International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 9, Issue 10, pp 135-142, October-2025

https://doi.org/10.47001/IRJIET/2025.910018

Structural Chassis Bus Analysis

[1]*Eflita Yohana, [2]Syaiful

[1,2]Dept. of Mechanical Engineering, Diponegoro University, Jl. Prof. Sudarto No. 13, Tembalang, Kec Tembalang, Semarang, Central Java 50275, Indonesia

*Corresponding Author's E-mail: eflitayohana@live.undip.ac.id

Abstract **- Transportation technology is developing very rapidly, this is due to the increasing level of human mobility. One of the most convenient, cheap, and efficient means of transport is the bus. In developing a bus, a chassis frame is required as a support for all the loads of the vehicle and therefore must have good durability. The study consists of two core steps, namely, the design of the bus chassis using Solidworks 2020 and the FEM (Finite Element Method) simulation using ANSYS. In the FEM simulation phase, the chassis model is imported from Solidworks. The materials used in this simulation are Aluminum 6061-T6, Aluminum 7075-T6, S690, ASTM A572 HSLA 60, and JIS G3101 SS400. The results of this study show that Aluminum 7075-T6 is more effective for use as a chassis material with a Deformation value of 14.347 mm, Equivalent Stress 303.13 MPa, and a Safety Factor of 1.6659.**

Keywords: Deformation, Equivalent Stress, Equivalent Strain, Chassis, FEM.

I. INTRODUCTION

Technology in the field of transportation is developing rapidly; this is due to increased human mobility. Therefore, it is necessary to develop a transportation system that meets the criteria of safety, speed, economy, and convenience [1]. In Lopes's view, the transport sector is undergoing gradual development to improve efficiency in passenger transport [2]. The transport sector plays an important role in ensuring the smoothness and safety of the rapid movement of people and goods. The smoothness and safety of such movements have a positive impact on accelerating the development process. Due to the importance of the transport sector's role in the development process, it is necessary that the transport system be seriously studied and integrated to improve services to society [3]. Most of the activities of the community relate to the use of means of transportation because it facilitates moving goods or individuals to their intended destination [4]. The information is seen through data published by the Central Statistics Agency of Indonesia, where in 2020 there were about 15,797,745 passenger cars, 233,261 buses, and 5.083,405 freight cars. These numbers continue to increase over time. One of the most efficient, cost-effective, and convenient transportation options is by bus. This advantage is due to the capacity of the bus, which can transport a lot of passengers, so it can reduce the use of private vehicles on the highway.

In addition to considering comfort, bus safety is also an aspect to pay attention to. In the bus manufacturing process, the chassis design plays an important role in ensuring the safety of the driver and passengers. A chassis is a crucial part of a vehicle designed to ensure the driver's comfort through its connection to the components of the curtain, suspension, power train, cabin, brakes, engine, and so on [5]. As the main frame, the chassis serves to support all components of the vehicle. When installing all parts of the vehicle, it is necessary to do so carefully to achieve optimal balance and avoid unwanted changes in vehicle weight [6].

In the automotive industry, research on chassis is a major challenge in obtaining lightweight and quality components [7]. The choice of material for the chassis can help optimize the weight and strength of the chassis itself. If the material is exposed to excessive loads, the possibility of deformation exceeds the tension limit of the ventricle and causes failure [8]. Therefore, analysis using the method of elements is necessary against some variation of the material used [9]. Thus, the study aims to analyze the structural performance of five types of materials used in the construction of bus chassis.

II. METHODOLOGY

In this study, the finite element method (FEM) is used. The method of element up is a method that divides an object to be analyzed into several parts with a quantity up to "finite". This method has several advantages, one of which is the flexibility in the variation of the forms of discretion of the elements used, such as the square, triangle, and other variations [11].

2.1 Software

There is a variety of commonly used FEM analytics software, and an effective solution to solve these problems is to use CAD and CAE. CAD (Computer Aided Design) is a design system that uses computer devices and specialized design software, enabling engineers to plan, model, and evaluate a product or item accurately before it is produced

ISSN (online): 2581-3048
Volume 9, Issue 10, pp 135-142, October-2025
https://doi.org/10.47001/IRJIET/2025.910018

[12]. CAE (Computer Aided Engineering) is a technology used to calculate the characteristics of a product or part of the product using computer aid[13]. One software that can be used for CAD and CAE is ANSYS. ANSYS is a software package that can model elements to solve a variety of mechanical problems, including static, dynamic, structural analysis (linear and nonlinear), heat transfer, fluid, acoustic, and electro-magnetic [14].

