Progress in Engineering Application and Technology Vol. 2 No. 1 (2021) 869-881
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PEAT

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/peat
e-ISSN : 2773-
5303

Design of Gating System for Green Sand Casting of Aluminium Alloy

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DOI: https://doi.org/10.30880/peat.2021.02.01.083
Received 13 January 2021; Accepted 01 March 2021; Available online 25 June 2021

Abstract: Sand casting is preferable and well-known as the most efficient way as it is cost efficient and can form shape through expendable mould process. The hollow cavity in the mould that determine the desired shape is then allowed to solidify. Gating system design is very essential in the casting process and described as one of the key elements in determining good quality of casting. A gating system in charge of controlling the flow pattern and mould filling process throughout the casting process. Improper design of gating system would contribute into porosities and shrinkage during mould fillings and solidification phase, cause turbulence flow of molten metal and consequently damage the castings yielded. The main focus of this study was to propose the best gating system design for green sand casting of aluminium alloy. There were three different designs of gating system proposed in this study based on the previous researches with various parameters installed on each design. The variety of gating parameters were studied involving the type of feeding system, the shape of sprue, type of runner, number of gate as well as the functional value of sprue well on the molten aluminium alloy in green sand casting. Simulation analysis was implemented through the application of Solidworks software version 2019. The simulation analysis was applied on the design of gating system in examining the aspects of stress and displacement regarding the parts of the gating system design. The cost analysis was performed in this study through the quotation method in analyzing the estimation of the cost charged on the materials as well as the manufacturing costs involved in the fabrication of the gating system design. Gating system design II indicates very small amount of stress at the two ingates with yellow to orange colour of stress distribution ranging from 1.828e+08 N/m² to 2.031e+08 N/m² compared design I and III. The total cost for fabricating the best gating system design II is RM 699.40. As a conclusion, Solidwork analysis feature available in the software able to assist in the design selection for fabricating the matchplate pattern for green sand-casting process.

Keywords: Gating System, Solidworks Simulation, Sand Casting

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1. Introduction

Casting is known as the process in the manufacturing which requires molten metal to be poured into a prepared mould. The hollow cavity in the mould that determine the desired shape is then allowed to solidify. Hence, the solidified part is known as castings. Sand casting is preferable and well-known as the most efficient way as it is cost efficient and can form shape through expendable mould process. The metal is melted in the furnace and then ladled and poured into the cavity of the sand mould, which is formed by the pattern. The sand mould separates along a parting line and the solidified casting can be removed. Almost any alloy can take part in the sand-casting process. Sand casting is also common in producing automobile components, for instance, engine blocks and cylinder heads [1]. Gating system design is very essential in the casting process and described as one of the key elements in determining good quality of casting [2]. The implementation of gating system brought about the fundamental yields in the casting foundry [3]. A gating system in charge of controlling the flow pattern and mould filling process throughout the casting process. There are factors that need to be put into consideration in designing the gating system in terms of their functionality to ensure a good quality of aluminium alloy castings produced. Such factors that need to be taken care of are the size and the number of gates as well as their location that connect the runner and casting [4].

Different design of gates would contribute to a different result in terms of the outcomes in sand casting process. Improper design of gating system would contribute into several casting defects like shrinkages, porosity, misruns, cold shuts and oxidation of metal. Other than that, poor design of gating system could contribute into turbulence flow of molten metal and damage the castings yielded [5]. The percentage of casting defects shrunk to 30.00 % through simulation method due to the effective gating system design [14]. Such requirements need to be considered in order to achieve a free casting defects throughout the casting process. Hence, the selection of the best design of gate systems needs to be studied for improvements regarding their performances in terms of the filling rate as well as the flow of the molten metal inside mould cavity in order to obtain a good quality of aluminium alloy castings with minimal defects.

1.1 Component of Gating System

A gating system is introduced as the essential plumbing network in which leading the molten metal in order to reach the mold cavity of a casting [5]. The major purpose of gating system is to provide a passageway for clean molten metal starting from the poring process from ladle to the casting cavity [4]. The components of gating system mainly consist of pouring chamber, sprue, sprue well, runners, ingates, mold cavity, vent and riser [6]. Each part of the filling system has a particular function of its own and is vital to success. Gating system is mainly designed in order to provide a clean channel for the molten metal at the starting of filling process from the ladle until it fills up the casting cavity in order to ensure a smooth, uniform as well as complete mould filling process. The proper design of gating system in casting process is one of the most critical decision-making tasks in foundries as it is related to the number of defects, for instances, air inclusions and surface defect concentration in which can minimize the quality of the final casting [7].

