© Universiti Tun Hussein Onn Malaysia Publisher's Office

JAPTT

http://publisher.uthm.edu.my/ojs/index.php/japtt

e-ISSN : 2821-286X

Journal of Automotive Powertrain and Transportation Technology

Analysis of Car Vehicle Seat Noise Under Different Forces

Muhammad Syazani[1], Rahmah[1*]

[1]Centre of Automotive and Powertrain Technology, Faculty of Engineering Technology, Universiti Tun Hussein Onn Malaysia, 84600 Pagoh, Johor, MALAYSIA.

*Corresponding Author

DOI: https://doi.org/10.30880/japtt.2023.03.02.003
Received 20 June 2023; Accepted 25 October 2023; Available online 26 December 2023

Abstract: The noise and rattling have been a problem constantly due to how it disturbs customers' comfort while driving. The objective of this project was to conduct the analysis for seat noise and to analyse the effect of different force and material for car seat. The main purpose of this study is to analyse the effect of different force and material for car seat. Seat model design was generated by using Computer-Aided Design (CAD) software which is SolidWorks 2020. Seat model was then analysed using Computer-Aided Engineering (CAE) which is ANSYS 2022 R1. This inquiry focuses on the data and graphs collected during the simulation, which was performed using the ANSYS. The data is then uploaded to Microsoft Excel, to be utilised to create graphs illustrating the PSD of displacement and acceleration of the vehicle seat when loads are applied to it. A simulation was run to analyse the noise on car seat. The characteristics of vibration of car seat for different type of material and different force was visualized. The comparison of different type of material and force has been investigated in the present study. Static structural analysis on car seat has been performed on different types of material and force by using ANSYS software to analyse total deformation, stress, and strain.

Keywords: Noise, static structural, total deformation

1. Introduction

Vehicle seat rattling or BSR (buzz, squeak, and rattle) noises in general are among the most common problems directly related to the NVH (Noise, Vibration, and Harshness) quality of the vehicle. Identifying and improving BSR noise in the early design phase is difficult. It is because of the complexity, non-linearity, and uncertainty of the impact mechanism at the joints, all of which contribute to the rattling. The vehicle seat is one of the most critical components that can cause annoying BSR noise. With the trend towards lightweight materials and an increasing number of sub-components of the seat, such as electrical devices, BSR control is becoming more critical. Furthermore, BSR has become more prominent in the quiet cabins of modern vehicles, as customers perceive BSR as direct indicators of vehicle build quality and durability [1-3]

Therefore, the aim of this study is to conduct analysis simulation for seat noise and rattling under different force and material. The result will be discussed on static structural and random vibration of vehicle seat. The noise and rattling have been a problem constantly due to how it disturbs customers' comfort while driving. The noise is sometimes caused by the design structure, with the gap between parts being too big [4-5]. The noise and rattling may be ignored at first, but as time passes, it cannot be a pleasant experience to the customers with its constant squeaking. This problem will affect the customer's evaluation of the vehicle. The matter of seat noise needs to be emphasized by the manufacturer as many customers have complained. This issue will cause the perspective of NVH quality of a vehicle to be lower [6-8].

**Corresponding author: rahmah@uthm.edu.my*

2. Materials and Methods

This chapter's methodology section provides an overview on the study's approaches, methodologies, and ideas. It also emphasises the research methods used. The major purpose of this study is to investigate the effects of different stresses and materials on cars seats. The seat model was designed using SolidWorks 2020 Computer-Aided Design (CAD) software. ANSYS 2022 R1 Computer-Aided Engineering was used to analyse the seat model (CAE) [9-12].

2.1 Geometry Modelling

The seat model is divided into three components: the seat cushion, the seat back, and the headrest. These components are linked by three joints: one between the seat cushion and its surrounds, one between the seat cushion and the backrest, and one between the backrest and the headrest. These joints allow the angle of inclination of the backrest and headrest to be changed, but also indicate the rigidity of the connections between the seat cushion and the backrest.

A swivel joint connects the backrest and seat cushion to allow rotations around the y-axis. Between the backrest and the headrest, a similar connection is made. This seat model does not allow you to modify the height of the headrest but there is a slider which could move the seat forward and backward [9]. The Figure 3.2 shows 3D model of car seat.