2.2 Material

In the study, the researchers selected five variations of materials used, namely Aluminum 6061-T6, Aluminum 7075-T6, S690, ASTM A572 HSLA 60, and JIS G3101 SS400. The last three materials were chosen because of their combination of strength, reliability, and relatively affordable prices. Meanwhile, Aluminum 6061-T6 and Aluminum 7075-T6 are chosen because they have a lighter weight than the three previous materials but have a fairly high strength. Information on the mechanical properties of these five materials can be seen in Table 1.

Table 1: Mechanical properties [1]

Properties	Aluminum 6061-T6	Aluminum 7075-T6	S690	ASTM A572 HSLA 60	JIS G3101 SS400
Yield Strength (MPa)	275	505	690	470	245
Ultimate Strength (MPa)	310	570	770	580	400
Young’s Modulus (GPa)	69,0	71,7	200	190	190
Shear Modulus (GPa)	26,6	26,9	60	73	79
Poisson Ratio	0,33	0,33	0,27	0,29	0,26

2.3 Meshing

In the context of the FEM (Finite Element Method) simulation, mesh elements are used to divide domains into smaller subdomains, where differential equations are applied and solved numerically. The importance of good meshing is to ensure the accuracy and stability of numerical solutions as well as optimize computing time. The meshing process involves several factors, including the selection of the type of element and the determination of its size.

In this study, the type of tetrahedron element was chosen, and the size of the element used was 5 mm. The choice of the type of tetrahedron mesh is based on its flexibility. Other types of mesh produce errors when used. The tetrahedron mesh can represent a variety of geometric shapes, including complex ones such as holes, gaps, sharp angles, or irregular surfaces. When dealing with complex structures, a tetrahedron mesh can easily follow and represent those features accurately.

The size of the 5 mm element is selected based on the results of the grid independence test. The grid independence test is a method used in numerical analysis, especially in up-element-based simulations, to evaluate the dependency of the analysis results on the size of the mesh or grid element. The aim of the grid independence test is to ensure that the numerical solution is not affected by the size of the mesh element used. If the results of the analysis do not change significantly as the size of the mesh continues to shrink, this indicates that the numerical solution has achieved stability and is no longer dependent on the size. In this context, the solution is said to be "grid-independent" or independent of the grid. Therefore, a mesh size of 5 mm is chosen because the results of the analysis do not change significantly when the size of the mesh is reduced.

The grid independence test is important to ensure the reliability and consistency of the numerical analysis results. By using optimal mesh sizes, analysis can produce accurate and computationally efficient solutions. Using a 5 mm mesh element, the nodes 779860, the number of elements 386948, and the skewness of 0,60672 are obtained. Figure 1 shows the model of the mesh used, while the results of the grid independence test can be seen in Table 2 and also in Figure 2.

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 9, Issue 10, pp 135-142, October-2025

