International Journal of Synergy in Engineering and Technology Vol.1 No.2 (2020) 78-85

International Journal of Synergy in Engineering and Technology
IJSET

Design and Simulation of Snap Clip on Pot Food Strainer Using 3D Solid Modeling

A.H.A.Haniff *, M.A.Joraimee, B.M.Hairy

University College TATI, Teluk Kalong, 24000, Kemaman,
TERENGGANU.
Corresponding author: hanifnear89@gmail.com

KEYWORDS

Snap Clip
Finite Element Analysis

ABSTRACT

A strainer used to strain liquids away from other ingredients. The objectives are to analyze in terms of design concept choices of the snap clip on pot food strainer using a morphological chart and simple matrix analysis. The design and analyses of the stress analysis of product using in the software Inventor 2019. The force applied to the design was 2N. The results of the analysis for the selected design shows the Von Mises Stress is 0.1322 MPa (maximum), the displacement was 12.12 mm (maximum), and safety factor 15.

1.0 INTRODUCTION

There are various products of strainer in the market nowadays that relates to types of material used such as plastic, metal and combination of both. The most common was plastic. But aluminum and stainless steel are also used (Guyott, 1997). Various manufacturers have supplied reliable strainers for domestic and commercial use. These strainers are usually bowls or shaped pots and may incorporate one or more features such as, one handle, a pair of handles, or an extended handle and leg. These strainers contain drainage holes that vary in number and size according to which part of the item will be tense. The amount of these filters also varies from small to large.

Most of people will use their hands to hold or prevent an item from being spilled while rinsing or washing. This will indirectly contribute to the hygiene factor. The straining operation was very simple. The strainer is placed in or held over a sink or a large bowl or service pot. The hot pot containing boiling water and the food to be strained is poured into the strainer so that the strainer catches the prepared food. The strainer and the used pots are placed about the cooking area as meal preparation continues and addressed later during clean up (Heilig, 2017).

By referring to the design part pattern (Chaudry et al., 2018a, 2018b; Chen & De Groote, 2011; Cloutier & Sasken-Duff, 2012, 2014; De Groote & Cautereels, 2005; Farkas, 2019), the new design of pot strainer was develop with some improvement. On the existing product, the clip used to hold the shape of the pot has a spring. Thus, the new design will make the clip without spring, making it easier for fix installed. In addition, the weakness with existing products can only be applied to one strainer to one pot sizes. Therefore, the new design will allow the strainer to separate into two parts. It somehow can save consumers more money than buying the product according to the size of the pot.

Received 20 October 2020; received in revised form 20 November 2020; accepted 25 November 2020.

Software used for the design also plays a major role in the producing a good products. Technology has been rapidly expanded and the designer has many choices in making decisions on which software to use during the development process. Inventor, Solidworks, Creo Parametric, Solid Edge, or even Pro Engineer is the valid 3D software in the market nowadays. 2D software is still available such as AutoCAD and still one of the main tools in developing 2D data in certain company (Simpson & Us, 2019).

This research was conducted to analysis in term of design concept choices with is using morphological chart and matrix analysis, to design new innovation of snap clip on pot food strainer and to analyze the static linear analysis. This research will focus on innovation of existing product. This project will be design by using Inventor software based on the existing lawn mower that already have in the current market. Then, the result will be analyzed by using Finite Element Analysis software (FEA) in Autodesk Inventor software 2019.

2.0 METHODOLOGY

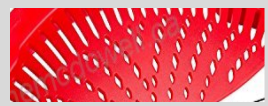
The purpose of the design will make it easier for the kitchen users. Morphological chart and matrix analysis was used for design concept. The result will be combining and decide to create three design concept. This study has three stages of methodology which is problem statement, design and final analysis. All this methodology is finding the best solution for improve the design.

