown number of safety. After testing obtained amounted to 413.73 MPa maximum stress, maximum strain of mm, and the safety factor at 0.6042. mm/mm, total maximum deformation of

Keywords: *Frame, Software Ansys V17, Stress, Strain, Total Deformation, and Safety Factor.*

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Introduction

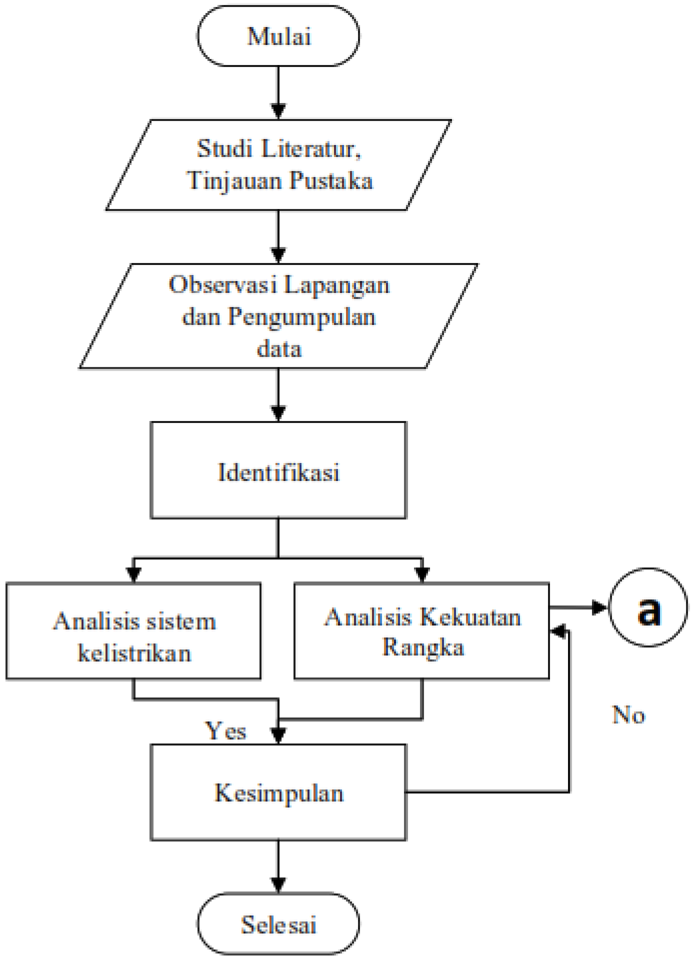
One of the important parts of this type of BMX electric bicycle is the frame, because the frame has two functions, namely a static function and a dynamic function. The electric bicycle frame has a static function, namely as a structural reinforcement in accepting the driver's load, goods and the seat of various components mounted on the bicycle. Meanwhile, the electric bicycle frame has a dynamic function, which is to make the control of the BMX type electric bicycle stable, so that it is easy and in the end will greatly affect the comfort when riding the bicycle.

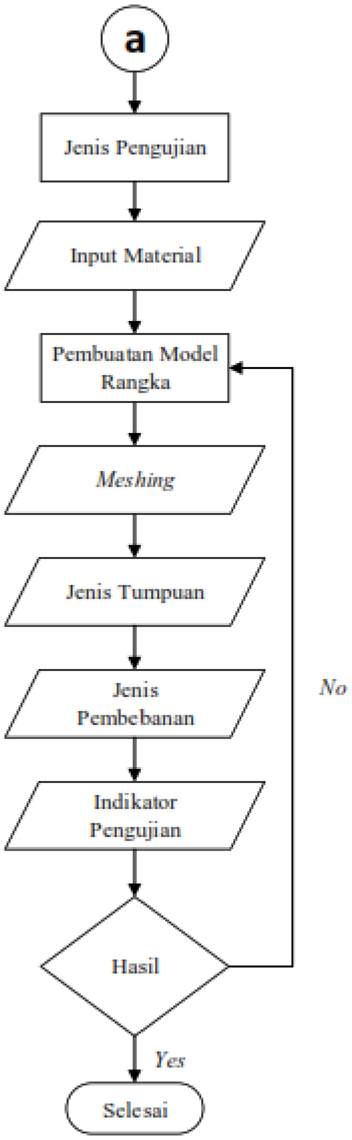
In addition to having a function, this electric bicycle frame has a maximum strength limit in supporting the load. Where the strength of the frame is the main thing that needs to be considered, because the frame will break if the load or stress received by the frame exceeds its maximum strength limit. The strength of this electric bicycle frame will affect the level of security, where the safety number of a frame can be known by calculating the ratio between the allowable stress of the material used and the maximum voltage. So it can be said that the strength of the bicycle frame can affect the safety of the rider.