https://doi.org/10.47001/IRJIET/2025.910018

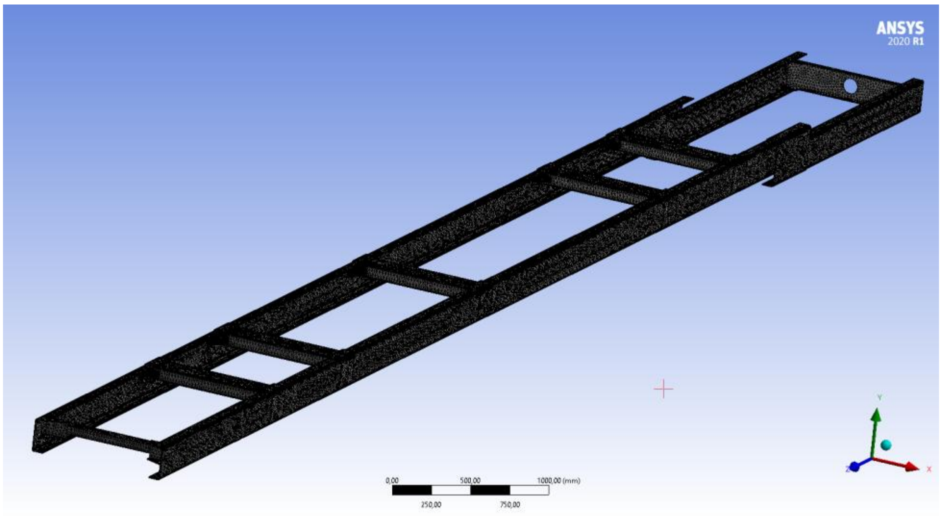

Figure 1: Mesh model

Table 2: Grid Independence Test

Boundary		Aluminum7075-T6		
Mesh	Element	Safety Factor	Equivalent Stess (Mpa)	Deformation (mm)
20	98368	1,6772	301,1	13,568
15	136865	1,5789	319,84	14,274
10	267581	1,2595	401,04	14,86
5	386948	1,3354	378,16	14,812
2,5	660621	1,3181	383,13	14,995
2	880675	1,3133	384,52	15,035

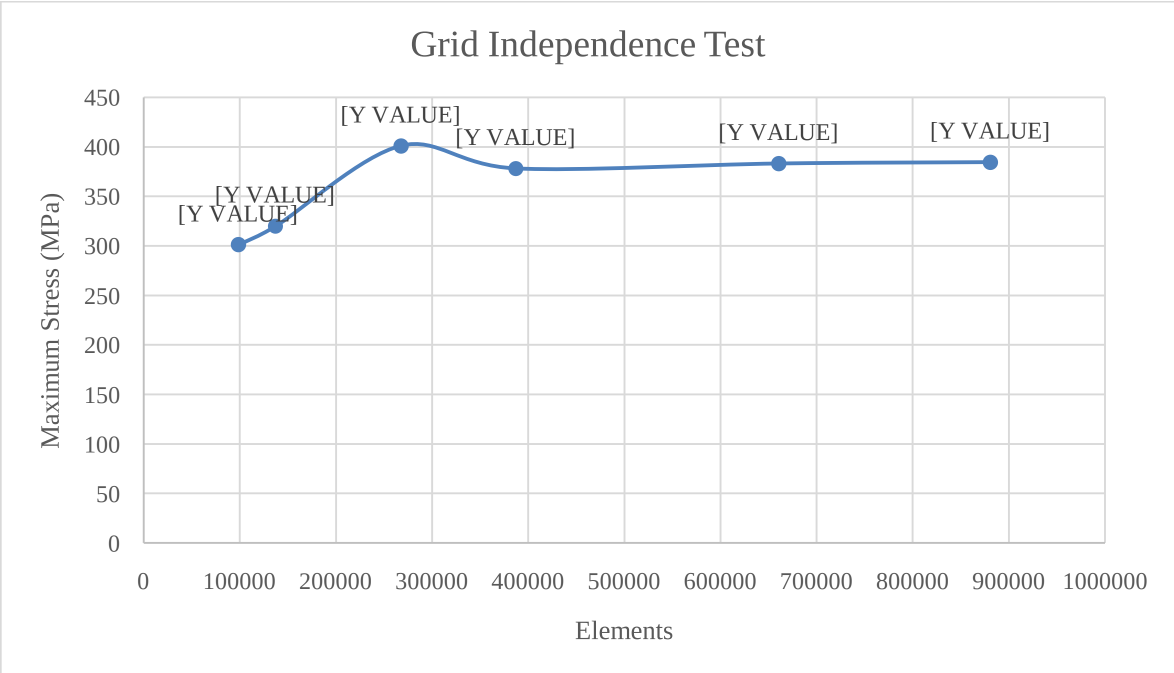

Figure 2: Grid Independence Test

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 9, Issue 10, pp 135-142, October-2025

https://doi.org/10.47001/IRJIET/2025.910018

2.4 Validation

The validation of the element method is carried out with reference to previous studies that have applied the method to the analysis of the structure of the bus chassis [6]. The simulation was carried out with two variations of load, namely low loading condition 71292N and medium load condition 109598N. The results of the simulation can be found in Table 3 and Figure 3.

