ISETC2025

UNIVERSITI TEKNOLOGI MARA

# ISETC2025

## 2 ND INTERNATIONAL SCIENCE, ENGINEERING AND TECHNOLOGY COLLOQUIUM



# THE POWER OF SCIENTIFIC INNOVATION

## INTELLIGENT SOLUTIONS FOR A SUSTAINABLE WORLD

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## PREFACE

Welcome to the 2nd International Science, Engineering and Technology Colloquium 2025 (ISETC 2025)!

It is with great pleasure that we present this year's colloquium, a distinguished gathering of scholars, researchers, and professionals dedicated to the advancement of applied sciences. Held virtually on 9th July 2025, ISETC 2025 serves as a platform to highlight cutting-edge research, foster meaningful networking, encourage collaborations, and explore innovative solutions to global challenges.

This year's theme, "The Power of Scientific Innovation: Intelligent Solutions for a Sustainable World" highlights our shared goal to solve global challenges through applied science. It celebrates innovation as a key to building a more sustainable and resilient future. We're proud to feature keynote speakers and presenters who bring fresh insights, bold ideas, and breakthroughs shaping tomorrow's world.

We would like to extend our heartfelt appreciation to the Faculty of Applied Sciences, Universiti Teknologi MARA, Perak Branch, Tapah Campus, for their outstanding support and assistance throughout the planning and execution of the event. Their dedication has been instrumental to the success of this colloquium. We would like to sincerely thank all participants and researchers for their valuable contributions. We also appreciate the reviewers for their careful evaluations and helpful feedback. Your hard work and support mean a lot to us.

As editors, we are proud to present this collection of proceedings. It is an honour to bring together the interesting and meaningful work of our speakers and authors. We hope the ideas shared will lead to new discoveries, encourage more research, and help solve global challenges through science and innovation.

Warm regards,

Dr. Emi Norzehan Mohamad Mahbob
Dr. Saiyidah Nafisah Hashim
Ms. Lili Widarti Zainuddin
Ms. Nurul Nazwa Mohammad
Ms. Rozaina Saleh

ISETC 2025 Proceedings Editors

# RUNNER SIZE DEPENDENCY OF TENSILE STRENGTH IN AA6063 ALUMINIUM ALLOY SAND CASTINGS

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**Abstract:** This study investigates the influence of varying runner sizes in sand casting gating systems on the mechanical performance of AA6063 aluminium alloy castings. Three distinct runner diameters (15 mm, 20 mm and 25 mm) were designed using CAD tools and fabricated via FDM 3D printing. Cast specimens were produced using green sand moulds, and tensile properties were evaluated according to ASTM B557M using a Universal Testing Machine (UTM). The findings revealed a direct correlation between runner size and tensile strength, with the 25 mm runner yielding the highest tensile strength of 97.88 MPa, compared to 70.55 MPa and 51.6 MPa for 15 mm and 20 mm runners, respectively. The results emphasize the critical role of gating design in optimizing mechanical performance, providing valuable insight for improving aluminium casting process

***Keywords*:** *Runner size, gating systems, aluminium alloy, casting, tensile strength*

## INTRODUCTION

In the casting process, rapid mould filling is essential to prevent premature solidification and defects like misruns or cold shuts, however this must be balanced to avoid excessive turbulence. Gating design is a critical factor in ensuring one of the key factors that must be carefully considered to ensure high-quality sand casting products. Extensive research has been conducted to investigate how gating design influences the mechanical properties of the casting alloy (Masyrukan et al., 2024; Raza et al., 2021; Rizuan et al., 2009). It has been demonstrated that the best gating system design could minimise air entrapment, sand inclusion, oxide film, and dross while reducing turbulence in the melt flow (Devendar et al., 2014)(Hu et al., 2000). The area percentage of defects like porosity and oxide films on the fracture surface of the casting sample is directly correlated with the decline in the mechanical qualities of castings made of aluminium alloys. Therefore, runner system design is a key factor influencing the tensile strength of aluminium-cast alloy. Higher metal flow velocity and surface turbulence are typically the results of improper runner system design, which makes it easy for surface oxide layers on the liquid aluminium advancing front to fold over and become caught in the bulk liquid metal. To optimize the mechanical performance of AA6063 castings, this study fabricated runner systems with three different size measurements 15 mm, 20 mm, and 25 mm using SolidWorks and 3D printing were deployed to fabricate the runner. In addition, the casting product that will go through the three distinct runner measures will be subjected to tensile testing to evaluate their mechanical behavior.

