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Design and Analysis of Cast Wheel Types Mt and Wm with Spoke Variations Using Aluminum Alloy Materials Type 7050-T7651 and 7075-T6 (Sn)

Muhammad Sobirin[1], Ardhi Fathonisyam P.N[1], Mokh. Hairul Bahri[1]
[1]Department of Mechanical Engineering, Faculty of Engineering, University of Muhammadiyah Jember, east Java, Indonesia.

E-mail: sobirinsobirin31@gmail.com

Abstract--*The automotive industry is growing rapidly. Produce changes, especially in the level of Safety and comfort. Vehicle manufacturers are competing to improve the quality of the components used in these vehicles. One aspect of Safety and comfort is the Safety and comfort of the vehicle's wheels, in addition to an attractive wheel design. Therefore, the material used on the wheels is high-quality, with precise calculations and correct designs. Vehicle wheels are one of the main components in vehicles because vehicles without wheels cannot run. There are two kinds of wheels: spoke wheels (spoke wheels) and cast wheels. This study aims to determine how to design cast wheel wheels type MT and WM and analyze material comparison and the number of spokes based on simulation using the software. The simulation results show the design of the MT-type cast wheel: the maximum stress value on the 7050-T7651 aluminum alloy material is 426.784 MPa, and on the 7075-T6 (SN) aluminum alloy material, which is 426.784 MPa, it is still within the safe limit because it is still below the value yield strength. In the design of the WM-type cast wheel, the maximum stress value on aluminum alloy type 7050-T7651 is 362085 MPa. On aluminum alloy material type 7075-T6 (SN), which is 362,085 MPa, it is still within safe limits because it is still below the yield strength value. The maximum strain value for the two materials used is 3.987 x 100-6, and the maximum displacement value for both materials is 9.959 x 100-4. The highest factor of safety value on WM 5 spoke wheels with aluminum alloy type 7050 –T7651 is 1.76.*

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1. INTRODUCTION

The development of the automotive industry is getting more and more rapid. Bringing about changes, especially in the level of Safety and comfort [1][2]. Vehicle manufacturers are competing to improve the quality of the components used in the vehicle [3]. One of the aspects of Safety and comfort is the Safety and comfort of the vehicle leg, in addition to the attractive wheel design [4]. Therefore, the material used in the wheels is high-quality, with the correct calculations and the right design. There are two types of wheels, namely spoke wheels and cast wheels. Lately, however, more people have used cast wheels rather than spoke-type wheels because they look more modern. Even many vehicle manufacturers use cast wheel-type wheels on their standard wheels. Cast wheels on a motorcycle are the skeleton of a tire that withstands the vehicle's heavy load and strains or blows from the contours of the road surface. M. Adimas Nugraha, in his research entitled Numerical Analysis of Motorcycle Wheel Strength Burdened with Impact Load, said that to facilitate the model design process and simulation that will be carried out on cast wheel wheels, it can be done by using software based on the finite element method in the form of SolidWorks [4].

Research related to Cast wheel design has been carried out by several previous researchers, including one entitled: implementation of the Finite Element Method in Solidworks To Optimize the Front Cast Wheel Design for Motorcycles [5]. In addition, there is also a design and analysis of material strength in the planning of cast wheels of WM and

MT types, the design of cast wheel planning, and a comparative analysis of material strength in the planning of cast wheels of WM and MT types are based on simulation and evaluation through software. With two variations of aluminum alloy 6063-T83 and Alloy 7050-T73510 on WM and MT-type cast wheel models with static loading simulation using software [6].

From the above background, the author is interested in discussing research on the design and analysis of cast wheel wheels of MT and WM types with spoke variations using aluminum alloy materials types 7050-T7651 and 7075-T6 (SN).

The formulation of the problem in this study is how to design MT and WM type cast wheel wheels, how to effect material variations on the strength of MT and WM type cast wheel wheels, and how to affect the variation in the number of spokes of MT and WM type cast wheel wheels.

The objectives of this study are: To find out how to design cast wheels, to find out the comparative analysis of material strength in the planning of MT and WM type cast wheels based on simulation and evaluation through software, to find out the comparative analysis of the strength of the influence of the number of MT and WM type cast wheels Based on Simulation and evaluation through software, which has indeed been widely used by researchers to simulate various designs such as car body design [7], simulation of Pelton turbine bucket design optimization [8], overhead crane design [9], and also machine or production equipment design [10].

This research focuses on design and analysis using software, not making products. Only Aluminum Alloy type 7050-T7651 and Aluminum Alloy type 7075-T6 (SN) are used. Testing uses only static loads, and design analysis uses only Solidworks software.