Table 3: Validation

Variation	Equivalent Stress (MPa)		Error
	Simulation Result	Previous Studies	
Low loading condition	160,34	162,03	0,0104
Medium loading condition	246,49	247,31	0,0033

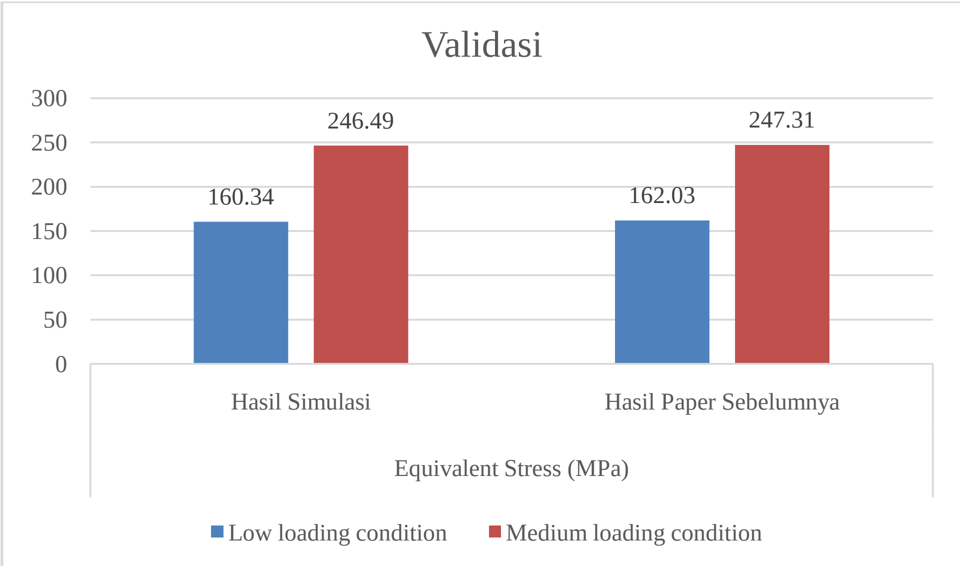

Figure 3: Validation

From Table 3, it is seen that the results obtained did not have significant differences from the previous paper. In low loading conditions, the Equivalent Stress value of 160,34 MPa was obtained, whereas in previous studies, the equivalent stress value was 162,03 MPa. Therefore, its error value is 0.0104. In the medium load condition, the Equivalent Stress value was 246.49 MPa, while in the previous study, the equivalent stress value was 247.31 MPa. The error value is 0.0033. This validation provides strong evidence that the up-to-element method used in this study is able to accurately describe the deformation of steel structures and is reliable. The results can be seen in Figures 3 and 4.

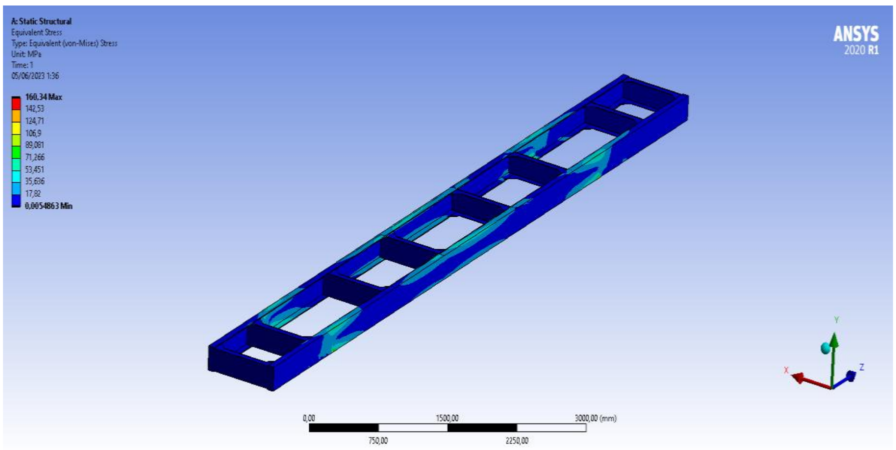

Figure 4: Validation of the low loading condition

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 9, Issue 10, pp 135-142, October-2025

