JIM Vol.6 (2) 2024

Received: 03 07 2024 | Revised: 03 09 2024 | Accepted: 20 10 2024

DOI: 10.15294/jim.v6i2.20153

Page 33 - 39

JIM: Jurnal Inovasi Mesin

Strength Analysis of Wheel Stopper Design on Dyno Test Based on Solidwork 2019 Software

Samuel Julianto Purba[1*], Widya Aryadi[1]

1 Department of Mechanical Engineering, Faculty of Engineering, Universitas Negeri Semarang, Indonesia
*samueljpurba@students.unnes.ac.id

Keywords:
Dyno test
Hydraulic
Innovation
Design
Wheel stopper

Abstract

Various innovations have been made in all parts of the world to deal with global warming. One of them is making electric vehicles. One of the things that must be done to keep up with the number of electric vehicle production is to innovate the vehicle 'test' tool. The dyno test is one of the 'test' tools for electric vehicles on two wheels. One of the innovation gaps that can be addressed is creating a wheel stopper design on a new dyno test to speed up production time. The wheel stopper was designed using a hydraulic system with MTEK WC1 UNS J13047 cast alloy steel metal material. The design was done using Autodesk Inventor 2024 and analyzed using Solidwork 2019. Then, the analysis results are compared with the existing wheel stopper design using ASTM A36 steel. It will also determine whether a hydraulic system design can be implemented. The maximum displacement and minimum safety factor results obtained on the hydraulic wheel stopper are 0.1746 mm and 2.5. These results show that the hydraulic wheel stopper design can be implemented.

1 Introduction

Currently, motorized vehicles are one of the main contributors to air pollution [1]. Even motorized vehicles are the most contributing thing in this regard [2]. By 2030, it is estimated that 23 percent of CO2 emissions are generated by fossil fuels [3]. Therefore, innovation in electric vehicle production is needed to reduce these emissions. One of the things that can help humans innovate is technology [4]. This is very likely to happen in Indonesia because Indonesia will become the center of the world's electric vehicles. By the end of 2023, there will be 108,000 units of electric vehicles in Indonesia. One of the things that can be done to keep up with the increase in electric vehicle production is to innovate on the electric vehicle testing equipment, in this case leading to the dyno test wheel stopper section for two-wheeled vehicles.

The dyno test is one of the tools to measure the torque and power produced or required by a vehicle [1]. Dyno test can also measure the initial drive output [5]. Dyno test is divided into two types, namely, chassis and engine dynamometer. One of the main parts of the dyno test is the wheel stopper. Innovation in the wheel stopper is expected to make the time of using the tool more efficient. Time in the industrial world is significant because it is related to the stress level of workers [6]. The function of the dynamometer itself is to resist and measure the torque generated by the prime mover to which it is connected, and its accuracy is vital to all other derived measurements made during the engine testing procedure [7]. In this article, the authors will design a wheel stopper that uses a hydraulic system [8]. The dyno test will be inertia-based [9]. The wheel stopper will be designed using Autodesk Inventor 2024 and analyzed using Solidwork 2019. The analysis results will be compared with those of the existing wheel stopper analysis.

ISSN 2746-7694

2 Research Methods

The data approach applied in this research is a qualitative approach with experimental methods. The tools used to help this research are a laptop, meter, and two software, Autodesk Inventor 2024 and Solidwork 2019. This research process is divided into several stages: literature study, data collection in the form of dyno test measurements, making 3D designs in Inventor, software validation using robotic arms as materials, frame analysis using Solidwork, processing data analysis, and drawing conclusions.

There are various variables in this research. The independent variables consist of ASTM A36 material for the first design and MTEK WC1 UNS J12047 cast alloy steel for the second design. The dependent variables include safety factors, von Mises stress, and displacement. The control variable is the loading number. The wheel stopper will be subjected to a load of 715.22 N horizontally. For the first design, a load of 580.16 N was added in the vertical direction because the wheel would also hit the bottom of the wheel stopper. The data validity technique uses validity techniques. Descriptive analysis techniques will be used for data analysis techniques.

3 Result and Discussion

The first thing that was done was software validation. Software validation is done using the robotic arm. The robotic arm in the journal uses stainless steel material as seen as table 1.

Table 1. Material properties of stainless steel in the journal.

