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# Parametric Investigation of Mechanical Aspect for TV Wall Mount Bracket via Finite Element Analysis

M.U. Rosli[1]* and S. Ahmad[1]

[1]Faculty of Mechanical Engineering and Technology, Universiti Malaysia Perlis, 02600 Perlis, Malaysia.

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**ABSTRACT**

*Nowadays, most flat screen television (TV) come with a feature that allows users to mount the TV and it takes some effort on the user's part to attach the mount to the wall and the TV to the mount. Various TV wall mount designs available on the market with different dimensions, thicknesses, and materials may cause mechanical problems. This study aims to analyze the effect of the design parameters on the wall mounting bracket and evaluate the best design parameters for minimal mechanical defects. The validated 3D model is simulated using SolidWorks software. Different wall mount lengths, widths, thicknesses, and TV wall mount bracket designs are selected as factors in this study. Meanwhile, stress, displacement, and strain are selected as responses in this study. Statistical regression analysis analyzes the correlations between design parameters and mechanical defects. The analysis shows that 6 mm thickness, 430 mm length, and 160 mm width have the lowest stress, strain, and displacement. Design 3 is the best wall plate design to minimize stress and strain. To conclude, the results of this study could make the TV wall mount bracket a universal mounting for various weights of TVs.*

**Keywords:** Finite element analysis, TV wall mount bracket, Mechanical aspects, Simulation

## 1. INTRODUCTION

Wall mounts have become handy tools for various applications. It can be used to secure flat-panel television (TV) s and other electronic equipment. The industry has many different types of TV wall mount brackets. Choosing the correct TV wall mount bracket is critical so users can enjoy excellent TV viewing with a properly positioned TV [1]. Users can end up gazing at a screen with a stiff neck if using an improper TV wall mount bracket. There are numerous vulnerabilities in the bracket because there are so many different TV brackets. For instance, the incorrect design parameters and materials caused the bracket to bend and the pin to come unplugged. The proper design parameter of the bracket could reduce the weakness.

The most common support devices for flat-screen TVs are stand mount and wall mount brackets. Nowadays, wall mounting bracket is becoming more popular because it allows placing the TV straight to the wall and conserving room. As a result, many markets are already creating low-cost thin and light brackets to mount the TV flat to the wall, regardless of the bracket's durability. This causes the resistance of the bracket to be so weak that it cannot withstand the load for too long. Also, there are a lot of big screens TVs produce. If the bracket is not strong enough, the TV will fall apart. Suitable materials and good parameter designs must be selected to manufacture the best designs. The material must be rigid and good strength is needed to support various TV weights.

*Corresponding author: uzair@unimap.edu.my

In past research, Xue et al. (2021) investigated the frame-to-wall connections, and specially designed steel connectors were fitted to provide a reliable mechanism of force transfer for the structure [2]. The effects of opening size, opening form (for example, door and window), and aspect ratio of wall panels on the lateral performance of the structural system were investigated using lateral cyclic loading experiments on this structural system. Neelakandan et al. (2019) studied the consideration of manufacturing feasibilities of casting wall thickness and drafting allowances with metal flow radius for the starting operating conditions, the design optimization methods for robust design to satisfy the product weight, and fatigue life cycle requirements [3].

Hazwan (2021) reported redesigning the main body of a wall-mounted automatic air freshener dispenser used to spray fragrance automatically based on the settings provided [4]. This air freshener eliminates the need to spray manually, saving time and making life easier. This automatic air freshener dispenser will spray the fragrance throughout the room, purifying the air and eliminating bad smells. Yunus et al. (2014) investigated bracket failure and plastic component FMEA (Failure Mode Effect and Analysis) to overcome the current chronic field failure optimization carried out at the failure site [5]. Various design options were prepared, and the most workable one was chosen. Finite Element Analysis (FEA) software applications were used to analyze the stresses on the bracket.

In a current study, the mechanical aspect of the TV wall mount bracket was investigated via finite element analysis. Finite Element Analysis (FEA) is a computer-aided engineering (CAE) tool used to analyze how a design reacts under real-world conditions. Useful in structural, vibration, and thermal analysis [6, 7], FEA has been widely implemented by automotive companies. Based on the current wall mount bracket design available in the market, this study focuses on the effect of having different parameter values of the design structure.

## 2. METHODOLOGY

From Figure 1, the study starts with 3D modeling by using SolidWorks. This undergoes a sketching and redesign process. Before designing the structure of the TV wall mount bracket, several other designs from today's market have been reviewed. The design parameters that will be further investigated also have been identified. After the 3D model is meshed and validated, the analysis is carried out based on the selected crucial design parameters: thickness, length, width, and design of the wall plate. SolidWorks simulation is used to study the effects of independent parameters on von Mises stress, displacement, and strain. After obtaining the result between each level design, the data will be analyzed using regression analysis, a statistical process for investigating the correlations between design parameters and mechanical defects.