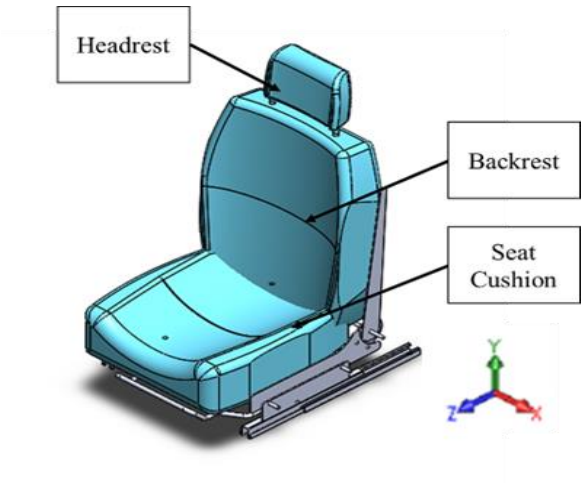

Fig. 1 - 3D model of car seat

2.2 Simulation Setup

The Project Schematic displays your project's project and workflow by giving a visual depiction of the elements in the project and their relationships to one another. Each Toolbox item that is added to the project is represented as a system. A system is made up of discrete components known as cells. Figure 2 displays the structures and analyses of a distinct cell-based ANSYS simulation configuration. Each cell relates to an application or workspace, such as Engineering Data (a native workspace), ANSYS FLUENT, or the Mechanical application (data-integrated applications).

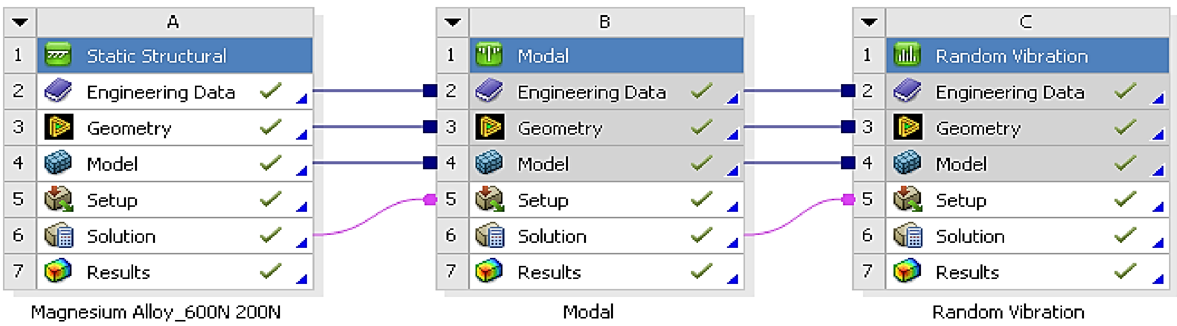

Fig. 2 - ANSYS simulation setup

2.3 Geometry Meshing

A mesh is, by definition, a network of points and cells that are linked together. As will be discussed later, this network can have a variety of geometry and topology. Meshes are frequently referred to as grids, which is due to the intrinsic organisation of the mesh and/or when those meshes are related to Finite Differences problems.

Depending on whether the equations were discretized over the cells or nodes, each cell or node of the mesh will contain a local solution of the equations. The discretization method is determined by the project [2]. The meshing of the model is done by using ANSYS software.