https://doi.org/10.47001/IRJIET/2025.910018

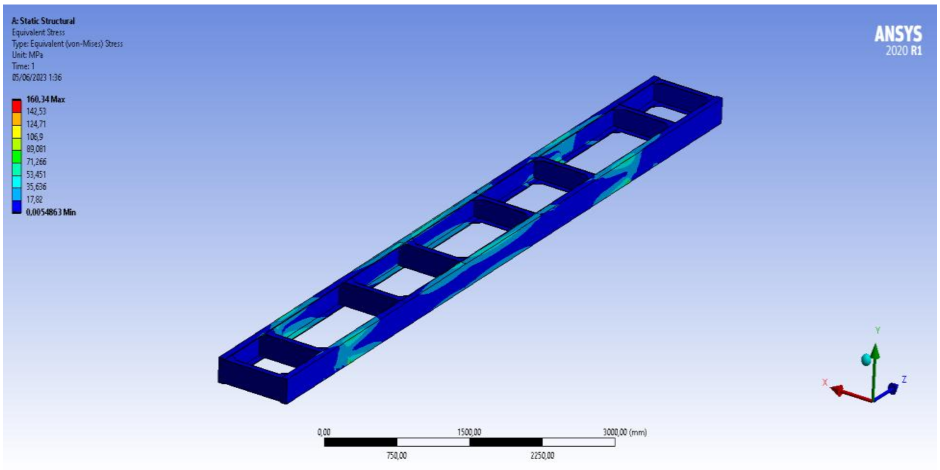

Figure 5: Validation of the medium loading condition

III. RESULT AND DISCUSSION

The analysis is carried out to look for the Deformation, Equivalent Stress, and Safety Factor values of the selected material. In this analysis, two loads were given: 96000N on the body part and 5400N in the engine part. Figures 6 - 10 show the results of the analysis.

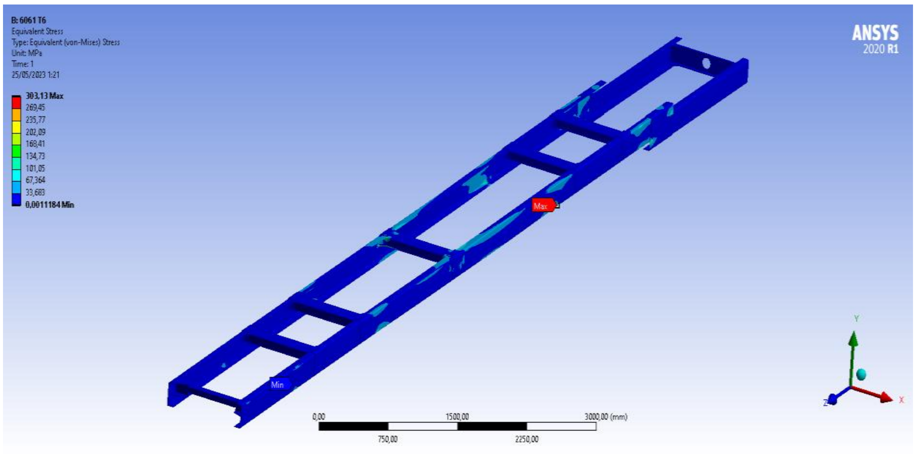

Figure 6: Equivalent Stress Aluminum 6061 T6

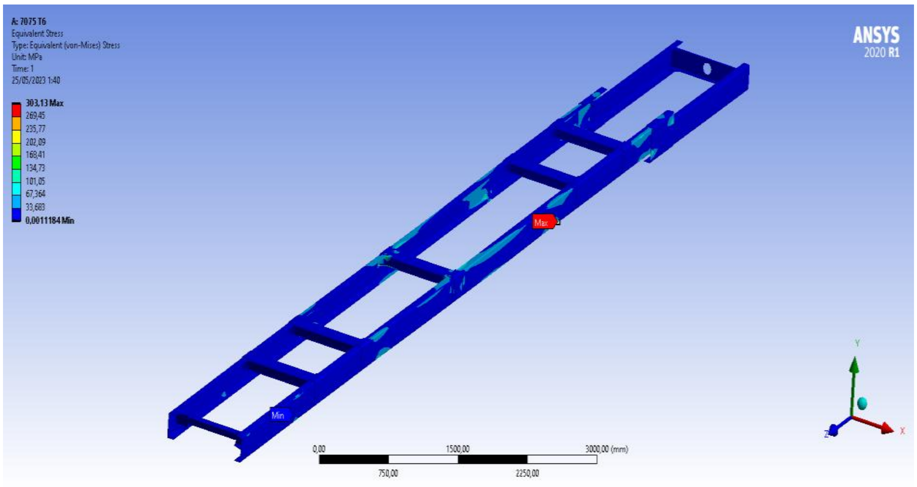

Figure 7: Equivalent Stress Aluminum 7075 T6

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 9, Issue 10, pp 135-142, October-2025