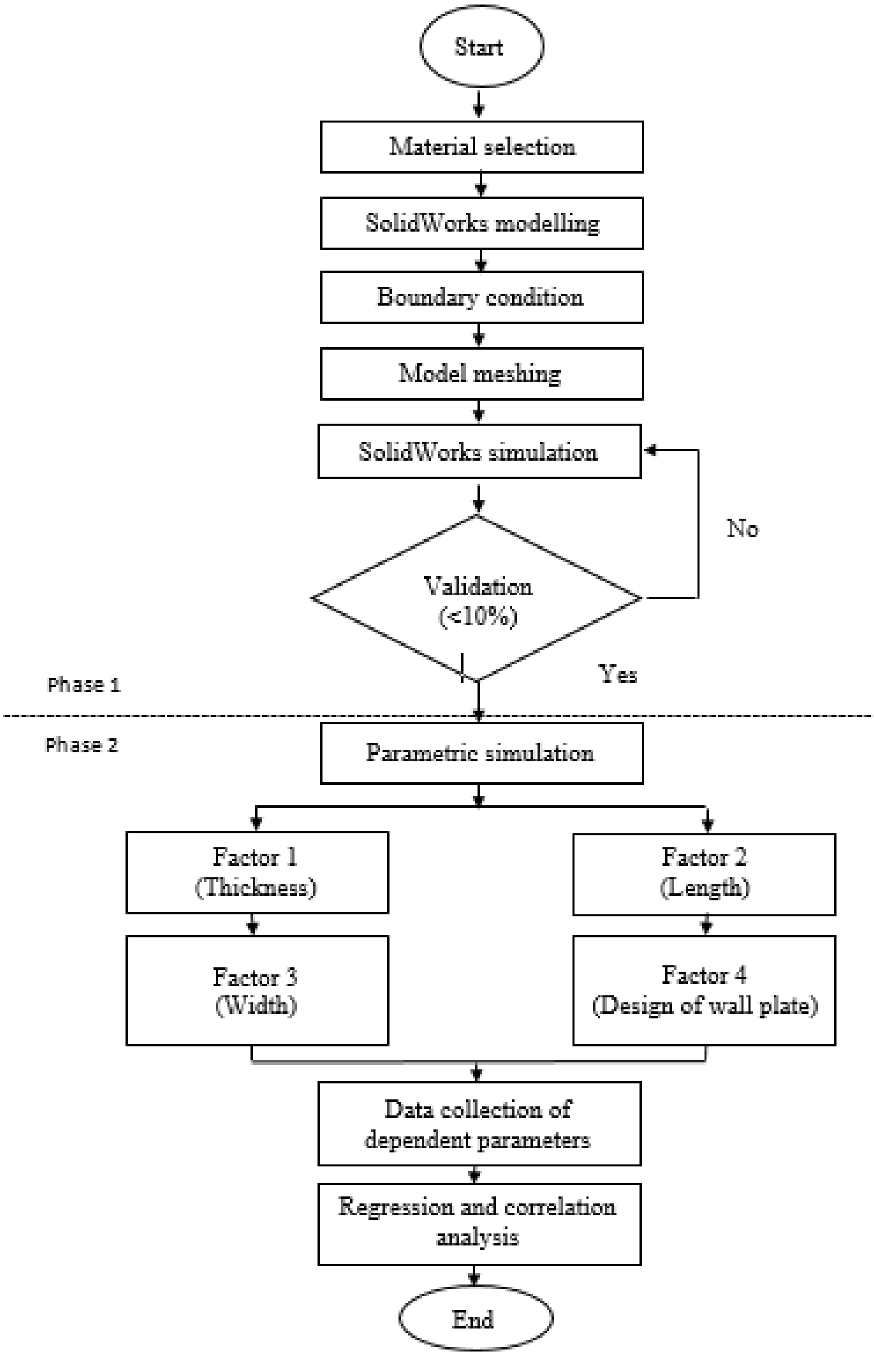



**Figure 1:** Flow chart of the research.

## 2.1 Three-Dimensional (3D) Modelling

The finite element model of TV wall mount bracket design is developed using rectangular profile materials. There are two parts to this design, which are the wall plate and the TV bracket. Figure 2 shows an isometric view of two parts of the design, and Figure 3 shows the 3D drawing with the dimensions of the design.