1.2 Gate Design

Suitable gate geometries and the use of feeders are required while designing a casting mold. Optimization in terms of the design of gate is a fundamental in order to prevent the presence of defects from the casting [8]. It is essential that the flow of molten metal through the gates at a speed lower than the critical velocity so as to enter the mold cavity smoothly [5]. There are several classifications of gates in terms of their position in the mold. Top gating system is not really advised due to it will provide results in a lot of erosive effect when melt stream impinges the bottom of the mold cavity and the associated splashing produce a presence of oxidation. Other than that, parting line gating give the best compromise between moulding convenience and the promising gating arrangement. On top of that, bottom gating is highly recommended as it will allow the steady flow of molten metal through the mold, splashing and metal mould impingement can be eliminated [9].

1.3 Runner Design

Runner described as the channel from the sprue to the gate through which the molten metal is transported [5]. It was favourable to have very thin runners and gates [2]. However, this will provide a negative bearing on the speed of pouring and the flow of the molten metal into the mould cavity. Implementation of two runners during the filling process of the die creates turbulences flow due to fluid jets collide at high pressures resulting in mixing and entrapping air and gases [10]. Air being entrapped in the part is larger with two runners in the injection than with one runner. The utilization of single runner to be considered for the laminar flow as the runners were proved by simulation that they can contribute to the presence of porosities defects caused by the turbulences flow. Sharp bends of runner can provide negative pressure and disrupt the flow of the fluid. Instead, maintaining consistent pressure throughout the runner need to be considered as it will lower the cross-sectional area in flow direction [4]. Early solidification in the runner can be avoided by the shorter distance of molten metal in reaching the castings. Longer design runner can provide laminar flow of the melt during filling process but early solidification might occur [11]. Suitable and optimum casting temperature will need to be considered in terms of the runner and gating system design.

1.4 Sprue Design

Sprue refers to the channel through which the molten metal reaches the mould cavity whereby it coming from the pouring basin. In several cases, the metal flow into the mould is regulated [12]. The tapered downgate minimizes the presence of vortex formation and turbulence flow due to the constricted opening. The uniform cylindrical downgate is able to cause vortex formation and turbulence resulted in defects and distortions of the sand mould. This will cause the lower in pouring speed in which can result in occurrence of early solidification or premature cooling before the pouring was completed [2]. Sprue helps in getting the melt down to the lowest level of the mold while leading a lower defect instead of the increasing velocity of the stream [9]. The design of the sprue should be as narrow as possible so that the metal has lower chances to break and entrain its surface during the fall. Sprues should be tapered so as to mimic the taper that the falling stream adopts naturally as a result of its acceleration due to gravity in order to minimize the presence of air entrapment and oxide formation.

1.5 Common Defects Occur in Sand Casting Process

There are various of defects that have been such a troublesome to foundry in producing a good quality of castings. Such defects occur are shrinkage, porosity, cold shut, mismatch, blow holes, misrun and crack for casting process. The unsteady flow of molten metal will absorb much air and thus increasing the chances of the occurrences of inclusions and air holes [13]. Shrinkage defects are the most favourable defects that frequently occurred defect among the other casting defects. Sharp bends of runner can provide negative pressure and disrupt the flow of the fluid which contributes to major casting defects [4]. Most of the casting defects occurred due to the improper design of the gating system. The uniform cylindrical downgate is able to cause vortex formation and turbulence resulted in defects and distortions of the sand mould [2].

2. Materials and Methods

This research was focused mainly in designing the gating system and the analysis of the gating design in order to propose the best design of gating system of aluminium alloy through green sand-casting process. There were several parameters involved in the analysis of the gating system design which were obtained from the literature review. The gating system designs were analysed on the stress and displacement study through Solidworks Software. A cost analysis was implemented to determine the fabrication cost for the best gating system design through quotation method.

2.1 Methods

The methodology of this project was organized in order to systematically arrange all the activities and plans involved regarding this project to be conducting smoothly and on time as well as to prevent any mistakes from occur during the activities especially on the analysis and preparation of procedures. Figure 1 shows the flowchart methodology of this study from the beginning to the end of study.