Material	Elastic Modulus (N/m^2)	Poisson's ratio	Density (kg/m^3)
Stainless Steel	1.95×10^{11}	0.247	7700

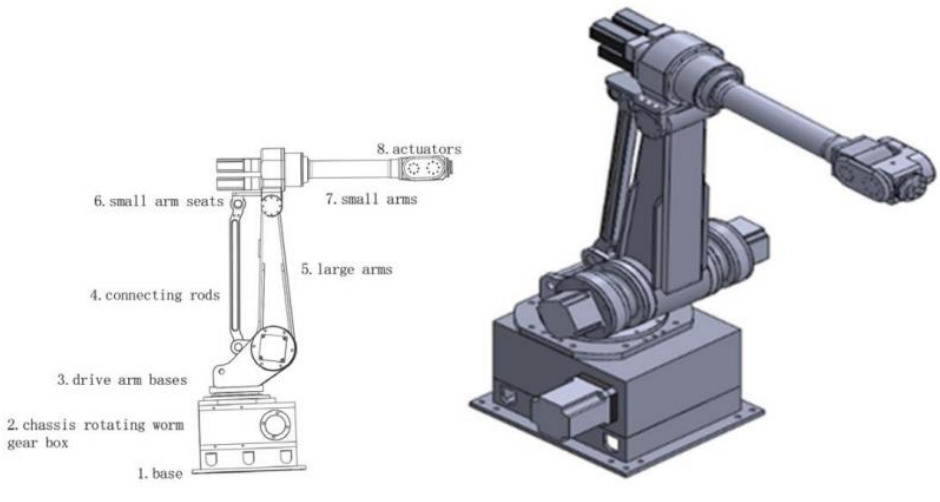

Figure 1. Robotic arm on the journal

In Figure 1. With the same item, we will look for a robotic arm whose shape is close to the shape of the journal and will arrange the loading conditions accordingly. In this case, the loading condition is in the state of the small arm facing down. At the end, the small arm will be subjected to a load of 500N [10]. The design will be entered into Solidwork 2019 for analysis as seen as figure 2 and 3.

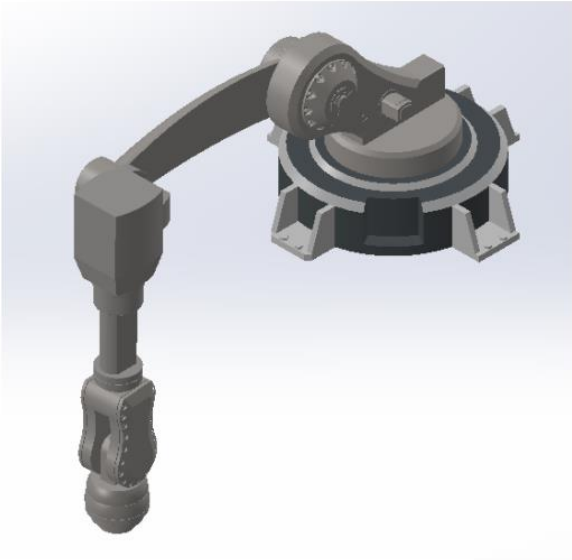

Figure 2. New robotic arm on Solidwork

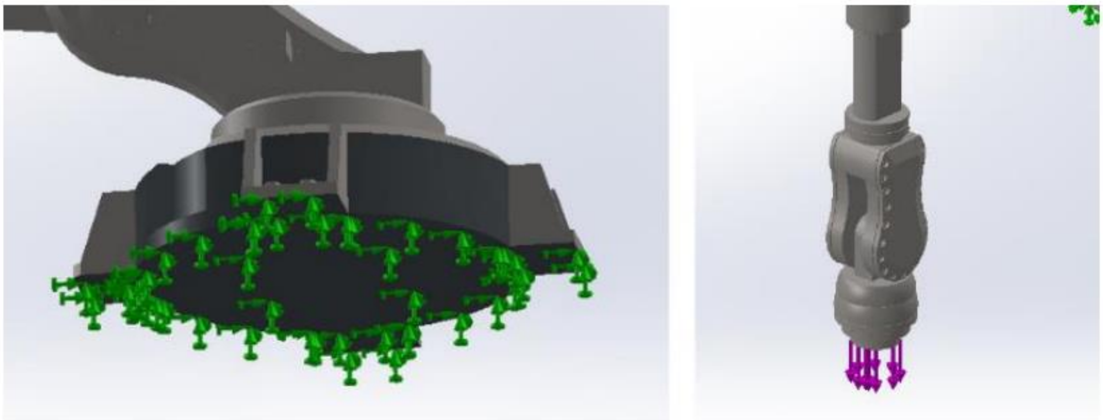

Figure 3. Fixed geometry points (green) and loading (purple)

From table 2, According to the mass type of robotic arm in the journal, cast stainless steel is the material to be applied in Solidwork. The meshing type that will be applied is curvature-based mesh. The maximum element mesh variation to be used is 30, 27.5, 25, 22.5, 20, and 17.5 mm. The minimum element mesh variation will be 6, 5.5, 5, 4.5, 4, and 3.5 mm.