2. METHODOLOGY

a. Literature study

The literature study is the first stage and the basis for carrying out this research. It includes data collection about the Velg cast wheel and the specification of the size and material to be used, the standard rules of cast wheel wheels, a research journal that discusses static tension, and a learning book about design, planning, and force analysis using the software. After collecting and studying this literature, it is hoped that it will support this research.

b. Tools and Materials

The tools needed in this study are as follows:

1. Laptops or computers in the author's research use laptops with the following specifications:
   - ASUS X455LJ series models.
   - INTEL(R) CORE(TM) I3-5010U CPU 2.10 GHz (4CPUs) processor.
   - 4 GB Memory
   - VGA INTEL(R) HD GRAPHICS 5500 and NVIDIA GeForce 920M VRAM 2 GB
2. SolidWorks 2017 Software

c. Selection of Cast Wheel Material Material. The material the author will use in the design of cast wheel wheels is Aluminum Alloy type 7050-T7651 and Aluminum Alloy type 7075-T6 (SN).

d. Simulation of Testing Cast Wheel Wheels with Static Load on the Wheels Things that must be determined in this study is one of the fixtures in the design of the Meshing Element wheels or the division of elements so that they become small elements.

e. Detailed drawings of this stage are the design details of MT and Wm type cast wheel wheels that have met the analysis test with the help of software

f. The conclusions and suggestions at this stage are the conclusions of the research results and suggestions for the research.