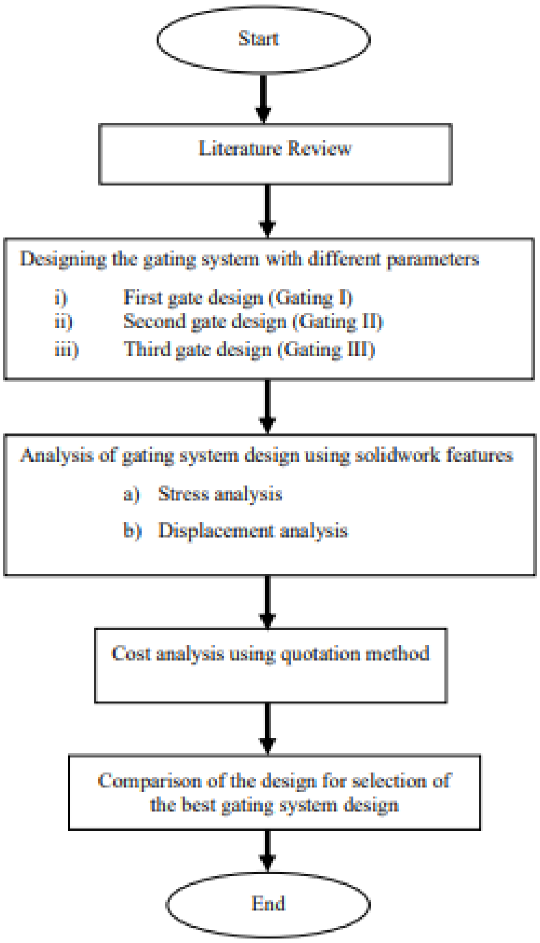

Figure 1: Flowchart methodology

2.2 Designing of Gating System for Sand Casting Metal Moulding Flask

There were several parameters manipulated in terms of the efficiency of the gating system. The design of gating system included were the sprue design, the type of runner design as well as the gating design. A total of three gating system design were proposed in this study with different parameters was analyzed in this study. Gating system design I is consisted of a conical pouring chamber or cylindrical chamber, a tapered sprue, a single runner with smooth bend, one cylindrical gate with top feeding system as well as the addition of top cylindrical riser, as shown in Figure 2. Gating system design II is consisted of a conical pouring chamber or cylindrical chamber, a tapered sprue connected with a single runner with smooth bend and runner extension, two cylindrical gates with bottom type of feeding system as well as a single cylindrical top riser which is shown in Figure 3. Gating system design III is consisted of a conical or cylindrical pouring chamber, a non-tapered sprue associated with sprue well, a single runner with sharp bend and runner extension, one cylindrical gate with bottom type of feeding system as well as a single cylindrical top riser as shown in Figure 4.