Table 2. Material properties cast stainless steel.

Elastic Modulus (N/m^2)	1.9×10^{11}
Poisson's Ratio	0.26
Shear Modulus (N/m^2)	7.9×10^{10}
Mass Density (kg/m^3)	7700
Thermal Expansion Coefficient (K)	1.5×10^{-5}
Thermal Conductivity (W/(m.K))	37
Specific Heat (J/(kg.K)	520

In Table 3, The thing that will be compared from the journal results and what has been done is the maximum displacement. Variations from the maximum displacement results that are closest to the maximum displacement in the journal will be sought.

Table 3. Results of analysis in Solidwork

Minimum element size **(mm)**	***Maximum displacement*** **(mm)**	***Nodes***
6	0.2387	5743
5.5	0.2388	7469
5	0.2389	8736
4.5	0.2393	10849
4	0.2394	14240
3.5	0.2396	17137

In the journal, the maximum displacement result is 0.28045. The closest figure to the Solidwork analysis results is 0.2396 mm, with a minimum element size of 3.5 mm. Therefore, the meshing that will be applied to design 1 is a curvature-based mesh with maximum and minimum element sizes of 17.5 and 3.5 mm. For design 2, the meshing that will be applied is a standard mesh with an element size of 3.5 mm and a tolerance of 0.175 mm due to the limited capabilities of the research tool as seen as figure 4 and 5.

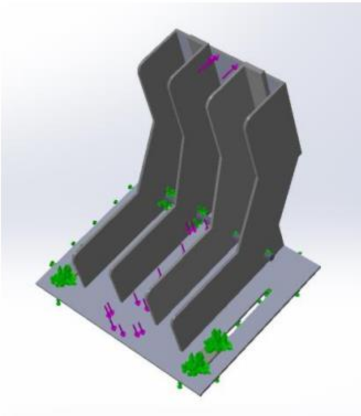

Figure 4. Location of fixed geometry (green) and loading (purple) design 1

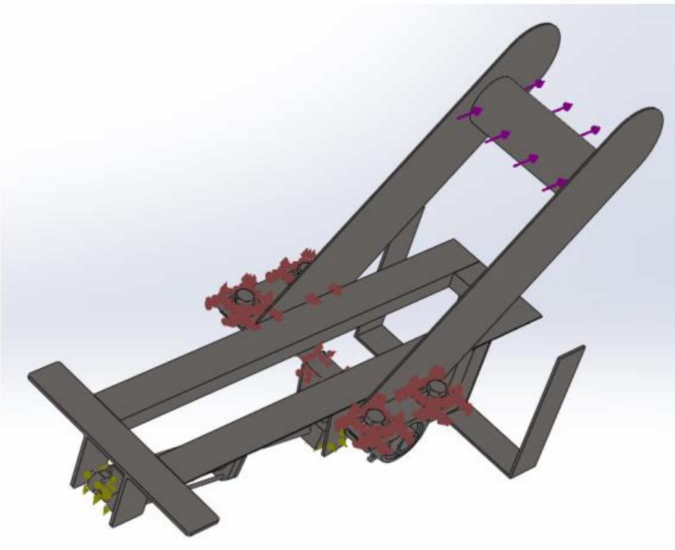

Figure 5. Location of fixed geometry (brown), fixed hinge (yellow), and loading (purple) design 2

From table 4, after the analysis is carried out, the analysis results consisting of von mises stress, displacement, and safety factor of design 1 and design 2 are obtained. As seen as figure 6 and 7.

Table 4. Analysis results of design 1 and design 2

No	Design	Frame Test Result Data					
		Von Mises Stress (Mpa)		**Displacement (mm)**		**Safety Factor**	
		Min	**Max**	**Min**	**Max**	**Min**	**Max**
1	Design 1	0.002391	5.945	0	0.01838	42.05	1.046×10^{11}
2	Design 2	0	96.52	0	0.1746	2.5	1×10^{16}