https://doi.org/10.47001/IRJIET/2025.910018

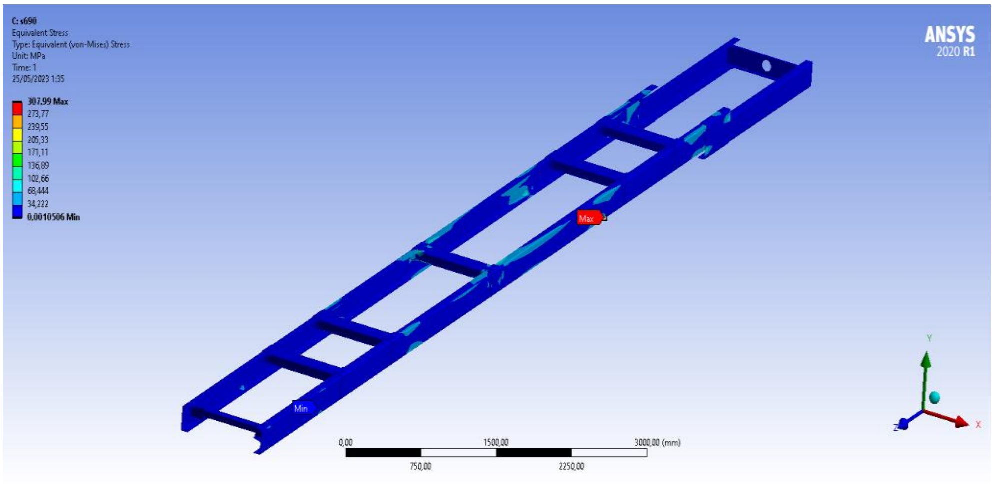

Figure 8: Equivalent Stress S690

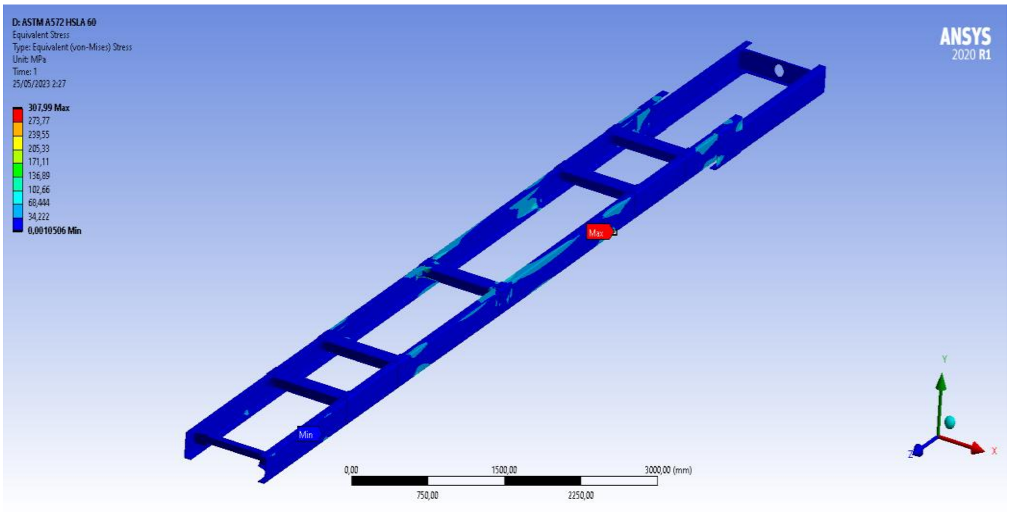

Figure 9: Equivalent Stress ASTM A572 HSLA 60

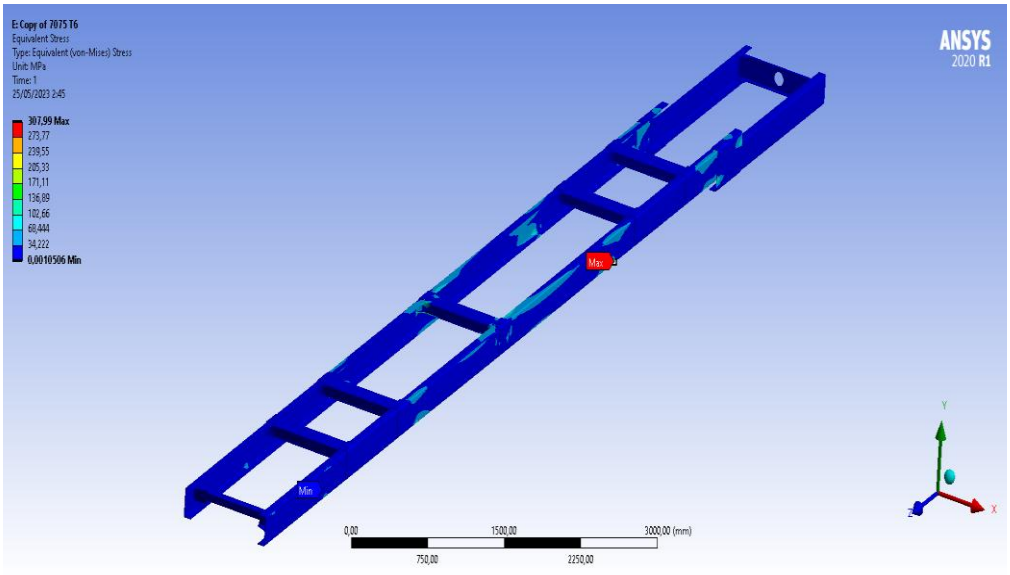

Figure 10: Equivalent Stress JIS G3101 SS400

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 9, Issue 10, pp 135-142, October-2025

https://doi.org/10.47001/IRJIET/2025.910018

Some data has been obtained from the analysis that has been carried out, and the data will be shown in Table 4 as follows.

Table 4: Simulation Results

Material	Safety Factor	Equivalent Stress (Mpa)	Deformasi (mm)	Weight (kg)
Aluminum7075-T6	1,6659	303,13	14,347	184,499
Aluminum6061-T6	0,9072	303,13	14,347	177,277
S690	2,2403	307,99	5,0949	515,416
ASTM A572 HSLA 60	1,526	307,99	5,0949	512,133
JIS G3101 SS400	0,79547	307,99	5,0949	515,416

From Table 4 above, it can be seen that the Equivalent Stress and Deformation values between the materials Aluminium 7075-T6 and Aluminium 6061-T6 are the same. Similarly, the Equivalent Stress and Deformation values between the materials S690, ASTM A572 HSLA 60, and JIS G3101 SS400 are also the same. This is due to the similar chemical composition of the materials[15]. Aluminium 7075-T6 and Aluminium 6061-T6 belong to the Aluminium category, while S690, ASTM A572 HSLA 60, and JIS G3101 SS400 belong to the steel category. Therefore, such materials have the same stress equivalent values when the loads applied to them both have similar characteristics, such as a similar distribution and direction of the load.

In this study, the material with the highest Safety Factor rating was S690, which is 2,2403. However, this material has a relatively heavy weight, which is 515,133 kg. Meanwhile, the 7075-T6 aluminum material has a Safety Factor rating of 1,6659, which is still classified as safe[16]. In addition, the Aluminum 7075-T6 also has a much lighter weight compared to the S690, which is 184,499 kg. Therefore, Aluminum 7075-T6 is considered more effective for use as a material on the bus chassis because it has a lighter weight compared to other metarials, and its Safety Factor value is also considered safe[16].