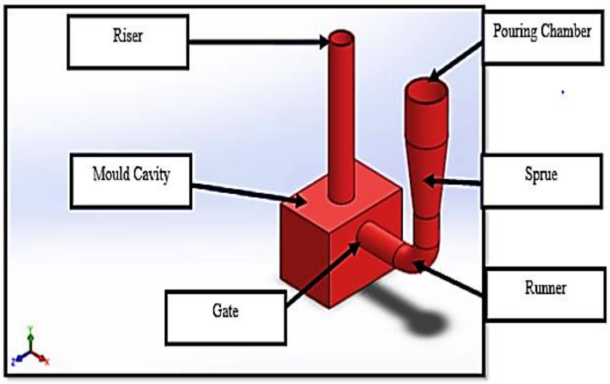

Figure 2: Proposed design of gating system I

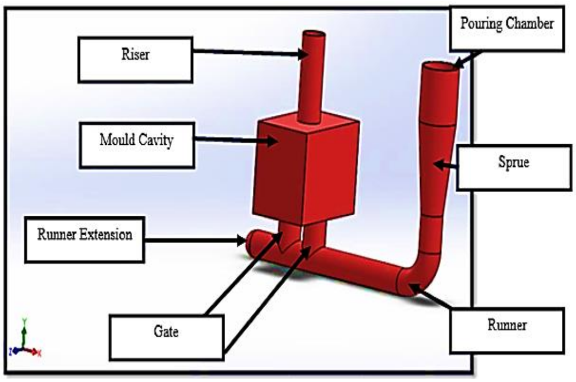

Figure 3: Proposed design of gating system II

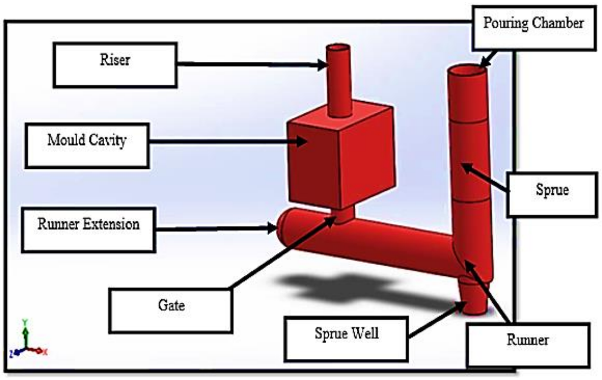

Figure 4: Proposed design of gating system III

2.3 Analysis of Stress and Displacement on the Gating System Design using Solidwork Software

The static study on the design of gating system has been done by using Solidworks software. There were two components assessed in the static study regarding the designs of the gating system in which include stress analysis and displacement analysis. The stress and displacement analysis were applied involving several steps regarding the simulation which consisted of applying design material, the geometry fixture of the part and the force on the design. After that, the design was mesh and the analysis was run in the Solidworks software to get the result.

2.4 Quotation costing method

The quotation costing method was implemented in preparing cost analysis for the fabrication of the gating system. The proposed designs of gating systems were analyzed thoroughly for fabrication including the materials as well as their charges of manufacturing process. The cost analysis was carried out with several measures regardless of whether the organization is a vendor or a sub-recipient in order to obtain the price of the necessary materials with reference to the design of gating system.

3. Results and Discussion

The findings of this study shown that the various components were analyzed based on the previous researches regarding the design of the gating system for green sand casting of aluminium alloy. Furthermore, it is also included that the analysis of stress and displacement for the gating system designs and their cost analysis through quotation method.

3.1 Designs of the gating system for green sand-casting application

There were various of parameters in terms of the design of gating system installed as shown in the Table 1. Several elements of the gating system design were kept constant due to the purpose of comparison in the study of the efficiency of each design on the quality of the aluminium alloy castings. The element of gating design that are fixed includes the pouring chamber and the riser which was design to be conical and cylindrical respectively. The position of the riser was kept constant throughout the study due to the good feedbacks obtained from most of the journals from the literature review. Hence, the gating system design was evaluated and assessed for their mechanical properties in green sand casting.

Table 1: Comparison of proposed design of gating system

GATE/CRITERIA	GATING DESIGN I	GATING DESIGN II	GATING DESIGN III
Pouring Chamber	Conical (Fixed)	Conical (Fixed)	Conical (Fixed)
Sprue	Tapered	Tapered	Non- Tapered
Runner	Single runner with smooth bend	Single runner with smooth bend	Single runner with sharp bend
Well	Absent	Absent	Present
Gate	One cylindrical gate	Two cylindrical gates	One Cylindrical gate
Feeding type	Top feeding	Bottom feeding	Bottom feeding
Riser	Single cylindrical top riser (Fixed)	Single cylindrical top riser (Fixed)	Single cylindrical top riser (Fixed)

3.1.1 Gating Design I

The specification of the design was determined based on the literature reviews according to the parameters of gating system installed in this design. This design implemented the conical pouring chamber to provide the constant pressure head over sprue and to assist in removing the slag entering the down sprue [5]. The tapered sprue design was really recommended from almost all of the literature review as in can control the pressure of molten metal flowing downwards and minimize the air entrapment as well as turbulences and the presence of oxide formation due to the narrow downstream sprue design [12]. Moreover, a single runner design was provided a more laminar flow of molten metal. Hence, a single runner was taken into consideration in this design for the comparison with the other gating designs in terms of their performances in assisting the casting process. A smooth bend runner was designed in order to minimize the turbulences occur from flow of the molten metal. Furthermore, this gating system was provided with a top feeding system and had been put into comparison as well due to the top feeding gating design will provide massive erosion of the mold cavity with huge velocity of molten metal stream with chance of oxidation presence [9]. A single circular gate was applied to provide a good flow of molten metal inside the cavity of casting and to prevent from the early solidification from occurring. A single gating was put into comparison with other two gating designs. Lastly, the specification of this design was a single top circular riser as top riser will be more efficient than side riser [9].

3.1.2 Gating Design II

The performances from the second gating design will be due to the specification installed in this design. There are various of characteristics of this gating design which can contribute to its overall performances in the casting process by assisting the molten aluminium alloy inside the mould cavity. Firstly, the implementation of the conical pouring chamber will be put into comparison with the other gating system design. The narrowed or tapered channel of sprue will assist a good flow of molten metal downstream to the runner [9]. 63 A single runner that having a smooth bend in this design also was put into comparison with the other designs for the analysis in terms of their performances of aluminium alloy casting process. Other than that, a runner extension was implemented in this design in order to investigate on its efficiency towards the production of aluminium alloy castings in the casting process. This is because runner extension was able to control the flow of the molten metal, provide a cleaner and less damages of molten metal to the gates as well as slow down the melt during entering the mould cavity [9]. However, this design was having two gates with bottom feeding of molten metal, unlike as the characteristics of the first design. This was due to bottom feeding provide better casting results than top feeding. Thus, the performances of the two gates were analyzed and compared with other designs in terms of their performances to determine the defects like porosity in the aluminium alloy castings. This second design was also be having a single top circular riser as it is recommended in providing good castings [12].