2.1 DESIGN

2.1.1. DETERMINE THE PART SELECTION USING MORPHOLOGICAL CHART

Provide a structured approach to concept generation to widen the area of search for solution to be a defined design problem. It can help to generate a complete range of alternative design solutions for a product through a systematics analysis of the form or configuration that a product or machine might take. A morphological chart is a visual way to capture the necessary product functionality and explore alternative means and combination of achieving that functionally. For each element of product function, there may be a number of possible solutions. The chart enables these solutions to be expressed and provides a structure for considering alternative combinations. This can enable the early consideration of the product 'architecture' through the generation and consideration of different combinations of 'sub-solution' that have not previously been identified. Used appropriately, it can help to encourage a user driven approach to the generation of potential solution. The highlighted part shows the possible sub-solutions which should represent the total 'solution space' for the product-made up of combinations of sub solutions. Table 1 shows the detail of part selection.

Table 1: Morphological Chart

Functions	Options	
Base Of Strainer		 Curve
Type Of Clips	 U-Type Clip	
Type Of Hole		 RECTANGLE AND CIRCLE HOLE
Size Adjustable Can Be Use	10 Cm To 24 Cm	28 Cm To 32 Cm
Material	Silicone	ABS

2.1.2. MATRIX ANALYSIS

One of the most common methods is to produce an evaluation matrix, where each solution concept is set against a list of selection criteria. For each criterion some kind of scoring system is used to indicate how the individual design concept compares with and agree norm. Concept proposal in a short written explanation should be provided for comparison purpose. Equality with the agreed norm is shown in the skeleton matrix by the letter 'E', if the design solution is considered better that norm, in some way, then a '+' sign is used, conversely a '-' sign is used, if the design solution is worse than the norm, in some way. A score may be obtained by allocating a '+1' to the positives, '-1' to the negatives and '0' to the E. For the symbol '+' is the part that are chosen. For the '-' is the part that are not been chosen. Symbol of 'E' is that part is equal for all type of design. Final result that be conclude at the score and based on the result score , the best chosen result is will be in first rank order. The proposed design matrix analysis was shown in Table 2.

Table 2: Design Proposal

	Design A	Design B	Design C	Design D (existing)
Material selection	E	E	E	E
Design complexity	-	-	+	+
No. of components	+	+	+	-
Ease of assembly	+	+	+	-
Safety	+	-	+	+
Feature	-	-	+	-
Ease of use	-	-	+	+
Cost	-	-	-	+
Ergonomical	-	-	+	+
Score (∑, +, -, E)	-2	-4	6	2
Rank order	3	4	1	2

2.1.3. DESIGN CONCEPT

Through this phase, three design concepts were proposed based on morphological chart and matrix analysis as shown in Figure 1 to Figure 3. In Figure 1 shows the dimension of slot in the middle was 35.0mm length and 2.0mm thickness for base. The design did not have any funnel on it.

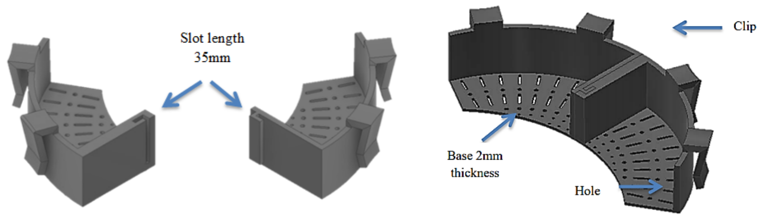


Figure 1: Design A

The Figure 2 with slot in the middle was 22.5mm length and 2.5mm thickness for base with four funnel and each side have two funnel as shown in Figure 2.2

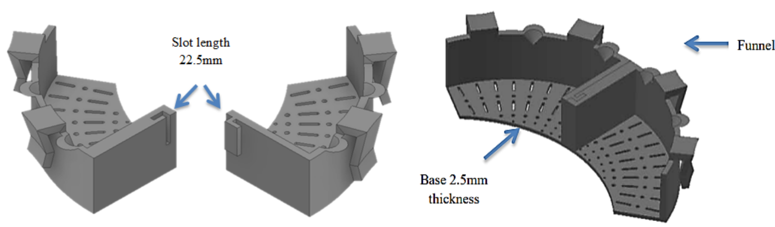


Figure 2: Design B

Finally, in Figure 3 show the dimension of slot in the middle was 35.0mm length and 3.0mm thickness for base with four funnel and each side have two funnel. The summary of the information was listed in Table 3.