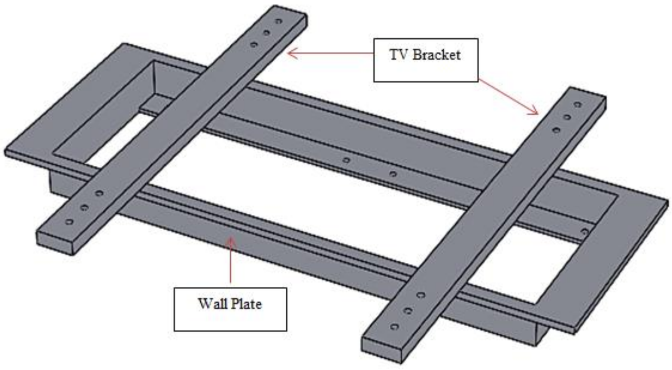



**Figure 2:** Isometric view of TV wall mount bracket.

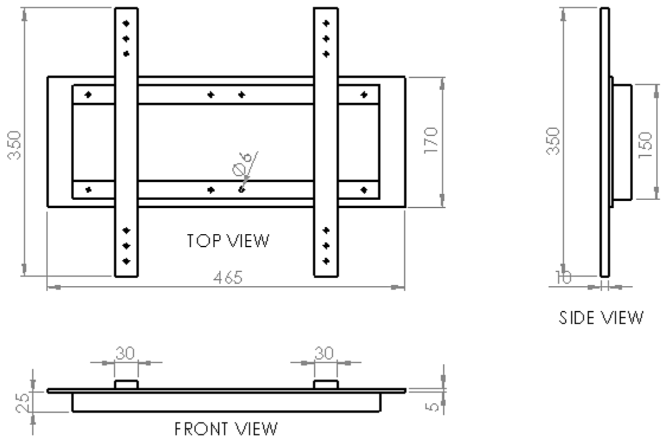



**Figure 3:** 3D drawing of TV wall mount bracket.

## 2.2 Boundary Condition

The wall plate model is fixed to the wall, which the plate bolted on eight holes. The green color shown in Figure 4 is fixed support on the model. The TV wall mount bracket usually supports flat-screen TV placed on the wall. The model was invented to support weight to 25 kg = 245.25 N. That assumes the loading conditions are constant. Figure 5 shows the total forces or load on four nut-hole of the TV wall mount bracket pointing downward.

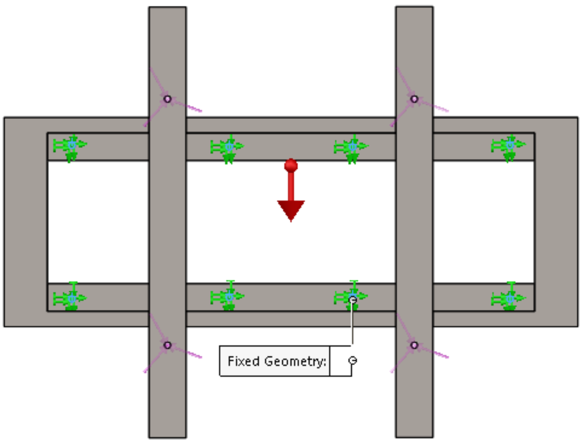



**Figure 4:** Fixed support on TV wall mount bracket.

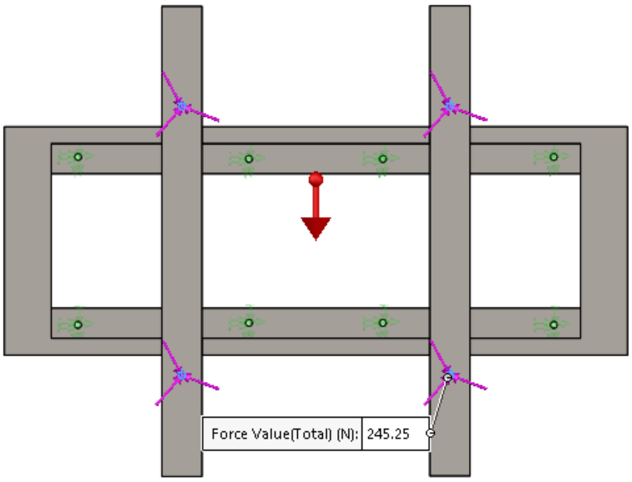



**Figure 5:** A load applied to the TV wall mount bracket.

## 2.4 Meshing of 3D Modelling

Modeling of technology processes is an essential part of implementing new technology. The geometrical input data and the parameter design inserted in the model are important to the simulation. It is noticeable that the meshing process of a generated SolidWorks model is the most important in this field [8]. The meshing process divides the geometry into elements. The elements created are then used by the SolidWorks simulation to determine the value of each node. Its objective is to produce a finite solid element defined by nodal points represented by nodes of fundamental finite elements, whose structure and localization should be appropriate for the simulated environment. The size element for the meshing parameter on the base market design is 8 mm. Figure 6 shows the meshing process generated around the geometry.

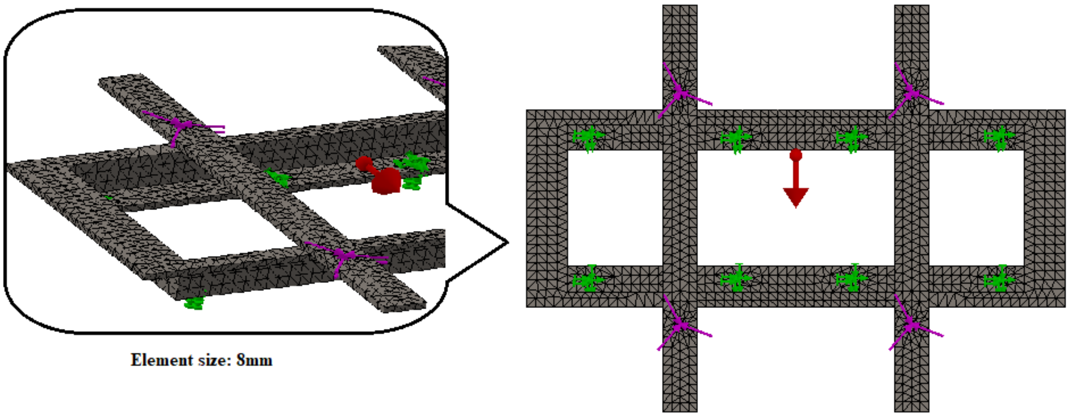



**Figure 6:** Meshing elements on TV wall mount bracket.

## 2.5 Selection of Design Parameter

Based on Table 1, the list of designs parameter has been selected. There are three designs with different dimensions, thicknesses, and designs of wall plates, as shown in Figure 7. SolidWorks software was utilized to design the 3D model and run the simulation for analysis of stress, strain, and displacement of deformation.