Based on this description, an analysis is needed to determine the strength of the frame on a BMX electric bicycle. By knowing the strength of the frame, it will also know the level of security of the frame. To analyze the strength of the frame on a bicycle, we need a software that can measure the variance of loads (loads) and the type of material, one of which is by using the Ansys V17 software. Therefore, the researcher will conduct a study entitled "Analysis of the Strength of the Electric Bike Frame Selis Brand Type Thunder BMX 350 Watt Using Ansys V17 Software".

Research methods

The process flow of this final project research system can be explained in Figure 3.1 below, including the following :





Explanation of Figure 3.2 the flow diagram of the final project research process, including the following :

a) Test Type; Determine the type of process analysis or testing of the BMX type electric bicycle frame on the ansys V17 software toolbox menu.
b) Input Materials; Entering material specification data that will be used for the framework on the Engineering Data menu.
c) Frame Model Making; The process of creating a frame model on the Geometry menu.
d) Meshing; Split or split the skeleton model into infinite elements in the mesh menu.
e) Type of Pedestal; Enter the type of pedestal that will be used on the frame in the support menu then select fixid support.
f) Type of Loading; Enter the type of loading in the loads menu then select force.
g) Testing Indicators; Enter the test indicators to be inputted, namely total deformation, equivalent elastic strain, equivalent stress and safety factor, then solve.
h) Results; Displaying test result data by software, namely color gradations, graphs and tables.

Results and Discussion

Test Type

In conducting simulations or testing of the electric bicycle frame with the Thunder BMX type 350 watt, the researchers used the Static Structural testing method. Static Structural is one part of the toolbox analysis system software Anys V17, one of which has a function to simulate or test the strength of the frame structure statically, so that changes that occur in the frame can be known. The concern in the stage of testing this software must be done systematically, because if it is not done systematically the test will fail and cannot proceed to the next stage. The selection of the type of static structural testing can be seen in Figure 4.1 below, as follows :