3. RESULT AND DISCUSSION

3.1 Simulation Results of MT Type Cast Wheel Wheels

1. Aluminum alloy material type 7050-T7651

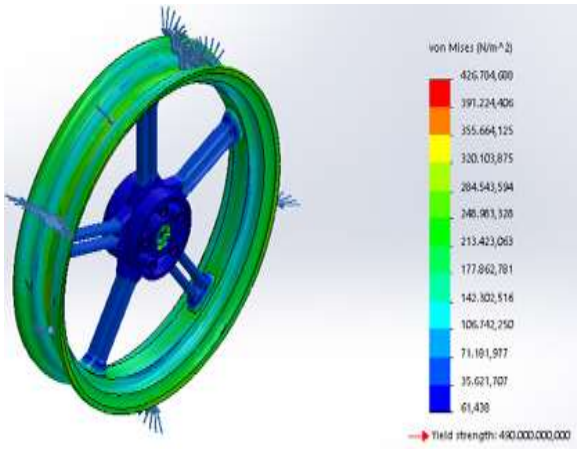

Figure 1. *MT 5 Spoke Wheel Tension*

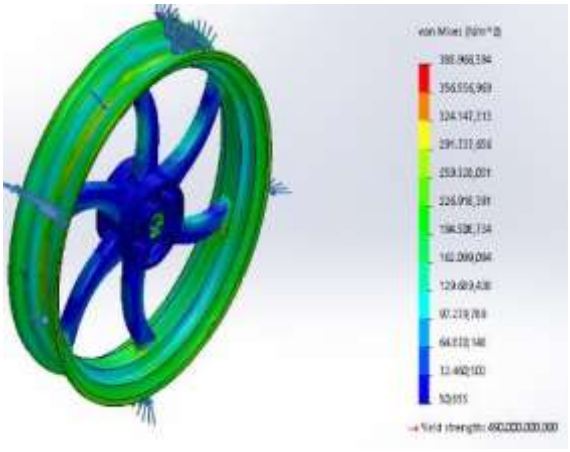

Figure 2. MT *6* Spoke Wheel Tension

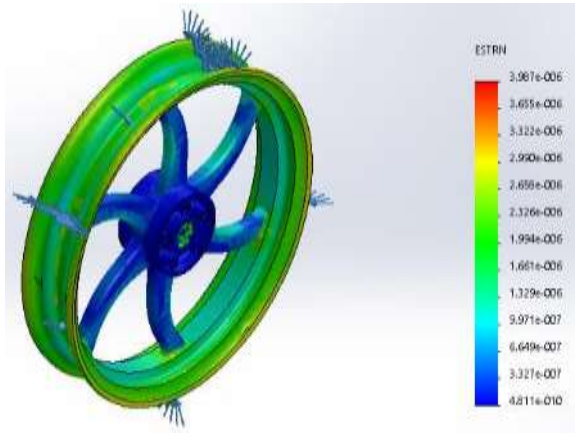

Figure 3. Stretch Wheels MT 5 Spoke

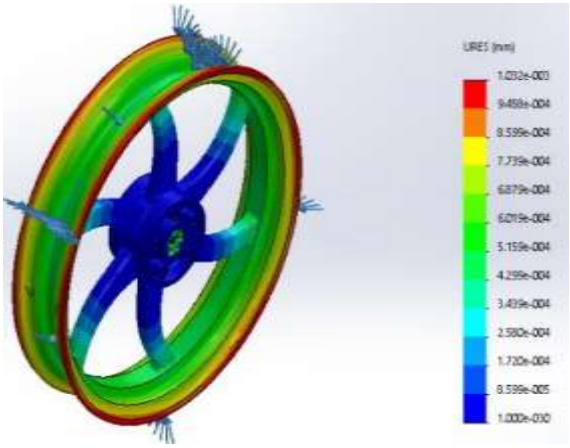

Figure 4. Stretch Wheels MT **6** Spoke

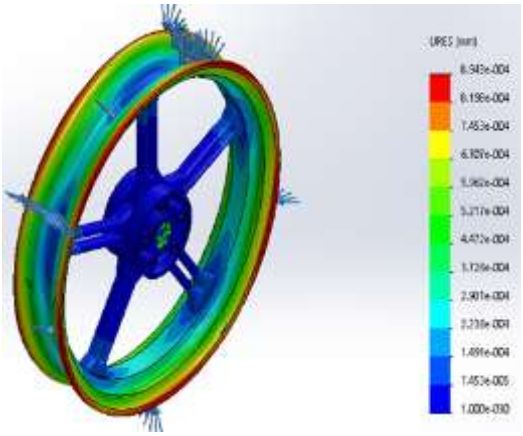

Figure 5. Displacement Alloy Wheels MT 5 Spoke

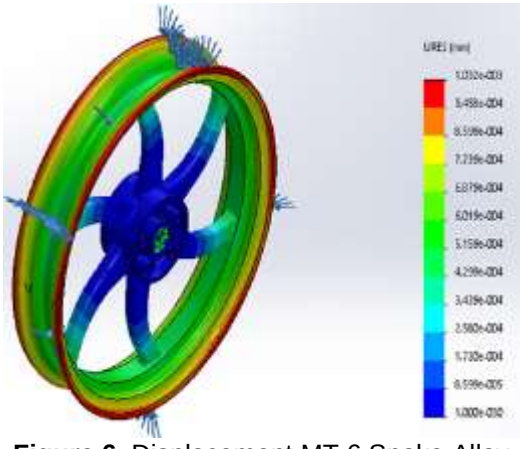

Figure 6. Displacement MT 6 Spoke Alloy Wheels

2. Material Alumunium alloy tipe 7075-T6(SN)

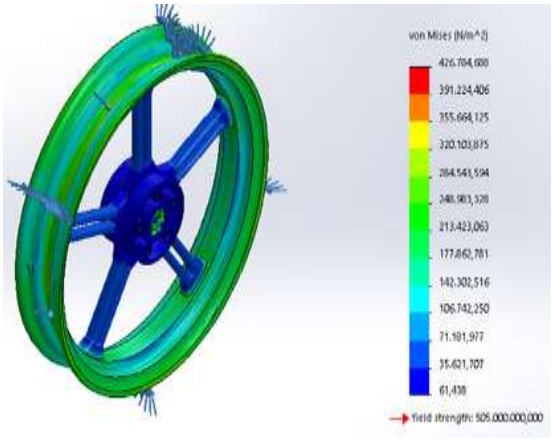

Figure 7. MT 5 Spoke Wheel Tension

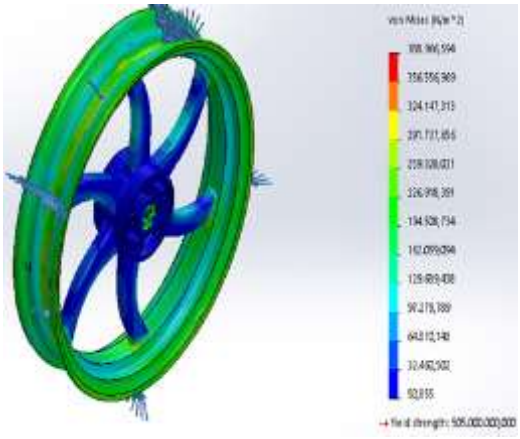

Figure 8. The stress of MT 6 Spoke Wheels