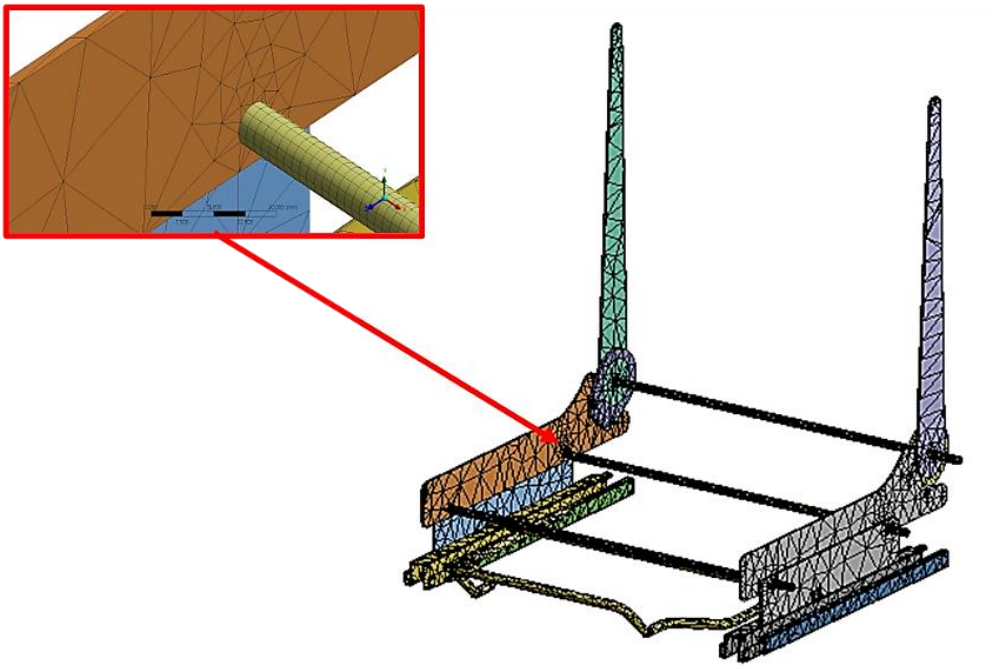

Fig. 3 - Mesh generated of seat frame

3. Results and Discussion

This inquiry focuses on the data and graphs collected during the simulation, which was performed using the ANSYS computer-aided design software. The data is then uploaded to Microsoft Excel, where it is utilised to create graphs illustrating the PSD of displacement and acceleration of the vehicle seat when loads are applied to it. A simulation was run to analyse the noise on car seat.

3.1 Static Structural Analysis

Total deformation of models was compared with three types of material and two forces. Figure 4.2 shows for each model total deformation, the maximum total deformation obtained was 1.4985mm for magnesium alloy 620N, 0.94361mm for aluminium alloy 620N, 0.3347mm for structural steel 620N, 1.4527mm for magnesium alloy 1000N, 0.92068mm for aluminium alloy 1000N and 0.32675mm for structural steel 1000N.

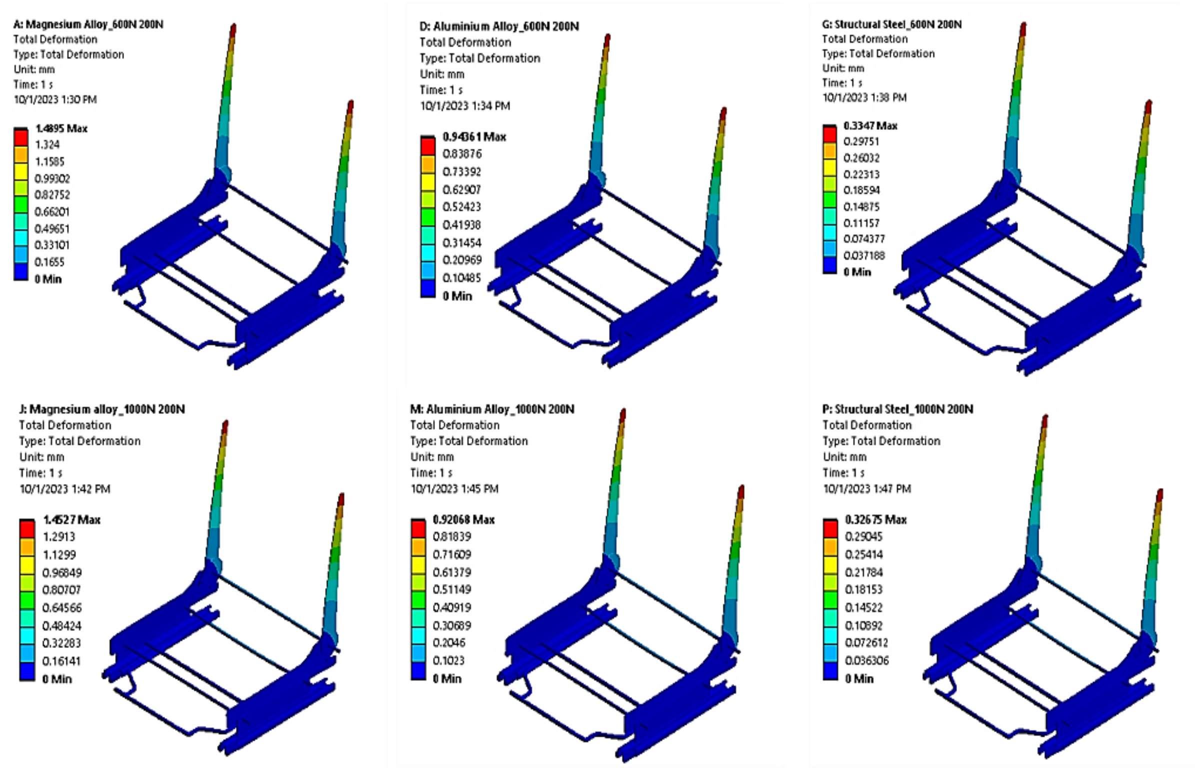

Fig. 4 - Total deformation of static structural analysis

3.2 Modal Analysis

Table 1 and Table 2 shows the basic 8 modes contain 4 linear motions and 4 rotation motions.