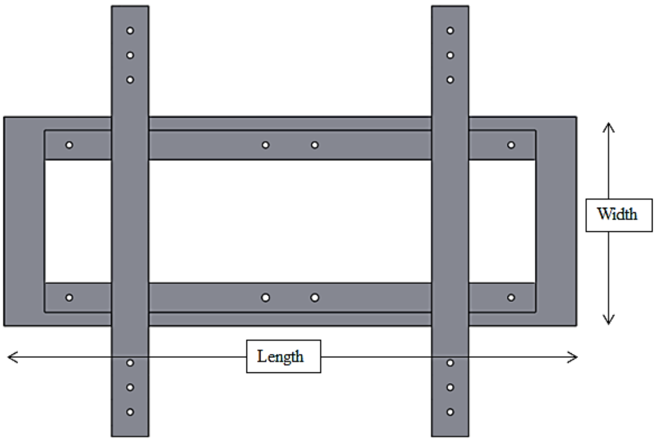
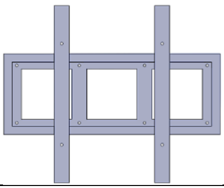
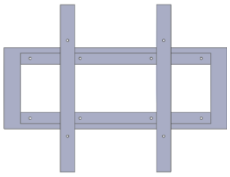
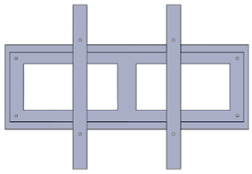



**Figure 7:** Parametric of dimension designs.

**Table 1:** List of designs parameter that has been selected.

| **Factors** | **Level** | | |
|---|---|---|---|
| | **1** | **2** | **3** |
| **Thickness** | 4 mm | 5 mm | 6 mm |
| **Length** | 430 mm | 465 mm | 520 mm |
| **Width** | 160 mm | 170 mm | 180 mm |
| **Design of wall plate** |  |  |  |

## 3. RESULTS AND DISCUSSION

### 3.1 Analysis of Factor 1: Thickness

In this analysis, only the thickness varies (4 mm, 5 mm, 6 mm), and the other factor is based on the level 2 value. All simulations were performed with a 25 kg (245.25 N) external load. The result of von Mises stress, displacement, and strain are shown in Figures 8 (a), 8 (b), and 8 (c), respectively. Based on the graph shown in Figure 8 (a), the highest value of von Mises stress was recorded at 4 mm thickness (1.720 MPa), and the lowest is at 6 mm thickness (1.28 MPa). The highest von Mises stress was located at every nut hole where the loading was applied. The lowest value is located at the tip of the TV bracket. From the comparison, it can be concluded that the von Misses stress decreased as the thickness increased. This finding strongly proved that the thin design structure has a minimum strength to support the loading and has low durability [10]. Based on the graph shown in Figure 8 (b), the highest value of displacement was recorded at 4 mm thickness (0.00145 mm) and 6 mm thickness (0.00086 mm). The highest displacement on both levels is located at the tip of the TV bracket, and the lowest value is located at every eight-hole on the wall plate. Figure 9 shows the effect of deformation on the TV bracket flexible, which is loaded axially in compression and deflects significantly. Al Nageim (2010) revealed that this situation is called bending, which happens while the stresses in the bracket are still substantially below those expected to cause compression and deformation [10].

Based on the graph shown in Figure 8 (c), the highest value of strain was recorded at 4 mm thickness (5.75 mm), and the lowest is at 6 mm thickness (4.50 mm). Like stress and displacement, the highest strain on both levels is located in each of the nut holes where the loading is applied, and the lowest value is located at the tip of the TV bracket. The effects of higher stress on the nut hole make the strain value higher. This result proves that the strain's effect decreased when the thickness increased, making it more robust and higher product durability [11].