## MATERIALS AND METHODS

The runner was designed with three different cross-sectional sizes of 15 mm, 20 mm, and 25 mm while maintaining a constant length of 250 mm were design using SolidWorks. These designs were fabricated using Fused Deposition Modelling (FDM) 3D printing with polylactic acid (PLA) material to produce casting patterns (Figure 1). Next, the sand casting process was carried out using green sand moulds. The aluminium alloy AA6063 melted in a crucible and poured into the moulds. Each runner design produced a set of tensile specimens, which were later finished by cutting, filing and cleaning. Figure 2 shows the casting product of different runner sizes. Tensile testing was performed using a Universal Testing Machine (UTM) in accordance with ASTM B557M standard.

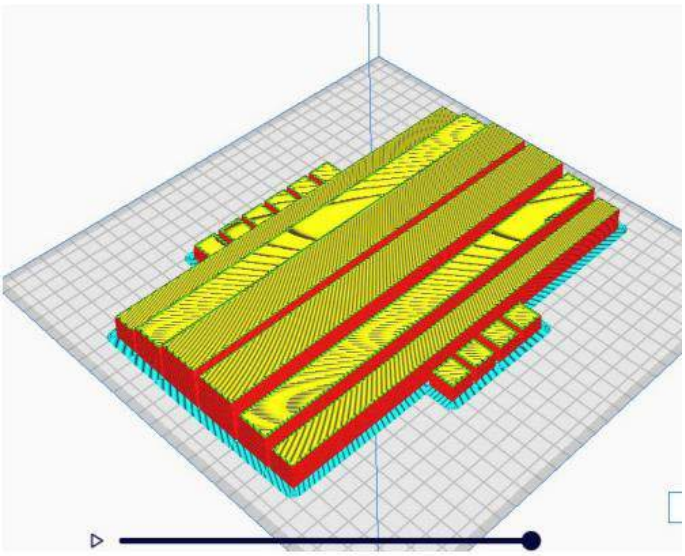


**Figure 1.** Runner and ingates pattern design before printed out using FDM 3D machines

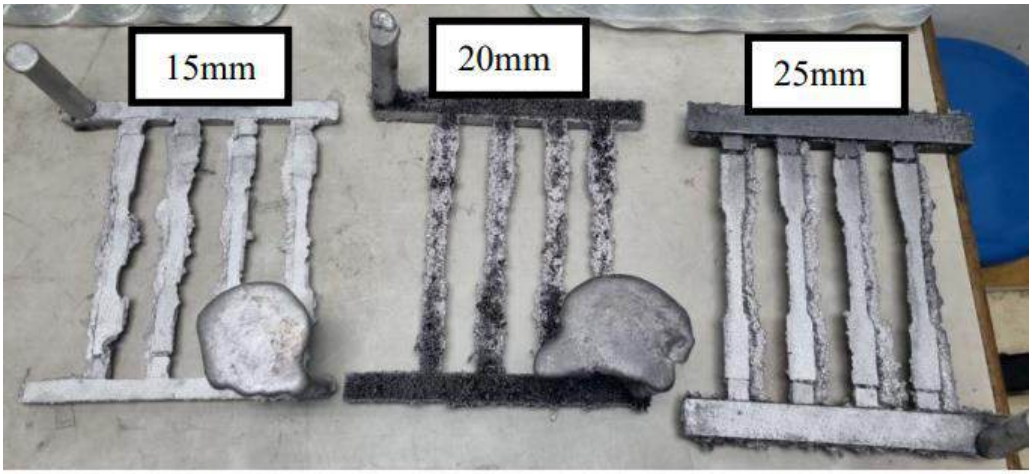



**Figure 2.** Casting product of different runner sizes; 15 mm, 20mmm and 25 mm

## RESULTS AND DISCUSSION

Figure 3 shows the typical tensile stress-strain graph compares the tensile properties of AA6063 castings using different runner sized of 15 mm, 20 mm and 25 mm. The tensile test results indicate that larger runner sizes correlate with improved tensile properties. The specimen cast with a 25 mm runner