IV. CONCLUSION

From the analysis carried out, it can be concluded that in the category of Aluminum, the superior material is Aluminum 7075-T6. Meanwhile, in the category of steel, the more superior material is S690. However, when these two materials are compared, both have their respective weaknesses and advantages.

The S690 material has higher safety factor values and lower deformation, but it has a much heavier weight compared to 7075-T6. In terms of price, the S690 also tends to be cheaper when compared to the Aluminum 7075-T6.

On the other hand, although Aluminum 7075-T6 has a lower Safety Factor value of 1.6659, it is much lighter than the S690. The safety factor value of the Aluminum 7075-T6 is also in the safe category. Therefore, although the price is higher than the S690, the 7075-T6 aluminum is superior because it has a much lighter weight. A light weight on the chassis will affect the overall weight of the bus and can improve fuel efficiency.

Thus, in the context of use on bus chassis, Aluminum 7075-T6 is a more profitable option because it has a lighter weight, although its safety factor value is slightly lower. A light chassis can have a positive impact on fuel efficiency.

REFERENCES

[1] S. Nandhakumar, S. Seenivasan, A. M. Saalih, dan M. Saifudheen, “Weight optimization and structural analysis of an electric bus chassis frame,” dalam Materials Today: Proceedings, Elsevier Ltd, 2020, hlm. 1824–1827. doi: 10.1016/j.matpr.2020.07.404.

[2] R. Lopes, B. V. Farahani, F. Q. de Melo, N. V. Ramos, dan P. M. G. P. Moreira, “A numerical dynamic analysis of a multi-body bus,” dalam Procedia Structural Integrity, Elsevier B.V., 2021, hlm. 81–88. doi: 10.1016/j.prostr.2022.01.062.