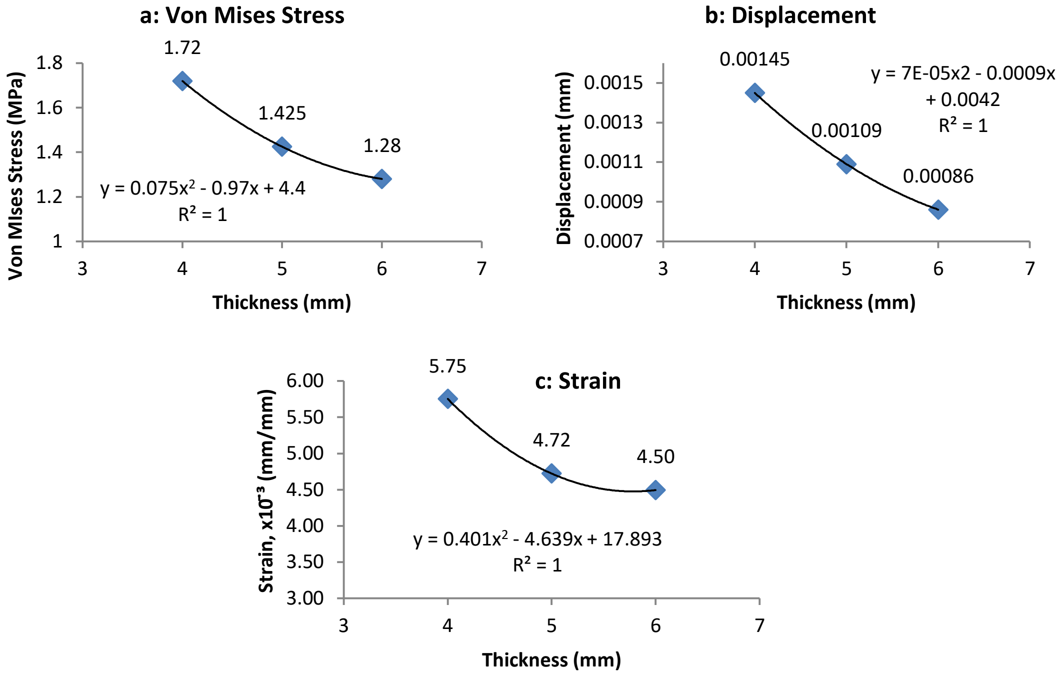



**Figure 8:** (a) Graph for von Mises stress for thickness, (b) displacement, and (c) strain for thickness analysis.

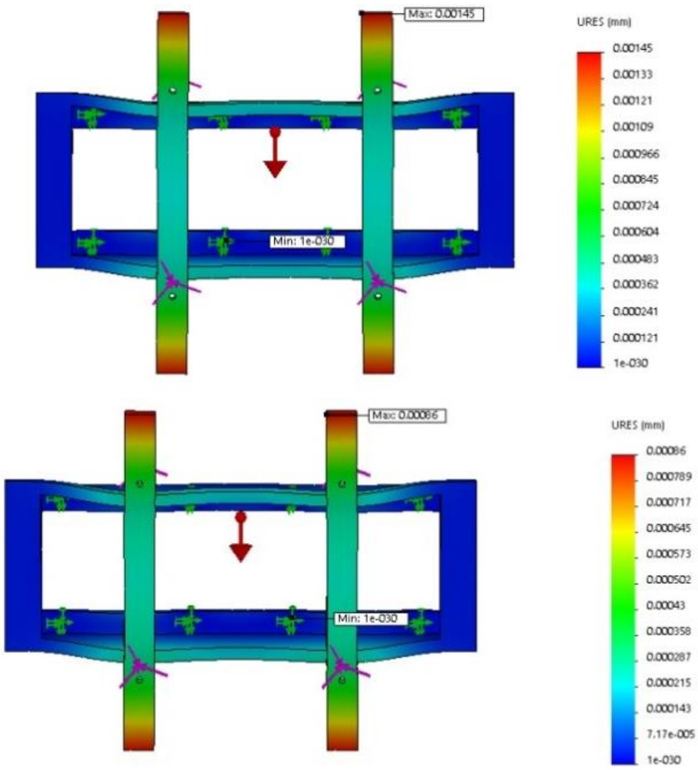



**Figure 9:** SolidWorks simulation for displacement.

### 3.2 Analysis of Factor 2: Length

In this analysis, only the length varies (430 mm, 465 mm, 520 mm), and the other factor is based on level 2 value. The result of von Mises Stress, displacement, and strain are shown in Figures 10 (a), 10 (b), and 10 (c), respectively. Based on the graph shown in Figure 10 (a), the highest value of von Mises stress was recorded at 465 mm length (1.425 MPa), and the lowest was 430 mm length (1.34 MPa). The highest von Mises stress is located at every nut hole where the loading is applied, and the lowest value is located at the tip of the TV bracket. The length of the design structure needs to be balanced with the width to have a good dimension of the cross-section surface of the designs (wall plate) to support the loading. Based on the graph shown in Figure 10 (b), the highest value of displacement was recorded on the 430 mm length (0.00111 mm), and the lowest is 520 mm length (0.00109). This proves that the shortest length makes the more significant displacement of the design structure. Based on the graph shown in Figure 10 (c), the highest value of strain was recorded on the 520 mm length (4.248 mm), and the lowest is 430 mm length (3.974 mm). This strongly proves that when the stress value is high, more strain will be recorded where the stress was.