3.1.3 Gating Design III

There are variety of elements implemented into the third design of gating system Firstly, this type of design was applying the conical pouring chamber in assisting the process of aluminium alloy casting. This kind of specification of this design was having non-tapered sprue with sharp bend of runner. The non-tapered sprue will provide a huge flow molten metal downstream to the runner with sharp bend runner and this as expected to provide negative pressure, turbulences and disrupt the flow of the molten metal [4]. Other than that, the chances of earlier solidification are higher with this design. Thus, a sprue well was designed in order to control the flow of molten metal and minimizing the turbulence flow of the molten metal throughout the horizontal runner and eliminating the bubble effects and entraining quantities of oxide [9]. The analysis on the ability of the sprue well throughout the aluminium alloy casting process were fully investigated through this gating system design. Furthermore, the single cylindrical gate as well as the top cylindrical riser were put into comparison with the other designs of gating system and the analysis on their performances were a major focus and investigated thoroughly through the aluminium alloy casting process.

3.2 Stress Analysis for Gating System Design

Stress refers to the loading of force applied to a certain cross-sectional area. Stress indicates the condition that happened within the material in terms of the internal distribution of forces within a body that balances and reacts to the load applied to it. Figure 5 shows the stress analysis result of the gating system design I. It was found that the stress distributed at the mould cavity which was located around the cube mould cavity with respected by the green colour. The value of stress was 1.024e+07 N/m² which was considered as medium stress. The stress at the gate for design I which was green coloured with value of 1.433e+07 N/m² whereas at the ingate was yellow to orange coloured which indicating high stress at the ingate. The value of stress was in the range of 1.843e+07 N/m² to 2.252 e+07 N/m². While at the rest of the gating system part such as riser, sprue and pouring chamber were in blue colour which indicating low stress.

Besides, the stress analysis of gating system design II is shown in Figure 6. Stress distribution on the mould cavity was almost quite similar with design I in which located at the corner of the cube mould cavity with green colour and the value of the stress was 1.015e+08 N/m². It is noticed that the gate was in green colour with the value of stress was 1.219e+08 N/m² which indicating medium level of stress. However, at the ingate of the design II, there were two ingates which indicating slightly very little yellow to orange colour of stress distribution with the value of stress ranging from 1.828e+08 N/m² to 2.031e+08 N/m². The other parts of the gating design such as the pouring chamber, sprue and the riser were in blue colour with low stress distribution signal.

Next, the stress distribution of gating system design III was shown in Figure 7. The stress distribution at the cube mould cavity was similar to design I and II which is at the corners. The stress distribution was greenish with the indication of low stress with the value of 7.117e+07 N/m². Whereby, the ingate shows light blue and green colour distribution indicating low to medium stress placed with the value ranging from 6.093e+07 N/m² to 1.015e+08 N/m². It could be due to the bottom feeding allocated in the design III with one ingate and the sprue well whereby it aids in the smooth flow of molten metal inside the mould cavity. The other parts of the gating design involving the sprue, pouring chamber, riser and sprue well were in blue colour showing that low stress distributed there. Hence, gating design III depicted less medium to high stress based on the stress distribution analysis