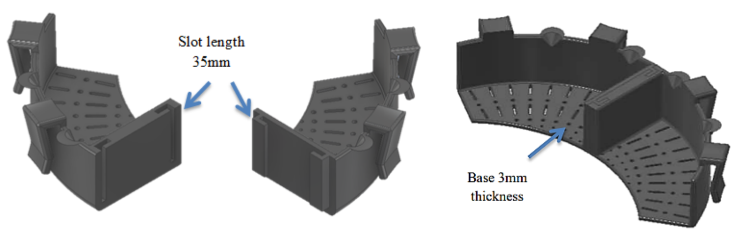


Figure 3: Design C

Table 3**:** Summary of Design A, Design B and Design C

Design	A	B	C
Length of slot	35.0mm	22.5mm	35.0mm
Thickness of base	2.0mm	2.5mm	3.0mm
Funnel	0	4	4

3.0 RESULTS AND DISCUSSION

3.1 FINITE ELEMENT ANALYSIS

In this section, finite element analysis will be run on base structure which is the most critical issue. In the software parameter, the part was given on 2 Newton force and material selection was silicone rubber. These parameters were constant for the analysis. The von misses stress, safety factor and displacement results were recorded. In most cases, results that display in red represent high stress or high deformation, or a low factor of safety. Each results set gives the different information about the effect of the load on part(Jaskulski, 2015).

a) Von Mises Stress shows the results use color contours to indicate the stresses calculated during the solution.

b) Displacement shows the results the deformed shape of model after the solution and indicates the magnitude of deformation from the original shape.

c) Safety factor indicates the areas of the model that are likely to fail under load.

3.1.1 DESIGN A

In design A, the software analyse that the maximum Von Mises Stress was 0.2493 MPa. The analysis also shows the maximum displacement is 25.26 mm and factory of safety is 15. The simulation and summary of result was shown in Figure 4(a-c) and Table 4 respectively.

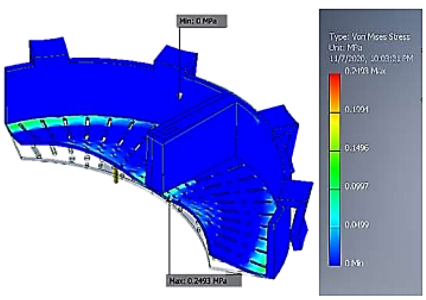


Figure 4 (a) : Maximum Von Mises Stress

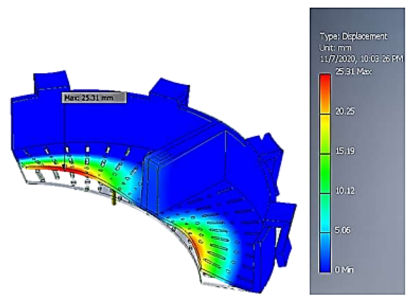


Figure 4 (b) :Maximum Displacement

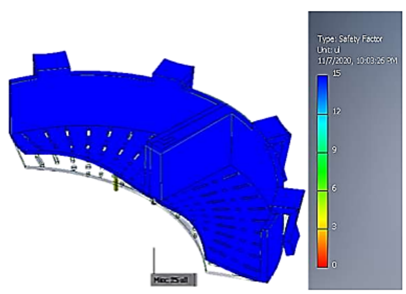


Figure 4 (c) :Factor of Safety of Design A

3.1.2 DESIGN B

The Figure 5(a-c) show that maximum Von Mises Stress was 0.1537 MPa, maximum displacement was 15.01 mm and factory of safety is 15. The summary of result was table in Table 4.