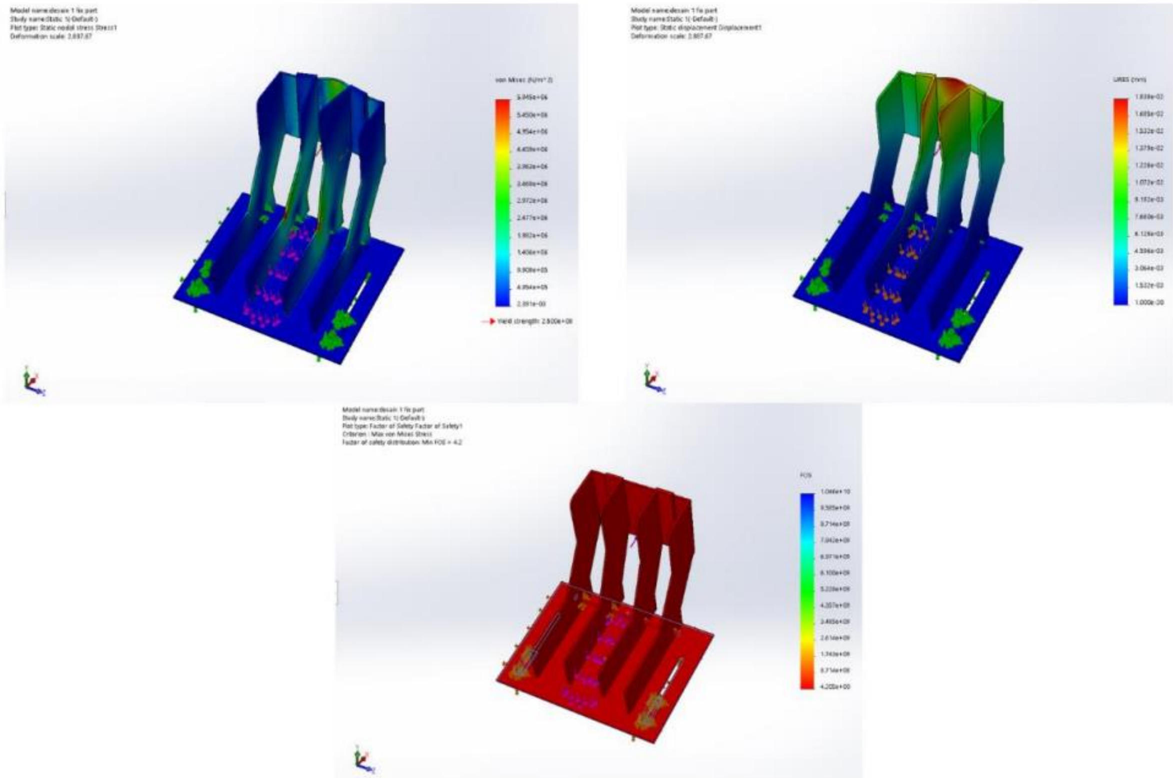

Figure 6. Distribution of von mises stress, displacement, and safety factor in design 1