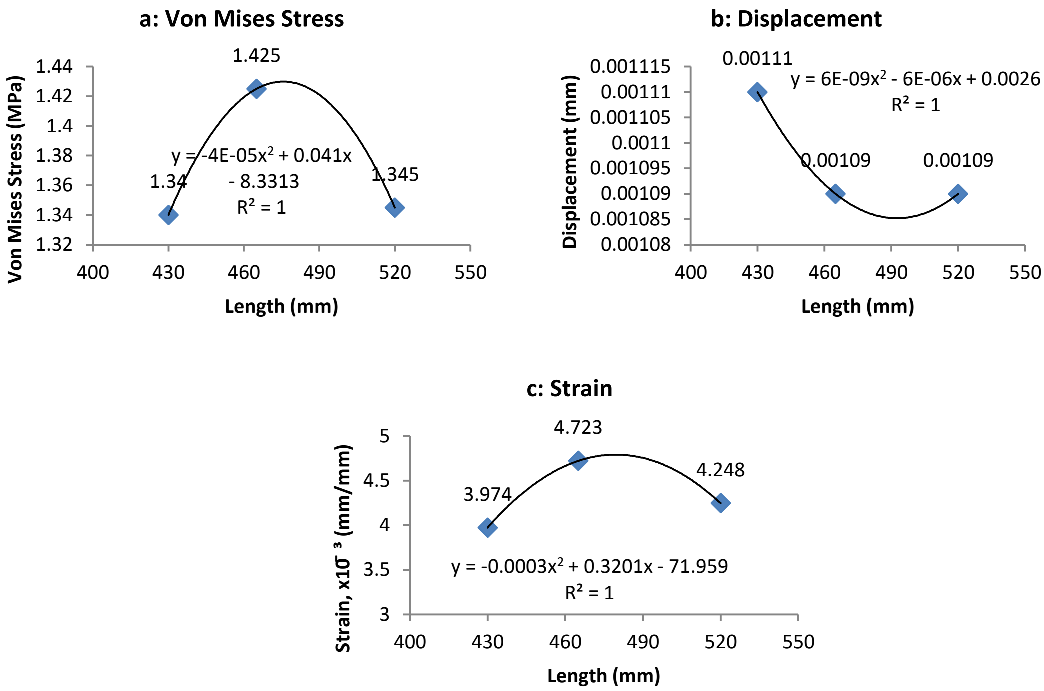



**Figure 10:** Graph for (a) von Mises stress, (b) displacement, and (c) strain for length analysis.

### 3.3 Analysis of Factor 3: Width

In this analysis, only the width is varied (160 mm, 170 mm, 180 mm), and the other factor is based on the level 2 value. The result of von Mises stress, displacement, and strain are shown in Figure 11 (a), (b), and (c), respectively. Based on the graph shown in Figure 11 (a), the highest value of von Mises stress was recorded on the 180 mm width (1.376 MPa), and the lowest is 180 mm width (1.325 MPa). This result strongly proves that the width of the design structure needs to be balanced with length to have a suitable dimension surface of the wall plate to support the loading. Based on the graph shown in Figure 11 (b), the highest value of displacement was recorded at 180 mm width (0.00119 mm), and the lowest is at 180 mm width (0.00103). Figure 12 shows the highest displacement on both levels located at the tip of the TV bracket with red color plotted. The lowest value is located at every eight-hole on the wall plate with blue color plotted. Based on the graph shown in Figure 11 (c), the highest value of strain was recorded on the 180 mm width (4.713 mm), and the lowest is 160 mm width (4.053 mm).