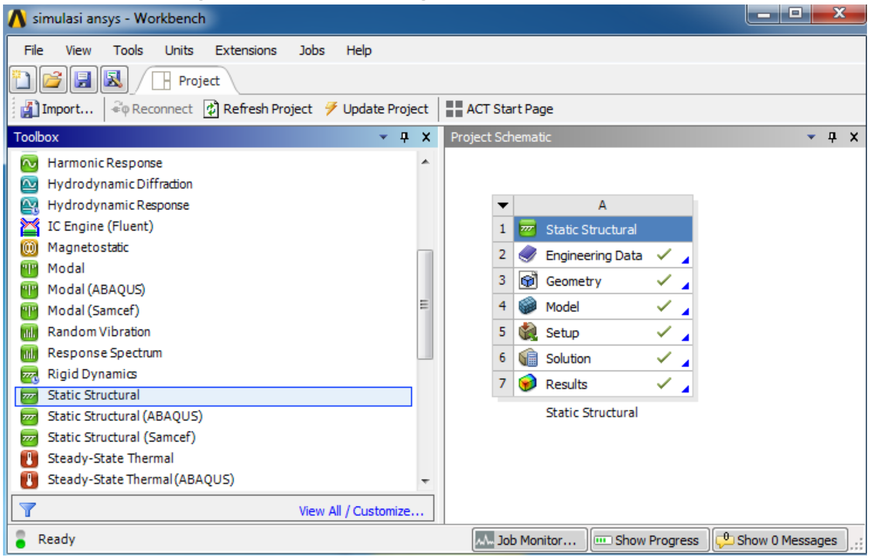


Figure 4.1 Static Structural Test Selection

Test result

4.4.1 Load 100 kg (981N)

a) Equivalent Stress

The minimum test data obtained is MPa with blue color meaning that it has not changed and maximum test data of 34,478 MPa with red color meaning that it has changed. As can be seen in Figure 4.7 below:

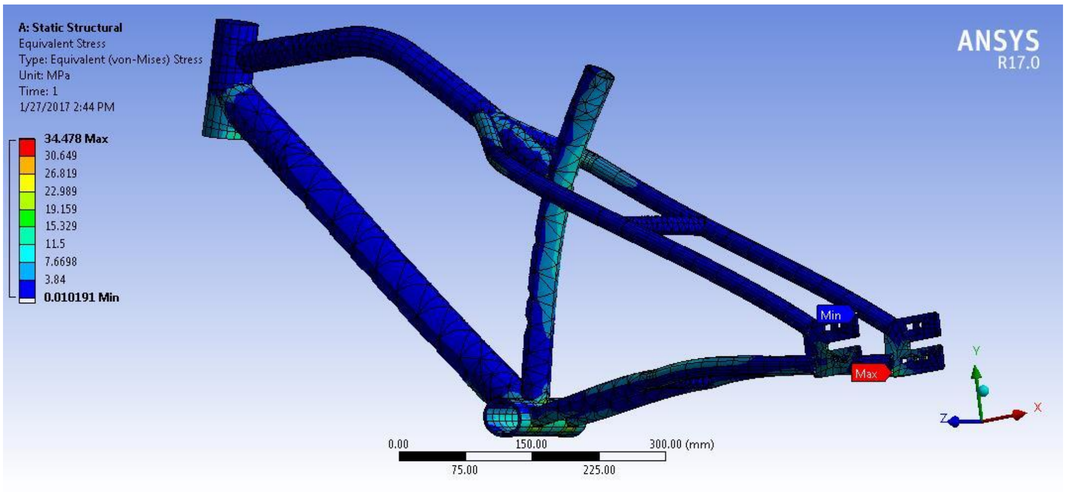


Figure 4.7 Equivalent stress load 100 kg

b) Equivalent Elastic Strain

The minimum test data is mm/mm with blue color meaning that it has not changed and the maximum test data of mm/mm with red color means that it has changed. As can be seen in Figure 4.8 below :