Table 1 - 8 modes of total deformation with force of 600N

Mode	Material					
	Magnesium Alloy		Aluminium Alloy		Structural Steel	
	Frequency [Hz]	Displacement [mm^2/Hz]	Frequency [Hz]	Displacement [mm^2/Hz]	Frequency [Hz]	Displacement [mm^2/Hz]
1	17.408	2386.408	17.765	2147.695	17.61	551.903
2	17.716	2305.282	17.872	2114.992	17.854	560.435
3	50.719	258.578	51.466	165.658	51.477	58.480
4	60.203	243.475	61.132	161.142	61.01	59.081
5	82.723	371.524	83.407	238.294	82.629	84.392
6	114.18	263.153	115.17	167.930	114.15	59.060
7	119.21	89.982	120.84	57.499	120.71	20.215
8	138.89	134.092	139.72	86.744	138.14	31.022

Table 1 above displays the displacement of different type of material with different force applied. The maximum mode has been set from six to eight that contains four linear motions and four rotational motions. The result was obtained by calculated the frequency with total deformation. The average displacement was 756.5618 mm^2/Hz for magnesium alloy, 642.494 mm^2/Hz for aluminium alloy, and 178.074 mm^2/Hz for structural steel.

Table 2 - 8 modes of total deformation with force of 1000N

Mode	Material					
	Magnesium Alloy		Aluminium Alloy		Structural Steel	
	Frequency [Hz]	Displacement [mm^2/Hz]	Frequency [Hz]	Displacement [mm^2/Hz]	Frequency [Hz]	Displacement [mm^2/Hz]
1	17.4	2382.822	17.76	2146.541	17.609	551.710
2	17.709	2301.174	17.867	2113.626	17.852	560.273
3	50.731	258.517	51.466	165.658	51.477	58.480
4	60.163	243.637	61.092	161.254	60.996	59.0951
5	82.659	371.303	83.361	238.189	82.613	84.378
6	114.19	263.251	115.16	167.994	114.15	59.066
7	119.22	89.9744	120.84	57.4994	120.71	20.215
8	138.77	133.403	139.64	86.4782	138.11	30.990

Table 2 above displays the displacement of different type of material with different force applied. The maximum mode has been set from six to eight that contains four linear motions and four rotational motions. The result was obtained by calculated the frequency with total deformation. The average displacement was 755.51mm^2/Hz for magnesium alloy, 642.155mm^2/Hz for aluminium alloy, and 178.026mm^2/Hz for structural steel.

3.3 Random Vibration Analysis

The structure is analysed under random vibration PSD Displacement in Z-axis.