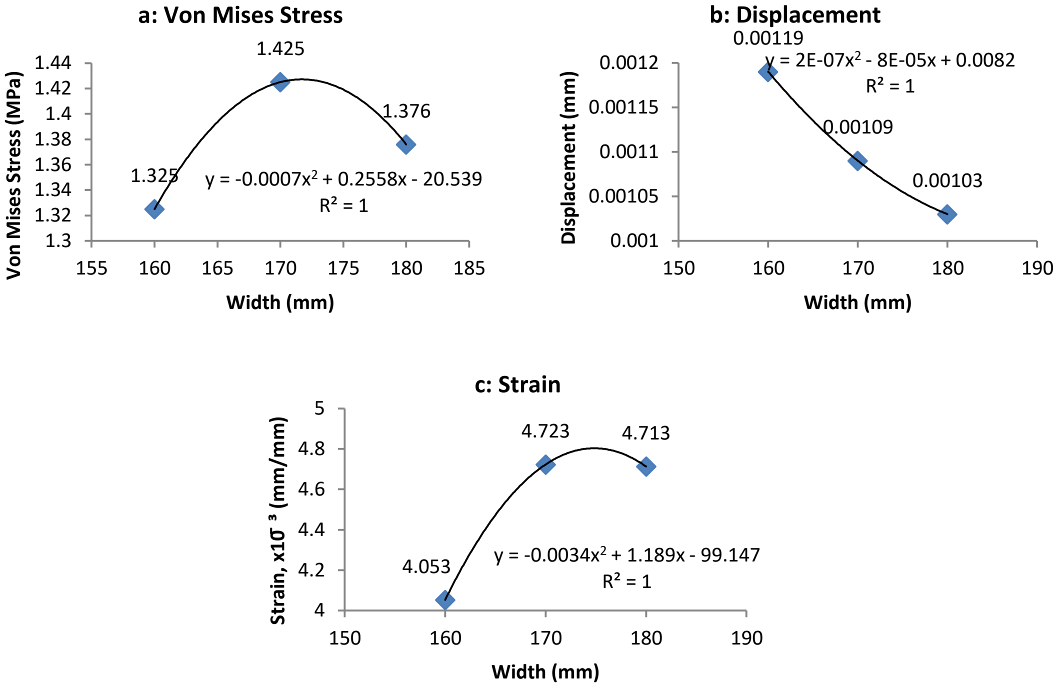



**Figure 11:** Graph for (a) von Mises stress for thickness, (b) displacement, and (c) strain for thickness.

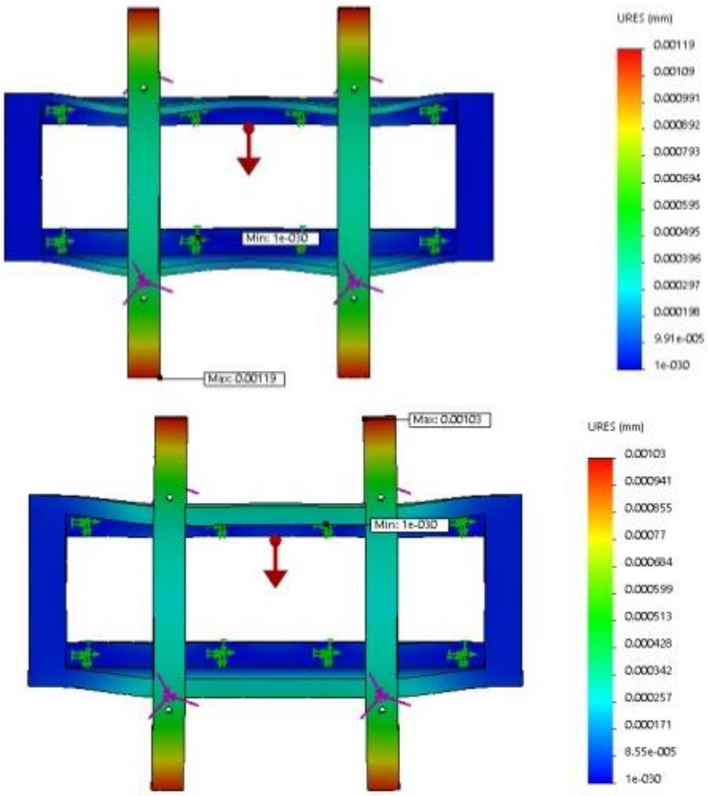



**Figure 12:** SolidWorks simulation for displacement results for width analysis.

### 3.4 Analysis of Factor 4: Wall Plate Design

In this analysis, the designs are varied based on Table 1, and the other factor is based on level 2 value. The result of von Mises stress, displacement, and strain are shown in Figure 13(a), (b), and (c), respectively. Based on the graph shown in Figure 13 (a), the highest value of von Mises stress was recorded on design 1 (1.42 MPa) and design 3 (1.35 MPa). The highest von Mises stress on both levels is located at each nut hole with red color plotted where the loading is applied. The lowest value is located at the tip of the TV bracket with blue color plotted as shown in Figure 14. This is because the TV load fixed to the TV bracket will compress to the middle of the bracket in a downward direction, putting the highest stress on every nut hole.

Based on the graph shown in Figure 13 (b), the highest value of displacement was recorded on design 3 (0.000953 mm) and design 1 (0.000872 mm). This is because design 3 only has one middle bar in the middle of the structure wall plate to support the loading compared to design 1, which has two middle bars on the design structure. The TV load fixed to the TV bracket will compress to the middle of the bracket in a downward direction. This situation contributed to the highest displacement, which made the TV bracket's design structure more deformed and located on the end of each TV bracket, as shown in Figure 15. Based on the graph shown in Figure 13 (c), the highest value of strain was recorded on design 1 (3.905 mm) and design 3 (3.961 mm). Effects of the loading make the highest strain identified on every nut hole, as displayed in Figure 16.