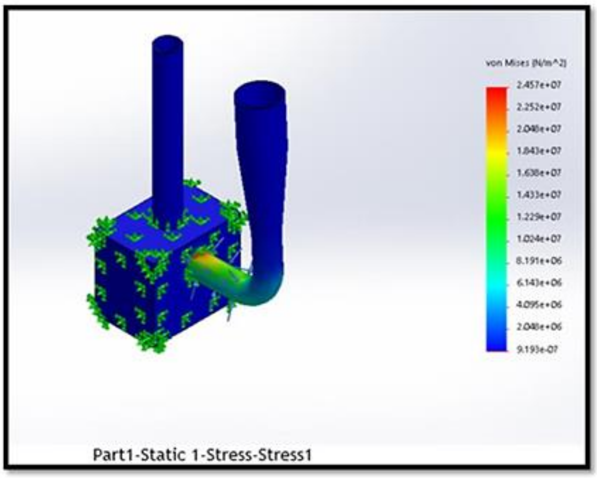

Figure 5: Stress analysis of gating system design I

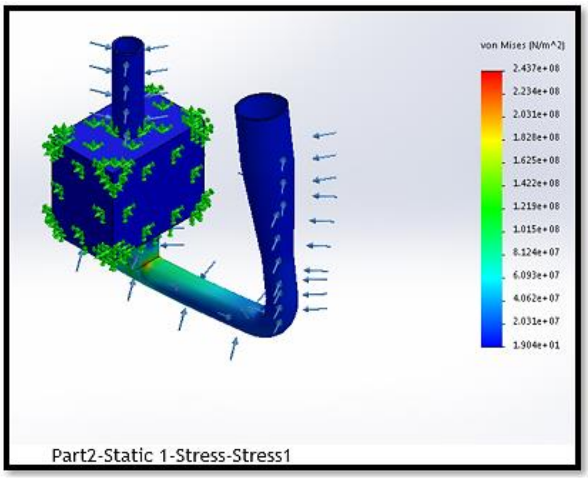

Figure 6: Stress analysis of gating system design II

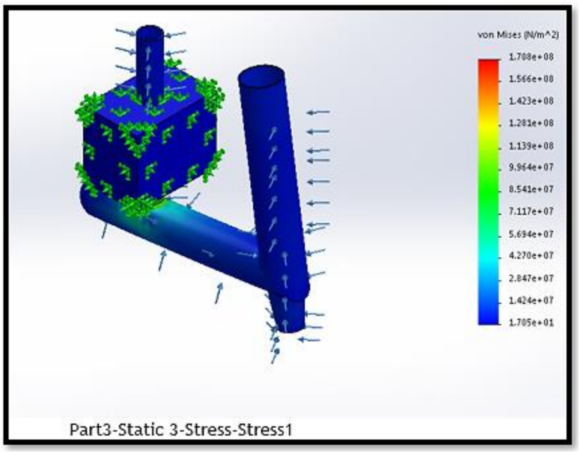

Figure 7: Stress analysis of gating system design III

3.3 Displacement Analysis for Gating System Design

Displacement can be described as the difference of position between the initial points or final point in terms of the placement of an object. Displacement applied for direction and magnitude as it is known as a vector quantity. Displacement analysis of the gating system design I is shown in Figure 8. It can be seen that high displacement was found at the pouring chamber with indication of orange colour at the value of 7. 312e+00 mm. There was slightly change in displacement towards the downwards of the sprue indicated by yellow and green colour with the value of displacement ranging from 3.047e+00 mm to 5.454e+00 mm. Meanwhile, the ingates, riser and mould cavity were in blue colour which shows low displacement. The corners of the cube mould cavity were green colour with medium displacement value of 6.094e+01 mm.

The displacement analysis of gating system design II was shown in Figure 9. It was found that the displacement of gating system design II showing similar trend with the design I. The pouring chamber was orange in colour represents high displacement with value of 7.829e+01 mm. Meanwhile, the area of sprue downwards to runner was green in colour showing medium displacement with the value ranging from 4.270e+01 mm to 6.405e+01 mm. The gate from the runner shows light blue indication of a little displacement with the value of 2.135e+01 mm. The rest of the parts such as the ingates, riser and mould cavity were showing low displacement with value of 1.000e-30 mm which represented by blue colour.

Figure 10 shows the displacement analysis of gating system design III. Based on the result obtained, it shows the exact trend with design I and II which was orange colour of displacement at the pouring chamber and yellow at the sprue ranged from 3.886e+01 mm to 4.651e+01 mm. The displacement analysis at the sprue area downwards to the sprue well was in green colour until at some gate area with the value of 2.537e+01 mm. The displacement of the mould cavity and the riser were all low in which represented by the blue colour except for the corners of the mould cavity which was in green colour with the value of 2.537e+01 mm.