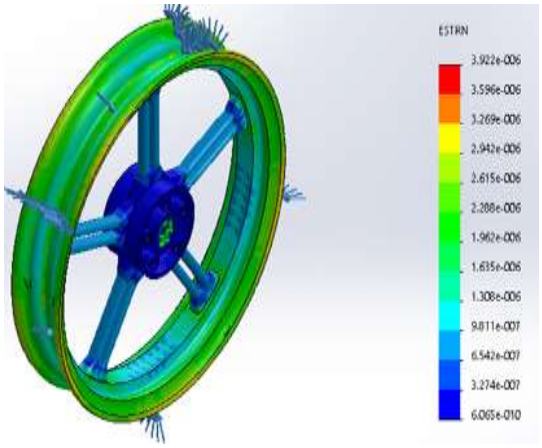

Figure 9. Stretch Wheels MT 5 Spoke

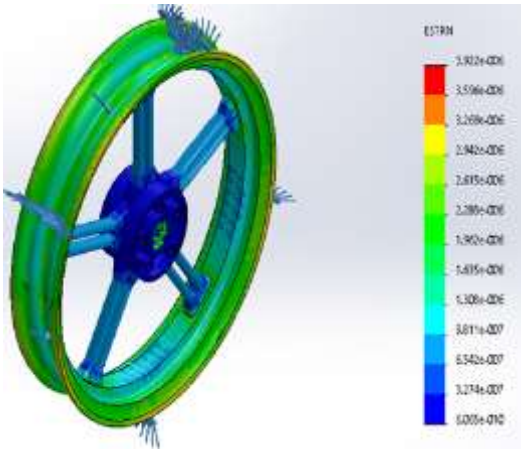

Figure 10. Stretch Wheels MT 6 Spoke

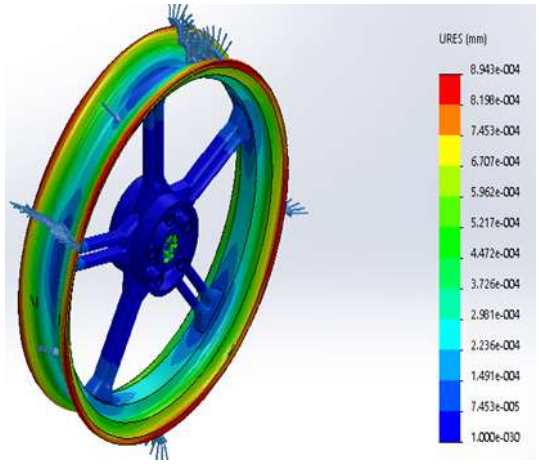

Figure 11. Displacement MT 5 Spoke Wheels

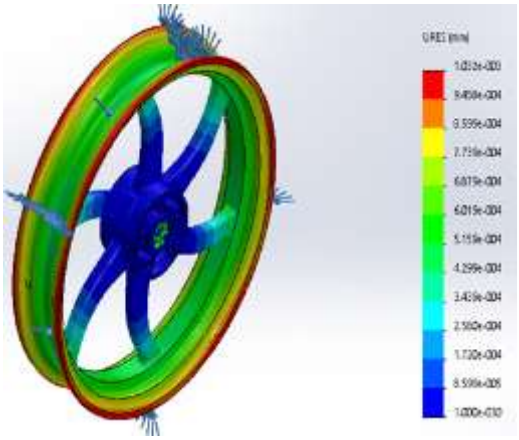

Figure 12. Displacement MT 6 Spoke Alloy Wheels

3.2 WM Type Cast Wheel Simulation Results

1. Material aluminum alloy type 7050-T7651

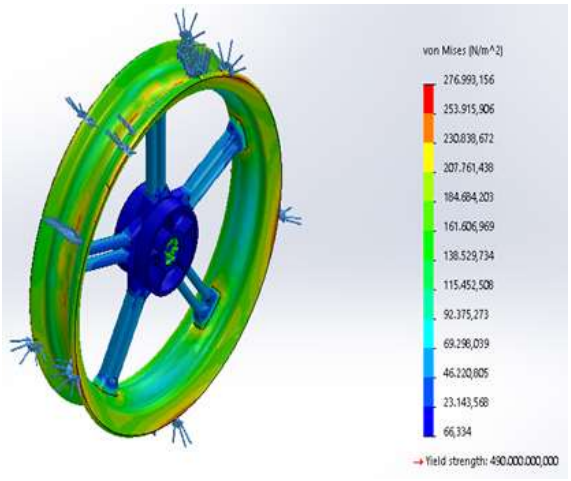

Figure 13. WM 5 Spoke Wheel Tension

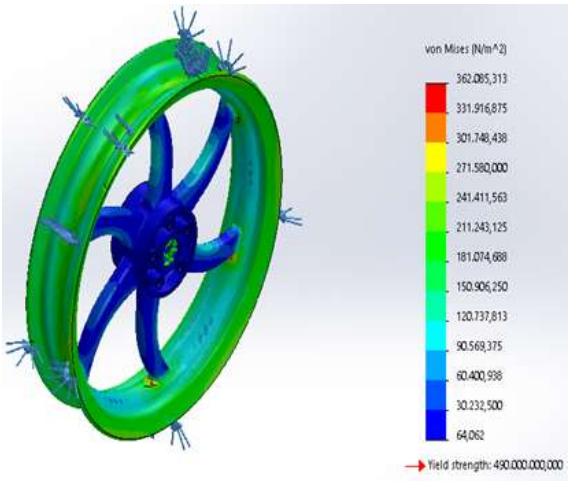

Figure 14. WM 5 Spoke Wheel Tension

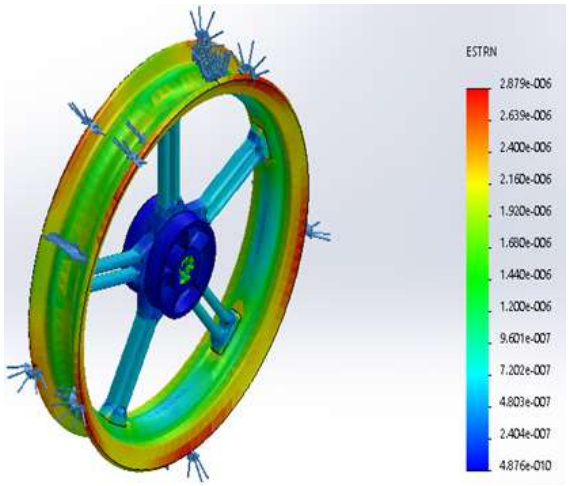

Figure 15. Stretch Wheels WM 5 Spoke

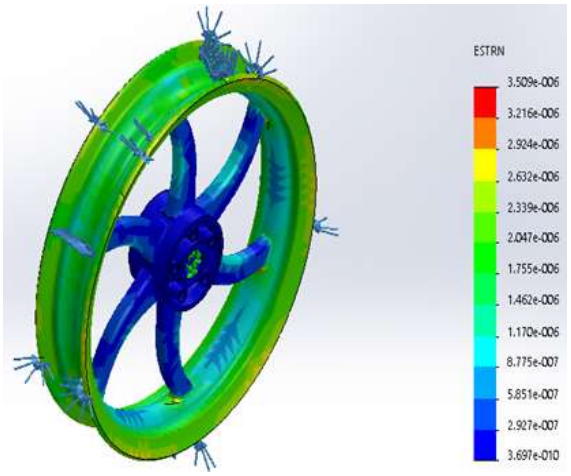

Figure 16. Stretch Wheel WM 6 Spoke

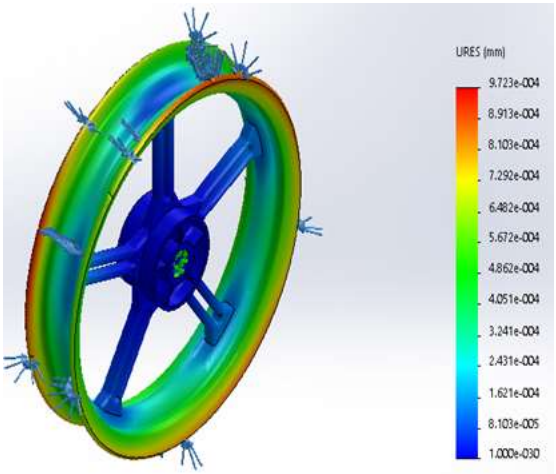

Figure 17. Displacement Alloy Wheels WM 5 Spoke