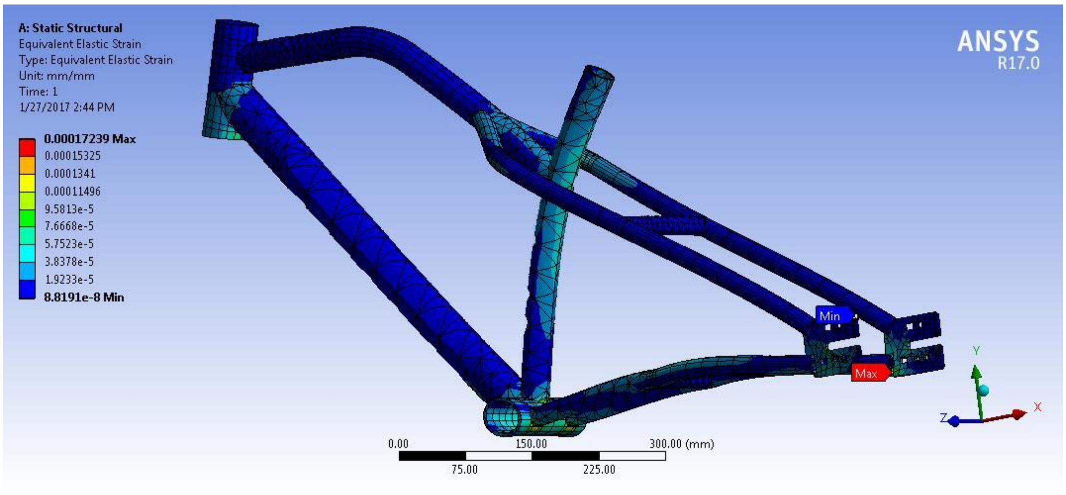


Figure 4.8 Equivalent elastic strain load 100 kg

c) Total Deformation

A minimum test data of 0 mm is obtained, with blue meaning that it has not changed and the maximum test data of red means that it has changed. As can be seen in Figure 4.9 below:

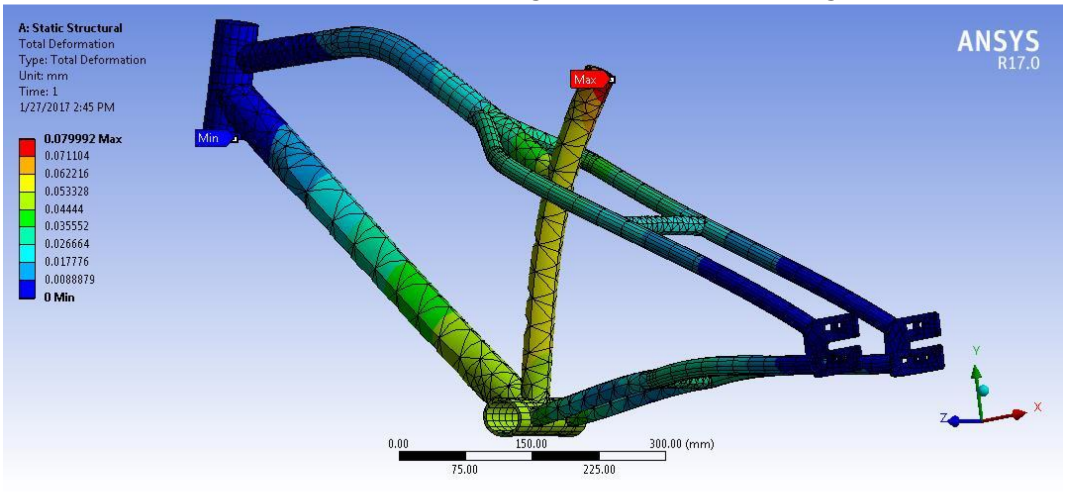


Figure 4.9 Total deformation load 100 kg

d) Safety Factor

The safety factor data obtained is 7.2509 with green color meaning that the safety factor value obtained shows the design of static structures or machine elements that receive dynamic loading with uncertainty about how many combinations of loads, material properties, stress analysis, or the environment. As can be seen in Figure 4.10 below:

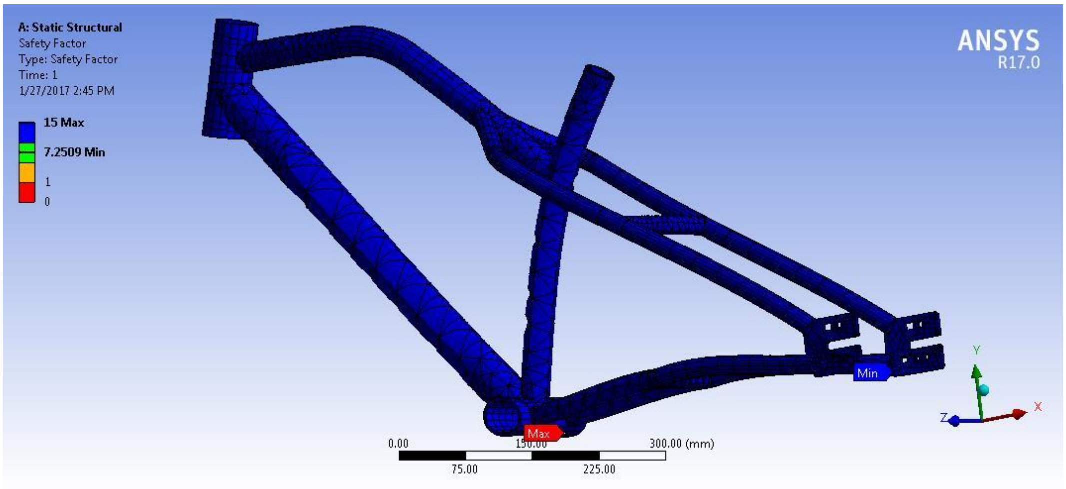


Figure 4.10 Safety factor load 100 kg

Framework Test Results Data Using Ansys V17 Software

After the simulation process or static loading testing has been carried out on the electric bicycle frame model of the Selis type Thunder BMX 350 watt using the Ansys V17 software, the data obtained from the test results include four test indicators, which include equivalent stress (tension), equivalent elastic strain (strain).), total deformation (total deformation) and factor of safety (safety factor). The test result data can be seen in table 4.2 below.

Tabel 4.2 Test result data

No	Load (kg)	Testing Simulation Strength Characteristics			
		Equivalent Stress (MPa)	Equivalent Elastic Strain (mm/mm)	Total Deformation (mm)	FOS
1.	100	Mak. : 34,478	Mak. : 1,7239	Mak. : 7,9992	7,2509
2.	300	Mak. : 103,44	Mak. : 5,1718	Mak. : 23,997	2,417
3.	500	Mak. : 172,39	Mak. : 8,6196	Mak. : 39,996	1,4502
4.	700	Mak. : 241,35	Mak. : 12,067	Mak. : 55,994	1,0358
5.	900	Mak. : 310,31	Mak. : 15,515	Mak. : 71,992	0,8056
6.	1.100	Mak. : 379,26	Mak. : 18,963	Mak. : 87,991	0,6591
7.	1.200	Mak. : 413,74	Mak. : 20,687	Mak. : 95,99	0,6042

Results of Stress and Strain Graph Analysis

After carrying out static testing on the frame by providing different loads, the data obtained from the results of stress and strain are also varied. In table 4.2 it is stated that the greater the given load, the greater the stress and strain. While the relationship between stress and strain based on a given load, is shown in the form of a graph below.

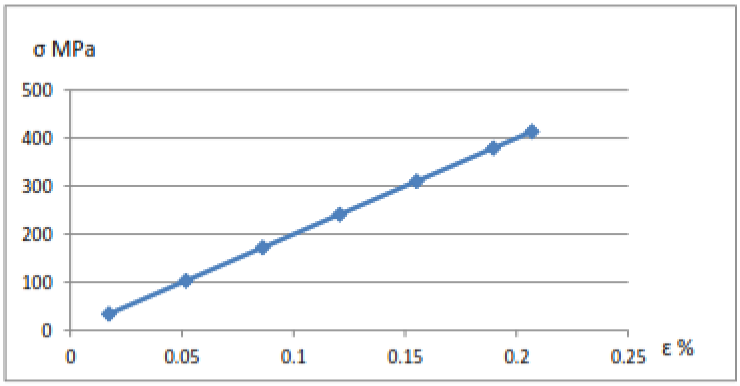


Figure 4.35 Stress-strain graph

Based on the graphic above, it states that the relationship between stress and strain is directly proportional, meaning that the greater the stress applied to a frame, the greater the strain received by the frame. In the graph it can be seen that the highest voltage value is in the range of 400 MPa, which is more precisely 413.74 MPa.

Whereas it has been known previously that the maximum allowable stress for the material used is 400 MPa, so the figure of 413.74 MPa is said to have exceeded the maximum limit. Then it can be ascertained, that the frame is not able to withstand the applied stress, so as a result the frame will break and be unsafe to use.