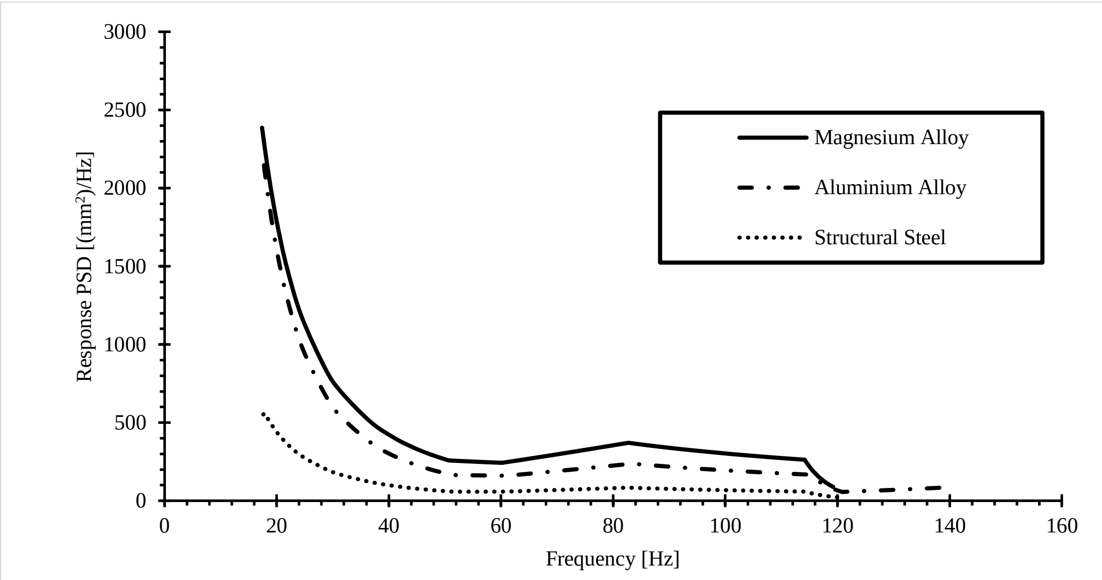

Fig. 5 - Respond PSD graph for 600N force on displacement

The Figure 5 and Figure 6 show the vibration PSD Displacement in Z-axis. The comparison of different type of material and force has been investigated in the this study.to be utilised to create graphs illustrating the PSD of displacement and acceleration of the vehicle seat when loads are applied. A simulation was run to analyse the noise on car seat. The characteristics of vibration of car seat for different type of material and different force was visualized. Static structural analysis on car seat has been performed on different types of material and force by using ANSYS software to analyse total deformation, stress, and strain.