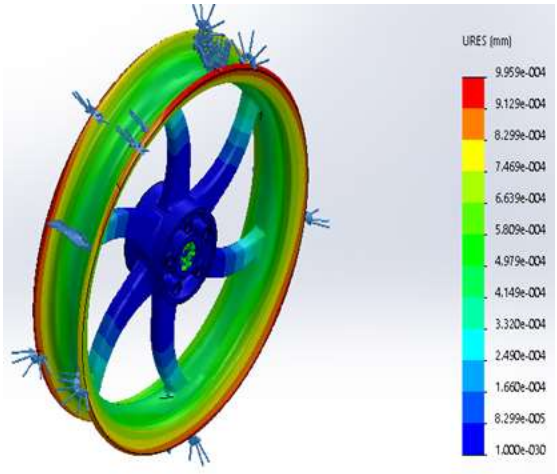

Figure 18. Displacement WM 6 Spoke Alloy Wheels

2. Material Aluminum alloy type 7075-T6(SN)

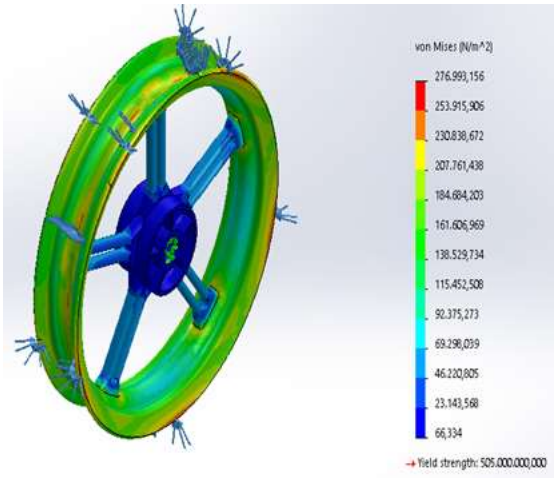

Figure 19. WM 5 Spoke Wheel Tension

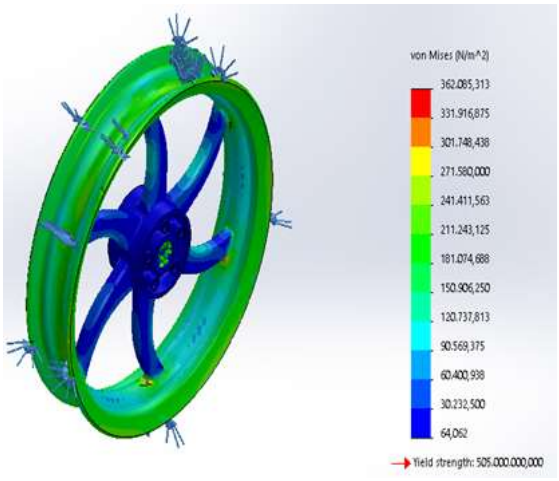

Figure 20. WM 6 Spoke Wheel Tension

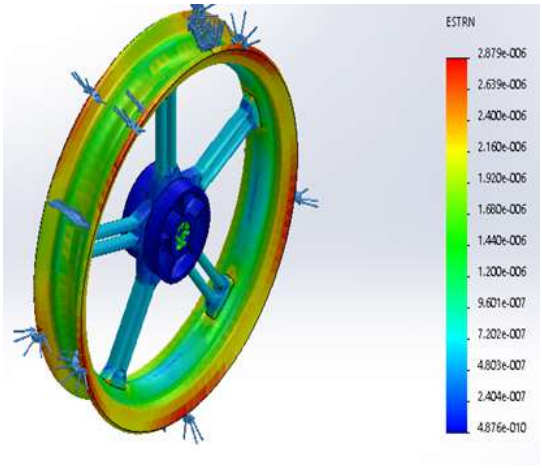

Figure 21. Stretch Wheels WM 5 Spoke

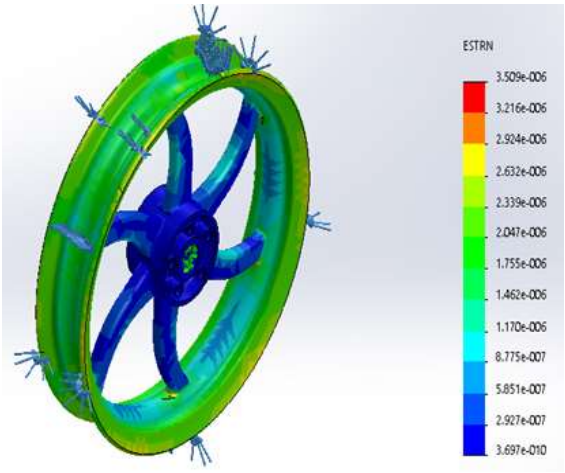

Figure 22. Stretch Wheel WM 6 Spoke

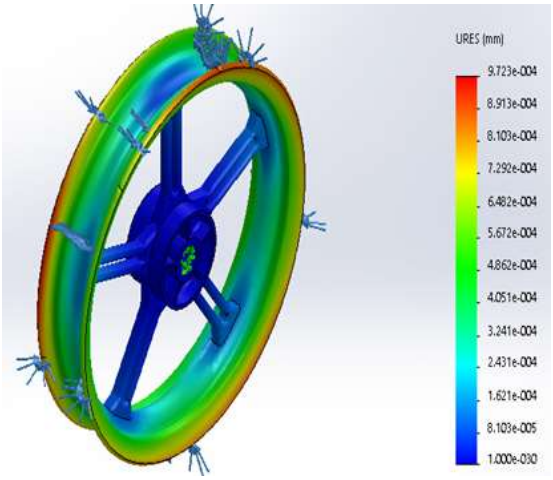

Figure 23. Displacement Alloy Wheels WM 5 Spoke

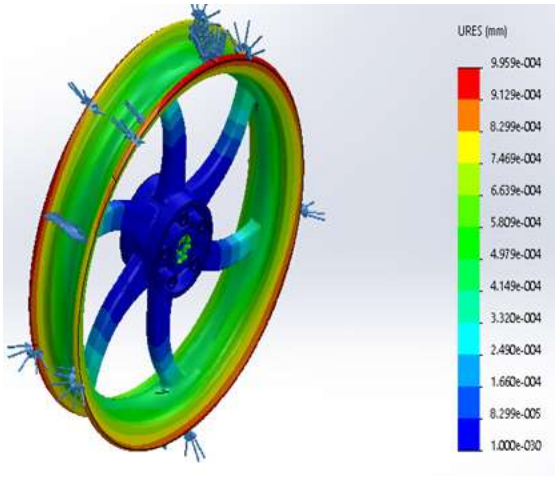

Figure 24. Displacement WM 6 Spoke Alloy Wheels

3.3 RESULTS OF CALCULATION AND DATA ANALYSIS

Table 1 shows the simulation results of MT and WM-type cast wheel wheels obtained with material variation and the number of spokes under static loading, resulting in tension, strain, and displacement with maximum and minimum values.