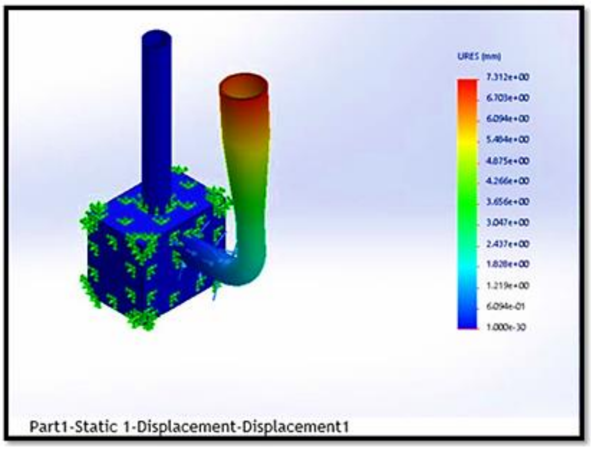

Figure 8: Displacement analysis of gating system design I

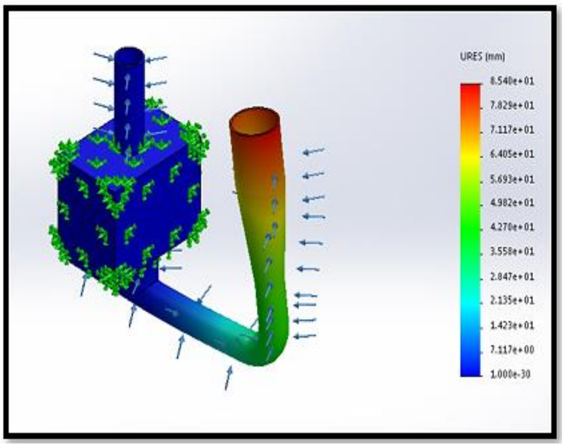

Figure 9: Displacement analysis of gating system design II

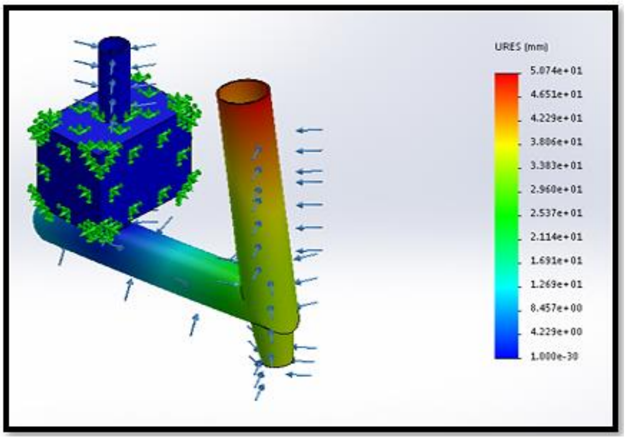

Figure 10: Displacement analysis of gating system design III

3.4 Comparison of the cost analysis between all gating system design

The quotation method was implemented in preparing cost analysis for the fabrication of the gating system design. The proposed designs of gating systems were analyzed thoroughly for fabrication including the cost of the materials as well as their charges of the fabrication process. The process involved for the fabrication of the gating system design are CNC turning, welding and finishing. The cost of the materials and the process involved for the fabrication of each gating system design which is gating system I, gating system II and gating system III are shown by Table 2, Table 3 and Table 4 respectively.

Table 2: Cost of materials and fabrication process for gating system design I

No	Material/Process	Description	Quantity	Price (RM)
1	Aluminum Round Bar	80 mm x 28 mm, 1.663 Kg/m	1	120
2	Aluminum Round Tube	60 mm x 25 mm x 2 mm, 0.390 Kg/m	1	80
3	Aluminum Round Tube	110 mm x 16 mm x 1 mm, 0.127 Kg/m	3	225
4	Aluminum Plate	60 mm x 40 mm x 1.5 mm	4	55.90
5	Aluminum Plate	50 mm x 40 mm x 1.5 mm	2	43.50
6	CNC Turning	Estimation made based on design	-	100
7	Welding	One unit per hour based on design	-	25
8	Finishing	Surface finishing process	-	10

Table 3: Cost of materials and fabrication process for gating system design II

No	Material/Process	Description	Quantity	Price (RM)
1	Aluminum Round Bar	80 mm x 28 mm, 1.663 Kg/m	1	120
2	Aluminum Round Tube	60 mm x 25 mm x 2 mm, 0.390 Kg/m	1	40
3	Aluminum Round Tube	110 mm x 16 mm x 1 mm, 0.127 Kg/m	6	55
4	Aluminum Plate	60 mm x 40 mm x 1.5 mm	4	55.90
5	Aluminum Plate	50 mm x 40 mm x 1.5 mm	2	43.50
6	Aluminum Bar	30 mm x 8 mm, 0.136 Kg/m	1	45
7	CNC Turning	Estimation made based on design	-	120
8	Welding	One unit per hour based on design	-	40
9	Finishing	Surface finishing process	-	10