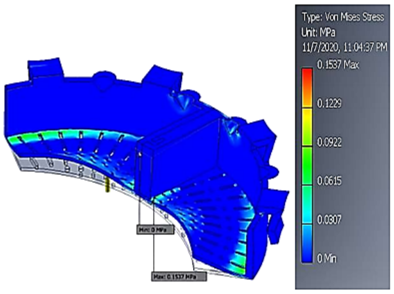


Figure 5(a): Maximum Von Mises Stress

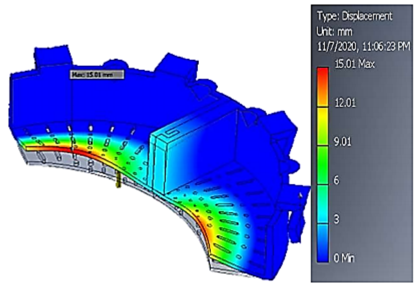


Figure 5(b): Maximum Displacement

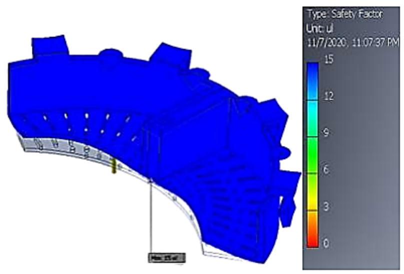


Figure 5(c): Factor of Safety

3.1.3 DESIGN C

The Figure 6(a-c) show the maximum Von Mises Stress of Design C was 0.1322 MPa and maximum displacement of was 12.12 mm. The result shows the minimum value of safety factor is 15.

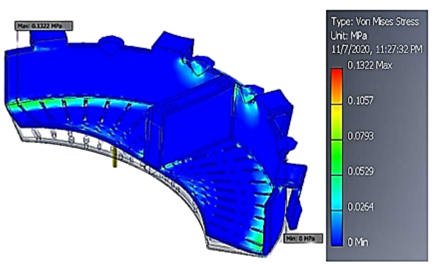


Figure 6(a) :Maximum Von Mises Stress

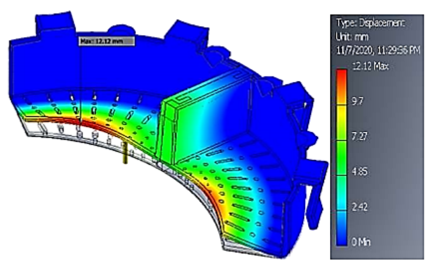


Figure 6(b) :Maximum Displacement

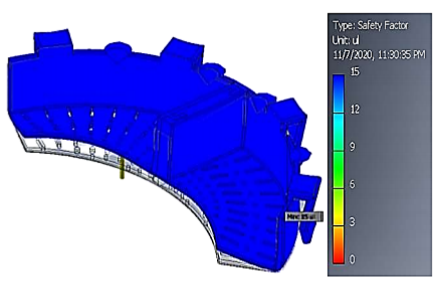


Figure 6(c) :Factor of Safety

Table 4: Summary of Analysis Result

Analysis Snap Clip on Pot Food Strainer	Silicone Rubber			
	Force	Maximum Von Mises Stress (MPa)	Maximum Displacement (mm)	Factor of Safety
Design A	2N	0.2493	25.26	15
Design B	2N	0.1537	15.01	15
Design C	2N	0.1322	12.12	15

3.2 SUMMARY OF ANALYSIS

Based on result, shown the highest Maximum Von Mises Stress occur to design A which is 0.2493 MPa while lowest Maximum Von Mises Stress occur to design C which is 0.1322 MPa. The highest Maximum Displacement occurs in design A which is 25.26 mm while lowest Maximum Displacement occur to design C was 12.12 mm. Lastly, Factor of Safety of all design have the same value of 15. Therefore the design C was chosen for the final design of the pot strainer. The detail drawing of the product is shown in Figure 7.