Table 1. Simulation Results of MT and WM Cast Wheel Wheels

Simulation Results of MT and WM Type Cast Wheel Wheels

Velg Tipe	Number of Spokes	Material	Stress MPa		Strain		Displacement mm	
			Max	Min	Max	Min	Max	Min
MT	5	Aluminum Alloy 7050 - T7651	426.784	61.438	3.922×100^{-6}	6.065×10^{-10}	8.943×100^{-4}	1×10^{-30}
		Aluminum Alloy 7075 - T6 (SN)	426.784	61.438	3.922×100^{-6}	6.065×10^{-10}	8.943×100^{-4}	1×10^{-30}
	6	Aluminum Alloy 7050 - T7651	388.966	50.855	3.987×100^{-6}	4.811×10^{-10}.	1.032×100^{-3}	1×10^{-30}
		Aluminum Alloy 7075 - T6 (SN)	388.966	50.855	3.987×100^{-6}	4.811×10^{-10}	1.032×100^{-3}	1×10^{-30}
WM	5	Aluminum Alloy 7050 - T7651	276.993	66.334	2.879×100^{-6}	4.876×10^{-10}	9.723×100^{-4}	1×10^{-30}
		Aluminum Alloy 7075 - T6 (SN)	276.993	66.334	2.879×100^{-6}	4.876×10^{-10}	9.723×100^{-4}	1×10^{-30}
	6	Aluminum Alloy 7050 - T7651	362.085	64.062	3.509×100^{-6}	3.697×10^{-10}	9.959×100^{-4}	1×10^{-30}
		Aluminum Alloy 7075 - T6 (SN)	362.085	64.062	3.509×100^{-6}	3.697×10^{-10}	9.959×100^{-4}	1×10^{30}

The highest strain value is found on the MT 6 Spoke velg with a value of 3.987×100^{-6}, and the lowest strain value is found on the WM 5 spoke wheels with a value of 2.879×100^{6}. More details are in the following graph:

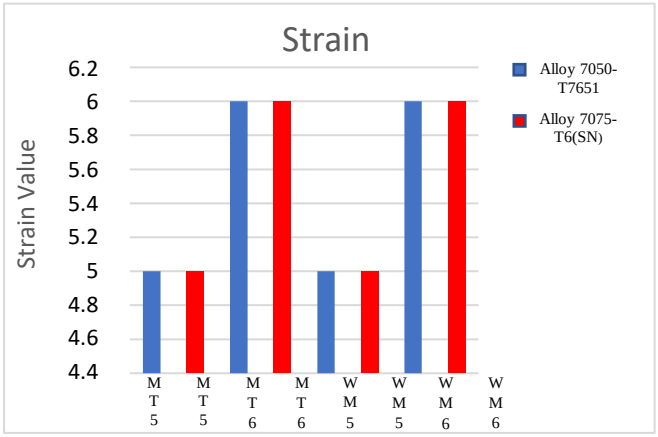

Figure 26. MT and WM Wheel Stress Chart

The highest displacement value is found on the WM 6 spoke wheels, with a value of 9.959×100^{-4}, and the lowest displacement value is on the MT 6 spoke wheels at 1.032×100^{-3}. More clearly in the graph below:

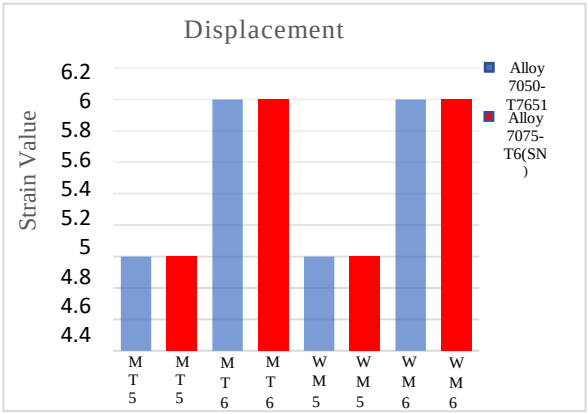

Figure 27. MT and WM Wheel Displacement Chart

The factor of Safety cast wheel MT and WM types with variations in material and number of spokes, the value of the results of the factor of safety analysis will be explained in the table below:

Table 2. Results of Factor Of Safety Analysis

Analysis		Material	Yield strength MPa	Maximum Stress MPa	Factor of Safety	Description
MT	5	Aluminum alloy 7050-T7651	490	426.784	1.14	Safe
	5		490	426.784	1.14	Safe
	6	Aluminum alloy 7075-T6(SN)	505	388.966	1.29	Safe
	6		505	388.966	1.29	Safe
WM	5	Aluminum alloy 7050-T7651	490	276.993	1.76	Safe
	5		490	276.993	1.76	Safe
	6	Aluminum alloy 7075-T6(SN)	505	362.085	1.39	Safe
	6		505	362. 085	1.39	Safe

Table 2 above shows that the factor of safety value with the highest value is found on WM 5-spoke type wheels, and the lowest value is on MT 5-spoke type wheels with a value of 1.14. More clearly in the graph below:

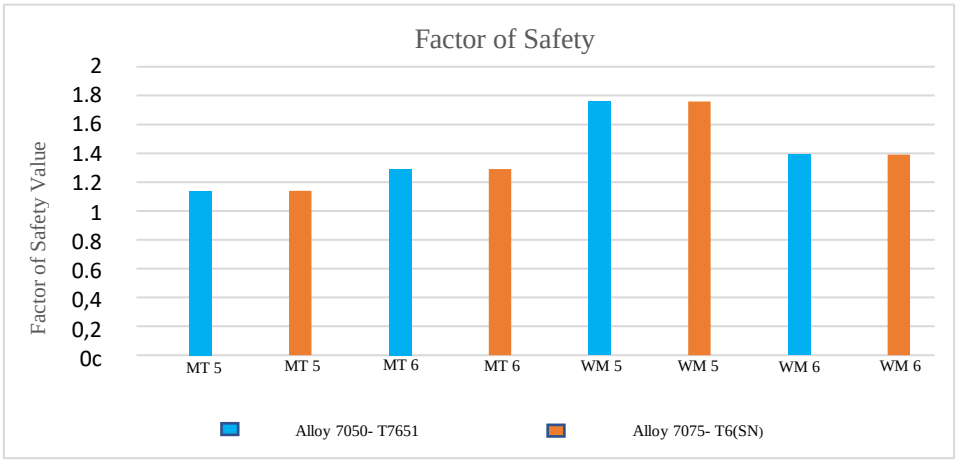

Figure 28. The Factor of Safety Graph

4. CONCLUSION

From the research that the author has carried out, the following conclusions can be drawn:

1. The design of MT-type cast wheel wheels has a maximum stress value of 426.784 MPa in aluminum alloy material type 7050-T7651, which is 426.784 MPa, and in aluminum alloy material type 7075-T6 (SN), which is 426.784 MPa is still within the safe limit because it is still below the yield value of stress. The design of the WM-type cast wheel has a maximum stress value of 362,085 MPa in aluminum alloy material type 7050-T7651, which is 362.085 MPa, and in aluminum alloy material type 7075-T6 (SN), which is 362.085 MPa is still within the safe limit because it is still below the yield value of stress.
2. The maximum strain value on the two materials used is 3.987 x 100^{-6}, and the maximum displacement value on both materials is 9.959 x 100^{-4}.

The highest safety factor value on WM 5-spoke wheels with aluminum alloy material type 7050 – T7651 is 1.76. The simulation results showed that the variation in the number of spokes and the variation of aluminum alloy material using a static load with a pressure of 1078 N affected each MT and WM-type cast wheel's stress, strain, and displacement values.

5. SUGGESTION

In order for the research carried out by the author to develop, the author gives the following suggestions:

1. Learn engineering drawings to make it easier to design.
2. Looking for more references to related journals as a comparison and source of research.
3. Use strong and safe materials when driving at economical material prices.
4. Use more qualified computer or laptop specifications so that the software operation is even better.

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