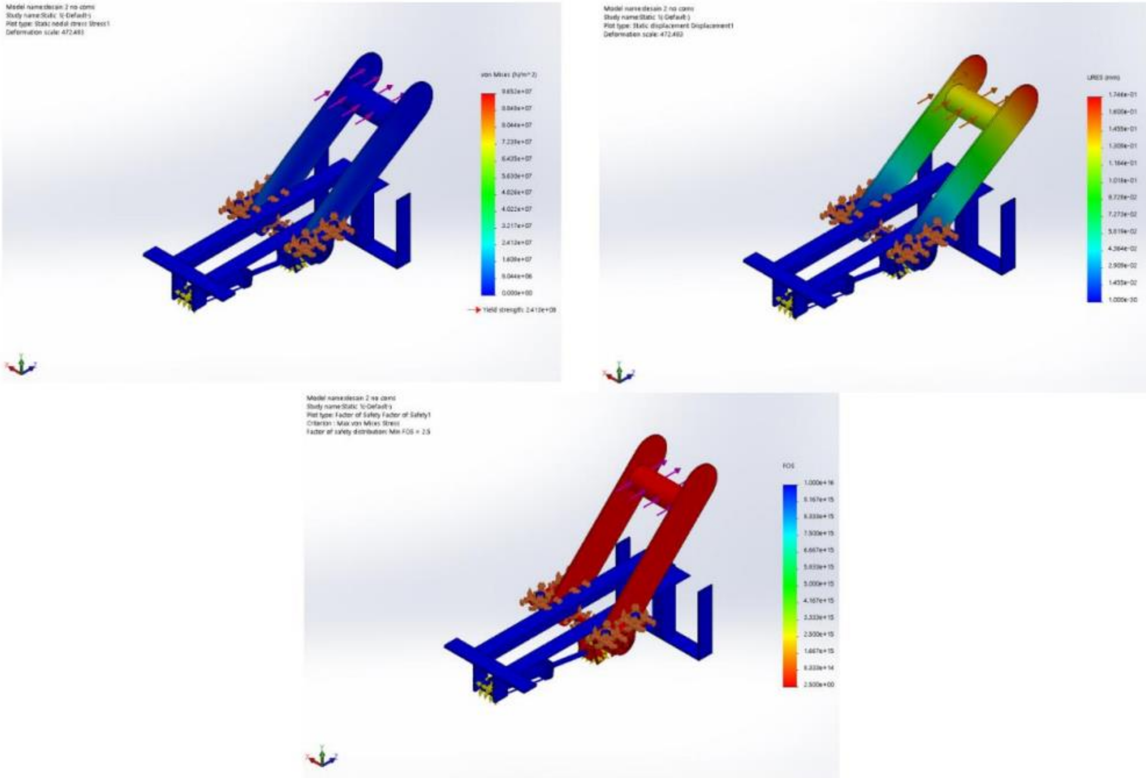

Figure 7. Distribution of von mises stress, displacement, and safety factor in design 2

4 Conclusion

The minimum von Mises stress value is most significant in design one at 0.002391 MPa. The most considerable maximum von Mises stress value is 96.52 MPa in design 2. Both designs have the same most minor displacement of 0 mm. The maximum displacement value is 0.1746 mm in design 2. The most considerable minimum safety factor value is in design one, worth 42.05.

From the values obtained, design 2, namely the dyno test wheel stopper design that uses a hydraulic system, is declared safe to implement because it has a minimum safety factor value above the recommended value of 2. By implementing this design, the working time for using the dyno test to test electric motorbikes is hoped to be more effective.

5 Acknowledgement

The author would say thank to Universitas Negeri Semarang for supporting the research.

References

1. Gandi Aditya and Denny Darlis, "PERANCANGAN DYNOTEST PORTABLE UNTUK SEPEDA MOTOR DENGAN SISTEM MONITORING MENGGUNAKAN MODUL ISM FREKUENSI 2 . 4 GHz DYNOTEST POTABLE DESIGN FOR MOTORCYCLE WITH MONITORING SYSTEM USING ISM MODULE FREQUENCY 2 . 4 GHZ," *e-Proceeding Appl. Sci.*, vol. 1, no. 2, pp. 1231–1238, 2015.

2. V. T. P. Sidabutar, "Kajian pengembangan kendaraan listrik di Indonesia: prospek dan hambatannya," *J. Appl. Stat.*, vol. 45, no. 12, pp. 2269–2278, 2018.

3. Budy P. Resosudarmo, Ditya A. Nurdianto, and Arief A. Yusuf, "Greenhouse Gas Emission in Indonesia: The Significance of Fossil Fuel Combustion," *Reg. Dev. Energy Environ. Indones.*, no. July, pp. 146–159, 2009.

4. Ana Maritsa, Unik Hanifah Salsabila, Muhammad Wafiq, Putri Rahma Anindya, and Muhammad Azhar Ma'shum, "Pengaruh Teknologi Dalam Dunia Pendidikan," *Al-Mutharahah J. Penelit. dan Kaji. Sos. Keagamaan*, vol. 18, no. 2, pp. 91–100, 2021.

5. Pramudya Teguh Pambudi, Ali Akbar, and Kuni Nadliroh, "Analisa Kinerja Dynotest Berbasis Momen Inersia," vol. 7, pp. 780–792, 2023.

6. Mila Hariani, Wulandari, Rahayu Mardikaningsih, Eli Masnawati, and Uswatun Chasanah, "Teknik Manajemen Waktu yang Efektif Untuk Mengatasi Stres Dalam Industri," *Tek. Manaj. Waktu yang Ef. Untuk Mengatasi Stres Dalam Ind.*, vol. 3, no. 1, pp. 70–77, 2021.

7. E. Grobbelaar, "The development of a small diesel engine test bench employing an electric dynamometer," *Stellenbosch Univ.*, vol. 155, no. March, pp. 2–5, 2017.

8. A. W. Rendra Agviola Putra, "Perancangan Dan Pembuatan Prototipe Mesin Pengepress Hidrolik Limbah Plastik," *J. Mech. Manuf. Technol.*, vol. 2, no. 1, pp. 27–34, 2021.

9. Moch. Enggie Satriawan, Ali Akbar, and Kuni Nadliroh, "Perancangan Sistem Dynotest Berbasis Momen Inersia," *Agustus*, vol. 7, pp. 2549–7952, 2023.

10. L. Jinmin Zhang, Lihong Wang, "Static Analysis of Manipulator Based on Solidworks and ANSYS Workbench," *J. Phys. Conf. Ser.*, vol. 2477, no. 1, 2023.