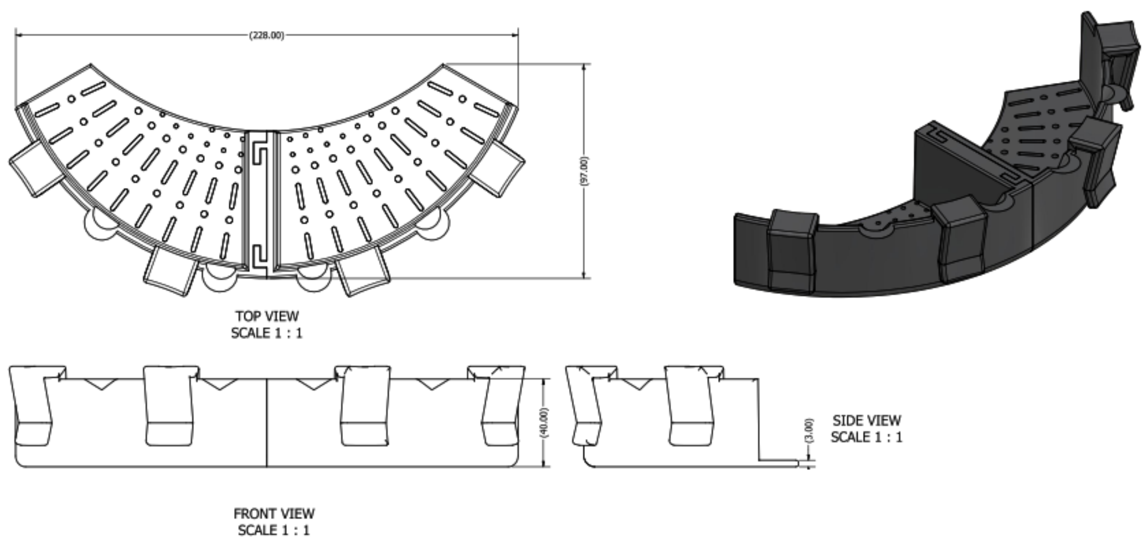


Figure 7: Detail drawing of the design C

4.0 DISCUSSION

Table 4 shows the overall data comparison of Von Mises Stress, displacement, factor of safety with design. The load applied on all design is same load that is 2Newton for maximum load and the material is silicone rubber that applied for three designs. According Von Mises Stress, the design C is the lowest value then other design. The lowest value of Von Mises Stress is the best design to choose because the risk to crack or damage is very low. The highest displacement is design A (25.26 mm) that can be considering that more movement occur at the base of design A. The factor of safety for design A, design B, design C is equal that is 15. The higher value Factor of Safety means that the design is in good condition.

5.0 CONCLUSION

In this study, Autodesk Inventor software 2019 simulation has been used to simulate the Snap Clip on Pot Food Strainer. The results have shown that, the selection design was Design C which maximum Von Mises Stress and maximum displacement have been observed. The result of Von Mises Stress and displacement was 0.1322MPa and 12.12mm respectively. Although there is a reduction in thickness in design A and B, the maximum stress does not change significantly even though the load applied is the same. The material applied is a silicone rubber that is commonly used in household that is more suitable for use in places that require significant deformation. In conclusions, the three main objective of this simulation were successfully achieved.

ACKNOWLEDGMENT

The author would like to thank University College TATI for the equipment and software used in this research.

REFERENCES

Chaudry, A., Conway, J., Montag, S. D., & Lehman, J. (2018a). Cooking pan strainer. In: Google Patents.

Chaudry, A., Conway, J., Montag, S. D., & Lehman, J. (2018b). Cooking pot pivoting strainer. In: Google Patents.

Chen, R. Y., & De Groote, J.-h. (2011). Food container with strainer basket. In: Google Patents.

Cloutier, A. D., & Sasken-Duff, D. L. (2012). Cooking pan with strainer. In: Google Patents.

Cloutier, A. D., & Sasken-Duff, D. L. (2014). Cooking pan with strainer. In: Google Patents.

De Groote, J.-h., & Cautereels, V. J. (2005). Strainer for food. In: Google Patents.

Farkas, J. (2019). Snap-on strainer. In: Google Patents.

Guyott, C. (1997). Foodservice Design—Planning for the Future. *Journal of the American Dietetic Association, 97*(10), S148-S149.

Jaskulski, A. (2015). *Autodesk Inventor Professional 2019PL/2019+/Fusion 360: metodyka projektowania*: Wydawnictwo Naukowe PWN.