[3] A. S. Mulyawan, “PENENTUAN PRIORITAS KEBIJAKAN UNTUK MENGATASI KEMACETAN DI KOTA BEKASI,” 2012.

[4] I. A. Majid, F. B. Laksono, H. Suryanto, dan A. R. Prabowo, “Structural assessment of ladder frame chassis using FE analysis: A designed construction referring to ford AC cobra,” dalam Procedia Structural Integrity, Elsevier B.V., 2021, hlm. 35–42. doi: 10.1016/j.prostr.2021.10.006.

[5] A. Agarwal dan L. Mthembu, “Weight optimization of heavy-duty truck chassis by optimal space fill design using light weight Graphite Al GA 7-230 MMC,” dalam Materials Today: Proceedings, Elsevier Ltd, 2022, hlm. 1278–1287. doi: 10.1016/j.matpr.2021.11.053.

ISSN (online): 2581-3048
Volume 9, Issue 10, pp 135-142, October-2025
https://doi.org/10.47001/IRJIET/2025.910018

[6] A. Kerebih Jembere, V. Paramasivam, S. Tilahun, dan S. K. Selvaraj, “Stress analysis of different cross-section for passenger truck chassis with a material of ASTM A148 Gr 80-50,” dalam Materials Today: Proceedings, Elsevier Ltd, 2021, hlm. 7304–7316. doi: 10.1016/j.matpr.2020.12.985.

[7] I. Widiyanto, S. Sutimin, F. B. Laksono, dan A. R. Prabowo, “Structural assessment of monocoque frame construction using finite element analysis: A study case on a designed vehicle chassis referring to ford GT40,” dalam Procedia Structural Integrity, Elsevier B.V., 2021, hlm. 27–34. doi: 10.1016/j.prostr.2021.10.005.

[8] I. D. Gunawan, I. Haryanto, dan G. D. Haryadi, “ANALISIS STRUKTUR CHASSIS SEMI-MONOCOQUE BUS LISTRIK MEDIUM DENGAN METODE ELEMEN HINGGA,” 2021.

[9] R. Ismail, Z. Kurniawan Ahmad, A. Priharyoto Bayuseno, dan J. Sudharto Kampus UNDIP Tembalang Semarang, “Analisis Displacement dan Tegangan von Mises Terhadap Chassis Mobil Listrik Gentayu,” 2018.

[10] D. D. A. Fakhri dan I. N. Sutantra, “Analisis Kekuatan Chassis Terhadap Impact pada Kendaraan Bus Mitsubishi Fuso FE 84G BC dengan Menggunakan Metode Elemen Hingga,” 2019.

[11] Supriyono, “APLIKASI METODE ELEMEN HINGGA UNTUK PERHITUNGAN PERAMBATAN PANAS PADA KONDISI TUNAK,” 2005.

[12] R. Sholikhah dan S. Nurmasitah, “PELATIHAN PEMBUATAN POLA BUSANA DIGITAL BERBASIS CAD DENGAN SOFTWARE RICHPEACE PADA GURU-GURU SMK TATA BUSANA,” 2021.

[13] R. Sukarno, W. Sugita, dan A. Syaefudin, “PELATIHAN DASAR-DASAR CAD/CAM/CAE DAN SOFTWARE AUTOCAD UNTUK GURU-GURU SMK BIDANG KEAHLIAN TEKNIK MESIN DI WILAYAH KABUPATEN BEKASI,” 2014.

[14] A. Ismawanto, A. Syarief, dan H. Isworo, “SIMULASI KEKUATAN MATERIAL PADA CARABINER DENGAN VARIASI GEOMETRI,” 2014.

[15] L. Eka, “UNIVERSITAS INDONESIA PENGARUH NILAI CARBON EQUIVALENT TERHADAP STRUKTUR MIKRO DAN SIFAT MEKANIS BESI TUANG NODULAR DINDING TIPIS 1 MM SKRIPSI,” Depok, Des 2009.

[16] M. A. Rozik, “PERANCANGAN DAN ANALISIS KEKUATAN RANGKA MESIN PENGAYAK PASIR MENGGUNAKAN AUTODESK INVENTOR 2019,” Aug 2020.

Citation of this Article:

Eflita Yohana, & Syaiful. (2025). Structural Chassis Bus Analysis. *International Research Journal of Innovations in Engineering and Technology - IRJIET*, 9(10), 135-142. Article DOI https://doi.org/10.47001/IRJIET/2025.910018

****