Load Analysis Results and Total Deformation

After carrying out static testing on the frame by providing different loads, the data on the relationship between the load and the total deformation is obtained. In table 4.2 it is stated that the load given is getting bigger, starting from 100 kg to 1200 kg. The data acquisition is shown in the form of a graph below.

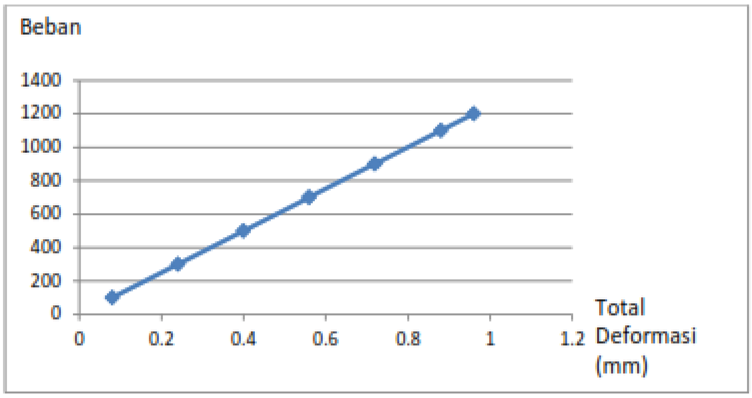


Figure 4.36 Graph of load and total deformation

Based on the graphic above, it states that the relationship between the applied load and the total deformation is directly proportional, meaning that the greater the load applied to a frame, the greater the total deformation received by the frame. In the graph it can be seen that at the smallest load of 100 kg, the total deformation is less than 0.2 mm. Meanwhile, at the largest load of 1200 kg, the total deformation is almost 1 mm. This shows a significant increase between the two indicators.

Load Graph Analysis Results and Safety Factor

After carrying out static testing on the frame by providing different loads, data on the relationship between the load and the safety factor is obtained. In table 4.2 it is stated that the load given is getting bigger, starting from 100 kg to 1200 kg. The data acquisition is shown in the form of a graph below.

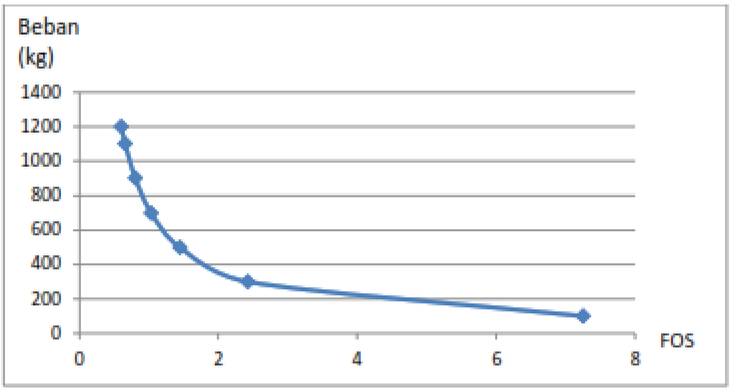


Figure 4.37 Graph of load and safety factor

Based on the graphic above, it states that the relationship between the given load and the safety factor is inversely proportional, meaning that in this case the greater the load, the smaller the safety factor. On the other hand, the smaller the load, the greater the safety factor.

In the graph above, if it is related to the theory of factor of safety, there are four categories regarding the value of the factor of safety in a designed structure, namely; (1) n = n = 1.25 to 2.0; (2) n = 2.0 to 2.5; (3) n = 2.5 to 4.0; (4) n = 4.0 or more. It can be seen that at the smallest load of 100 kg, the obtained safety factor is 7.2509 which is included in category 4, meaning that the design of static structures or machine elements that receive dynamic loading with uncertainty regarding how many combinations of loads, material properties , stress analysis, or environment.

At giving a load of 300 kg, a safety factor of 2.417 is obtained which is included in category 2, meaning that for the design of machine elements that receive dynamic loading with an average confidence level for all design data. At the loading of 500 kg obtained a safety factor of 1.4502 which is included in category 1, meaning that for the design of structures that receive static loads with a high level of confidence for all design data.