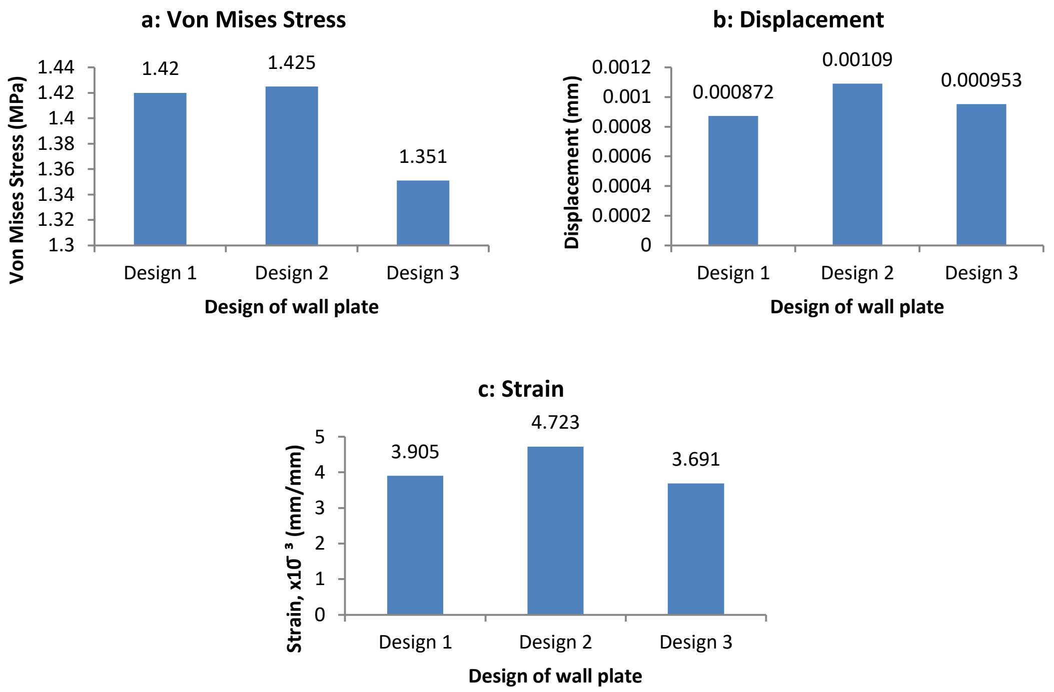



**Figure 13:** Comparison of (a) von Mises stress, (b) displacement, and (c) strain for 3 designs.

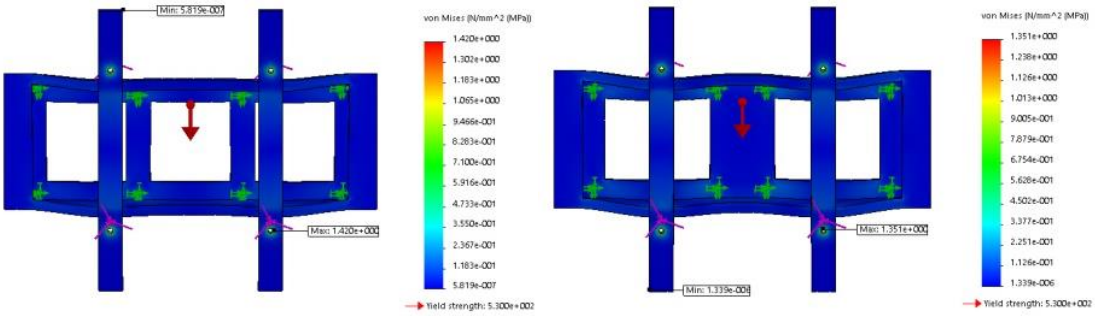



**Figure 14:** SolidWorks simulation for von Mises stress (design of wall plate).

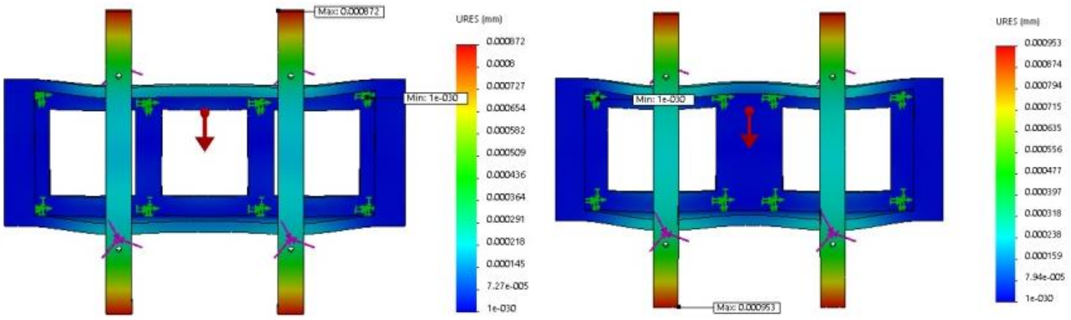



**Figure 15:** SolidWorks simulation for displacement (wall plate design).

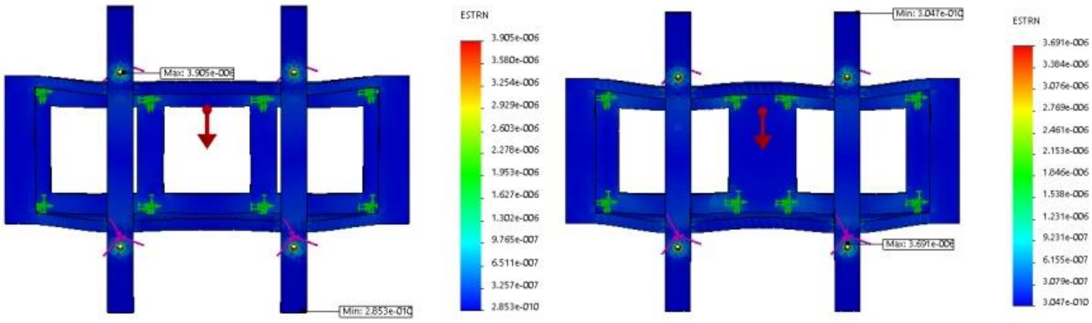



**Figure 16:** SolidWorks simulation for strain (wall plate design).

## 4. CONCLUSION

The effect of the design parameters on the wall mounting bracket has been analyzed and evaluated to find the best design parameters for minimal mechanical defects. The validated 3D model is simulated using SolidWorks software. Different wall mount lengths, widths, thicknesses, and TV wall mount bracket designs were selected as factors in this study. Stress, displacement, and strain were the responses. Statistical regression analysis analyzes the correlations between design parameters and mechanical defects. From the thickness analysis result, 6mm thickness shows the lowest stress, strain, and displacement. This is because the thicker of TV wall mount bracket, the stronger the force to support loads of TV. For the length analysis, 430 mm length is better to minimize the stress, strain, and displacement than 465 mm and 520 mm. The width analysis shows that the 160 mm width is the best to minimize mechanical defects compared to 170 mm and 180 mm widths. The plate design analysis revealed that design 3 is more effective in minimizing the mechanical defects on stress and strain. Nevertheless, design 1 is effective in minimizing the displacement of the part. Design 3 might be the best design to minimize the defects. Design 3 has more displacement because it only has one middle bar on the structure of the wall plate to support the TV load. This study is expected to be a valuable guideline and reference for the process design by the production companies. The present studies may be extended for more design parameters, including material selection.

**ACKNOWLEDGEMENTS**

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