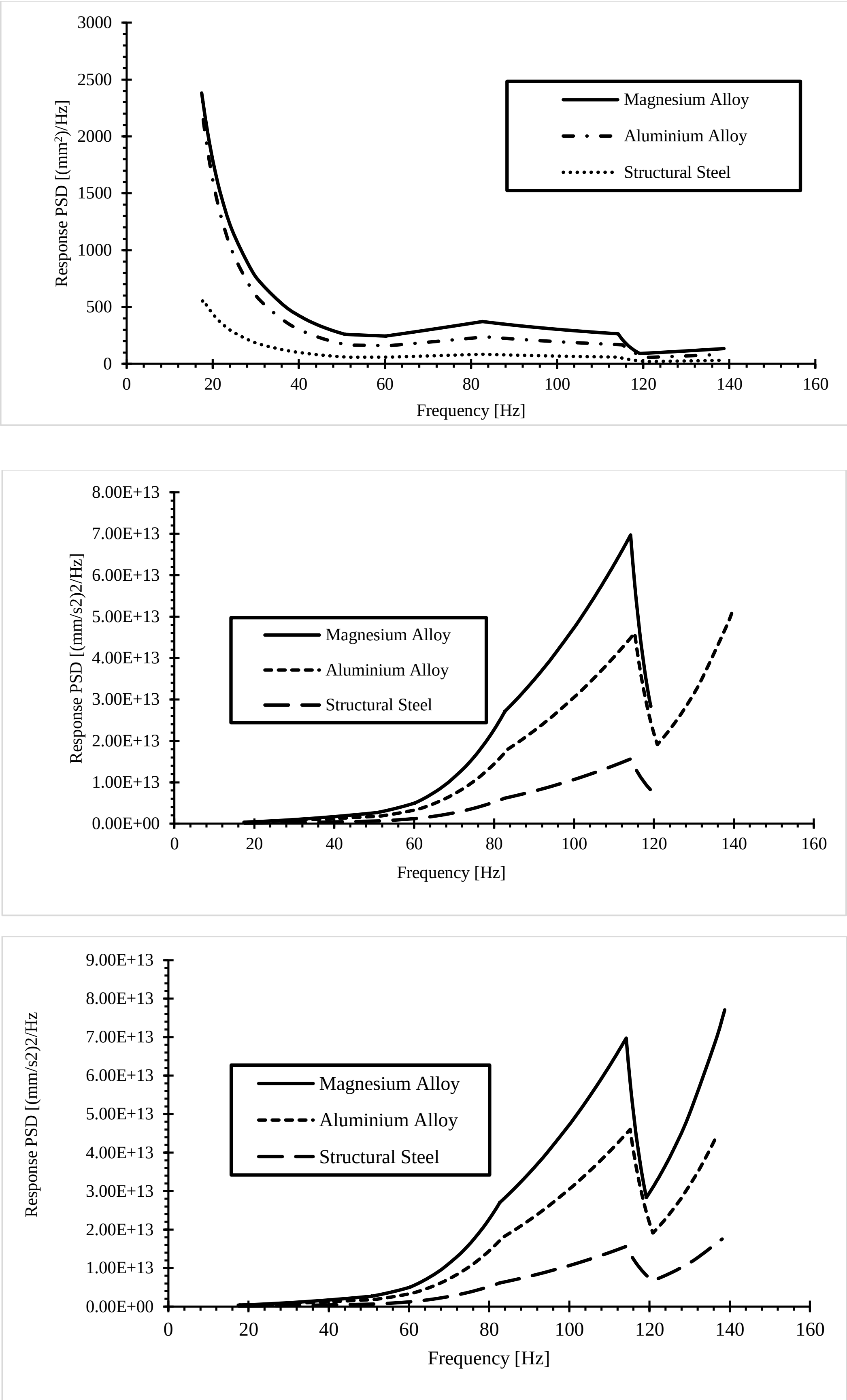

Fig. 6 - Respond PSD graph for 1000N force on displacement

4. Conclusion

As a conclusion, the major purpose of this study is to analyse the effect of different force and material for car seat. The characteristics of vibration of car seat for different type of material and different force was visualized. The comparison of different type of material and different force has been investigated and show characteristics of vibration of car seat for different type of material and different force was visualized. Static structural analysis on car seat has been performed on different types of material and force by using ANSYS software to analyse total deformation, stress, and strain.

Acknowledgement

The authors would like to thank the Universiti Tun Hussein Onn Malaysia for supporting this research under grant H804.

References

[1] Tatari, M., Fard, M., Nasrollahzadeh, N. and Mahjoob, M. (2014) CAE Characterization and Optimization of Automotive Seat Rattle Noise. World Journal of Engineering and Technology, 2, 201-210. http://dx.doi.org/10.4236/wjet.2014.23022.

[2] What is a mesh? SimWiki documentation. SimScale. (2021, September 2). Retrieved December 26, 2022, from https://www.simscale.com/docs/simwiki/preprocessing/what-is-a-mesh/

[3] Verver, M. M., de Lange, R., van Hoof, J., & Wismans, J. S. H. M. (2005). Aspects of seat modelling for seating comfort analysis. Applied Ergonomics, 36(1), 33–42. https://doi:10.1016/j.apergo.2004.09.002.

[4] Arshad, M. F., Ahmad, M. F., Khalid, A., Ishak, I. A., Zainal Abidin, S. F., & Razali, M. A. (2023). Investigation The Influences of Electric Motor and Electric Go Kart Performance. Journal of Automotive Powertrain and Transportation Technology, 2(2), 17–23.

[5] Alias, M. A., Azizul, M. A., Sulaiman, S., & Ismail, M. M. (2023). Development Eco Idle Kit System for Motorcycle. Journal of Automotive Powertrain and Transportation Technology, 3(1), 42–51.

[6] Azmi, M. A. I., & Mustaffa, N. (2022). Experimental Evaluation of Brake Response Time on Motorcycle Brake Lamp. Journal of Automotive Powertrain and Transportation Technology, 2(1), 37–46.

[7] Yee San, C., & Mustaffa, N. (2019). Evaluation of SI Engine Fuelled by Liquefied Petroleum Gas on Performance and Emission Using 1D Simulation. Fuel, Mixture Formation and Combustion Process, 1(1).

[8] Jofaris, N. K., Jaat, N., & Mahmudin, R. (2023). Random Vibration and Noise Analysis of Vehicle Seat Using Numerical Method. Journal of Automotive Powertrain and Transportation Technology, 3(1), 9–16.

[9] Abdul Aziz, M. A. S., Mohmad Jaat, N., Mohamed, N., & Azhar, A. H. (2023). Design of The Mechanism for Auto Release Seat Belt in End-Button Release Buckle. Journal of Automotive Powertrain and Transportation Technology, 3(1), 26–32.

[10] Muhamad, A. D.., Mahmudin, R.., Mohamed, N., & Azizul, M. A. (2023). An Exploratory Study of Integrating Booster Seat Design on Rear Seat Vehicle in Static Test. Journal of Automotive Powertrain and Transportation Technology, 2(2), 9–16.

[11] Ahmad, M. K.., Mahmudin, R.., Mohamed, N., Darlis, N., Zainal Abidin, S. F., & Mohamed Nazar, M. I. S. (2023). Analysis of Auto Release Seatbelt System for Multipurpose Vehicle. Journal of Automotive Powertrain and Transportation Technology, 2(2), 30–41.

[12] Mohammad Aris, M. H.., Darlis, N., Ishak, I. A., Sulaiman, S., Jaat, N., & Hakim, A. F. (2021). HVAC CFD Analysis of Air Flow and Temperature Distribution Inside Passenger Compartment. Journal of Automotive Powertrain and Transportation Technology, 1(1), 25–33.