Meanwhile, at the load of 700, 900, 1100 and 1200 kg the safety factor values obtained are 1.0358, respectively; 0.8056; 0.6591; 0.6042. The four safety factor values are not included in the predetermined safety factor category. This is because the number obtained based on the test results from the loading is below the minimum safety factor limit of 1.25. This shows that at the loading exceed the minimum security limit.

Conclusion

Based on the results of the analysis of static structural testing on the electric bicycle frame model, the Thunder BMX 350 watt type using the Ansys V17 software, the following conclusions were obtained.:

a. The maximum strength that can be held by the electric bicycle frame of the Thunder BMX type 350 watt with a maximum static test of 1,200 kg, the test indicator values obtained are for Equivalent Stress of 413.74 MPa, Equivalent Elastic Strain of mm/mm, and Total Deformation of mm.

b. b. After carrying out static testing with a maximum factory loading with a load of 100 kg, the Safety factor is 7.2509, which means that the design of static structures or machine elements that receive dynamic loading with uncertainty regarding how many combinations of loads, material properties, stress analysis, or environment. Then a maximum static test was carried out with a load of 1,200 kg, a safety factor of 0.6042 was obtained, meaning that the value of the safety factor obtained showed that it was past the minimum limit set so that the frame was not safe to use..

Reference

Arif, A. 2010, Melihat Indonesia dari Sepeda, Kompas, Jakarta, ISBN 978979-709-525-3

Firman, Mahandri, C. P., dan Satyadarma, D., 2007, Kaji Awal Kekuatan Rangka Sepeda Motor Hibrid, Jurusan Teknik Mesin Fakultas Teknologi Industri Universitas Gunadarma, Depok.

Fuad, M. A., 2015,Analisis Defleksi Rangka Mobil Listrik Berbasis Angkutan Massal Menggunakan Metode Elemen Hingga, Skripsi, Jurusan Teknik Mesin Fakultas Teknik Universitas Negeri Semarang, Semarang.

Gere, J.M. dan Timoshenko, S.P., 1984, Mekanika Bahan Jilid I, (terjemahan oleh : Ir. Bambang Suryoatmono, MSc. PhD.), Erlangga, Jakarta.

Irawan, A. P. 2007, Diktat Kuliah Mekanika Teknik, Program Studi Mesin Fakultas Teknik Universitas Tarumanagara, Tangerang.

Kastiawan, I. M. 2013, Statika Struktur, Andi, Yogyakarta.

Selis, 2016, Sepeda Listrik, www.selis.co.id/our-product/simple-series/selisthunder-bmx/, Diakses tanggal 07 Oktober 2016.

Smallman, R. E. and Bishop, R. J., 1999, Modern physical metallurgy dan materials engineering sixth edition, Butterworth-Heinemann.

Stolarski,T., Nakasone, Y., dan Yoshimoto., 2006, Engineering Analysis With Ansys Software, Butterworth-Heinemann., ISBN 0 7506 6875 X.

Syam, B., Fadila, A., 2015, Analisis Simulasi Struktur Chassis Mobil Mesin USU Berbahan Besi Struktur Terhadap Beban Statik Dengan Menggunakan Perangkat Lunak Ansys 14.5, Departemen Teknik Mesin Universitas Sumatera Utara, Medan.

Sutikno, E., 2011, Analisis Tegangan Akibat Pembebanan Statis Pada Desain Carbody TeC Railbus Dengan Metode Elemen Hingga, Teknik Mesin Universitas Brawijaya, Malang.

Widayana, G., K. Rihendra Dantes, dan K. Budarma, 2016, Analisis Kompratif Tegangan Statik pada Frame Ganesha Electric Vehicle 1.0 Generasi 1 Berbasis Continous Variable Transmission (CVT) Berbantu Software Ansys 14.5, Jurusan Pendidikan Teknik Mesin Universitas Pendidikan Ganesha Singaraja, Indonesia.