Table 4: Cost of materials and fabrication process for gating system design III

No	Material/Process	Description	Quantity	Price (RM)
1	Aluminum Round Bar	40 mm x 25 mm, 1.325 Kg/m	1	70
2	Aluminum Round Tube	160 mm x 25 mm x 2 mm, 0.390 Kg/m	2	250
3	Aluminum Round Tube	200 mm x 14 mm x 1 mm, 0.110 Kg/m	1	170
4	Aluminum Plate	60 mm x 40 mm x 1.5 mm	4	55.90
5	Aluminum Plate	50 mm x 40 mm x 1.5 mm	2	43.50
6	CNC Turning	Estimation made based on design	-	70
7	Welding	One unit per hour based on design	-	40
8	Finishing	Surface finishing process	-	10

Table 5 shows the comparison of total cost for the fabrication of the gating system design involving the price of materials and the cost of the manufacturing with reference to each of the gating system design.

Table 5: Total total cost for the fabrication of gating system design

	GATING SYSTEM DESIGN I	GATING SYSTEM DESIGN II	GATING SYSTEM DESIGN III
Total price of materials	RM 524.40	RM 529.40	RM 589.40
Total cost of the process	RM 135.00	RM 170.00	RM 120.00
Total cost	RM 659.40	RM 699.40	RM 709.40

According to the Table 5, it was clearly shown that the lowest cost of fabrication for the gating system design is design I which costs around RM 659.40. The cost of gating system design II is slightly higher than design I which be priced at about RM 699.40. On top of that, the highest cost of fabrication for gating system design is design III which costs approximately at RM 709.40.

3.5 Selection of the best gating system design

According to the findings of this study, the best gating system design will be gating system design II. The simulation analysis through Solidworks software is very essential in determining the stress and displacement distribution on the design of gating system. In the aspects of stress analysis, the stress distribution at the ingate shows significant difference for each design of gating system. The stress at the ingate for design I shows big portion of yellow to orange coloured which indicating high stress. The value of stress was in the range of 1.843e+07 N/m² to 2.252 e+07 N/m². It could be due to the feeding type installed in gating system design I which is top feeding. Meanwhile, there is slightly very little yellow to orange colour of stress distribution at the two ingates for gating system design II with the value of stress ranging from 1.828e+08 N/m² to 2.031e+08 N/m². The feeding type allocated for gating system design II is bottom feeding system. Bottom feeding is preferable than the top feeding and recommended by the previous research as well. This is because the design of gating system with bottom feeding provides steady flow of molten metal throughout the mould cavity and eliminates the metal mould impingement [9]. The ingate at gating system design III shows light blue and green colour distribution indicating low to medium stress placed with the value ranging from 6.093e+07 N/m² to 1.015e+08 N/m². It could be due to the bottom feeding allocated in the design III with one ingate and the sprue well as it aids in the smooth flow of molten metal inside the mould cavity [5]. Although design III has bottom feeding system, it was designed with sharp bend runner which will contribute to the disruption on the flow of the molten metal as it can provide negative pressure, thus inevitable turbulence flow of molten metal will occur [4]. The displacement analysis for each and every gating design were shown quite the same result with no significant difference. The displacement distribution is visible at the area of sprue downwards to runner from the pouring chamber for each design of gating system with green to orange colour which indicate low to medium displacement for every gating system design. Furthermore, cost analysis through quotation method was implemented on all design of the gating system. Based on the result, it was shown that the lowest cost of fabrication for the gating system design is design I which costs around RM 659.40. The cost of gating system design II is slightly higher than design I which be priced at about RM 699.40. It could be due to the number of materials needed as well as the cost of fabrication process in fabricating the design of gating system II. Although the fabrication cost of gating system design I is the lowest, the possibility of the gating system to break is higher due to the large stress distribution at the ingate. Meanwhile the fabrication cost for gating system design III is approximately at RM 709.40, which is higher than gating system design II. The fabrication cost of gating system design II is at reasonable cost with lower possibility of break due to little stress distribution at the ingates. Hence, the best gating system design selected is gating system design II.

4. Conclusion

It can be concluded that the objectives of this research were achieved. The best gating system design is gating system design II with the cost of the fabrication for the gating system design II is at RM 699.40. The optimum design of the gating system was evaluated to be practically applied on aluminium alloy in green sand-casting process. The Solidworks simulation involving stress and displacement analysis and cost analysis through quotation method on each and every gating system design had been performed and analyzed. The Solidwork analysis features able to assist in design selection for fabricating the matchplate pattern for green sand casting of aluminium alloy.

Acknowledgement

The authors would like to thank the Faculty of Engineering Technology, Universiti Tun Hussein Onn Malaysia for its support

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