exhibited the highest ultimate tensile strength (UTS) of 97.88 MPa and strain before failure indicating good ductility and strength, followed by the 15 mm runner with 70.55 MPa, and the 20 mm runner with the lowest UTS of 51.6 MPa. The 20 mm runner exhibits an early rise in stress but plateaus quickly, suggesting brittle behaviour and early failure, might be due to defects such as porosity as shown in Figure 4. These findings suggest that gating system play an important roles an to enhances molten metal flow, reducing turbulence and defects, thereby improving mechanical strength (Brůna et al., 2024). The unexpected reduction in UTS observed in the 20 mm runner specimens due to the defect occurred on the specimens. The results align with prior studies that reported a positive correlation between increased runner diameter and enhanced mechanical performance in aluminium castings (Ahmad & Hashim, 2011). Table 1 shows the Tensile data characteristics for AA6063.

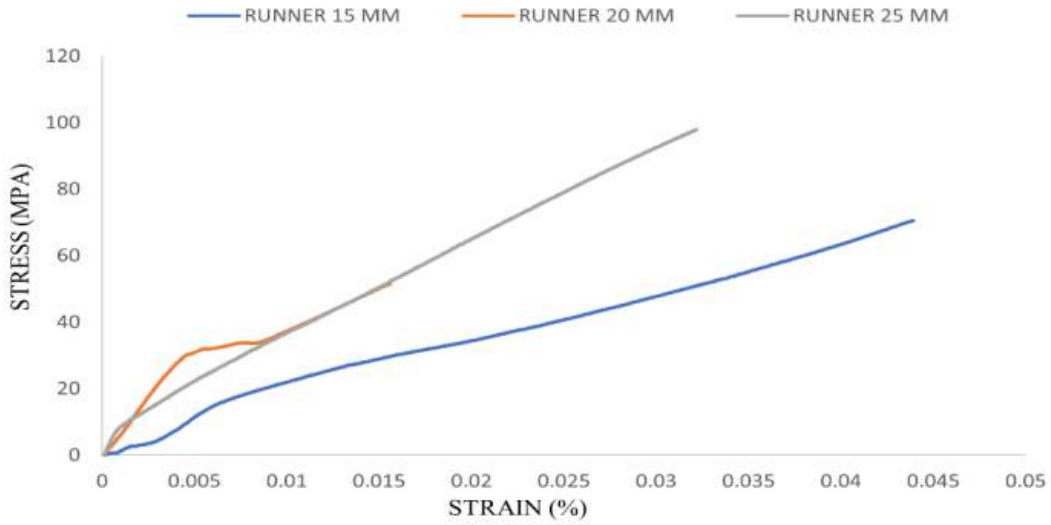



**Figure 3.** Typical tensile stress-strain graph

**Table 1.** Tensile data characteristics for AA6063

| Samples | Maximum Force (kN) | Maximum Stress (N/mm2)(UTS) | Maximum Strain (%) |
|---|---|---|---|
| Runner 15 mm | 4.41 ± 0.998 | 70.55 ± 15.96 | 4.41 ± 0.632 |
| Runner 20 mm | 3.23 ± 0.24 | 51.6 ± 3.84 | 1.51 ± 0.251 |
| Runner 25 mm | 6.12 ± 1.60 | 97.88 ± 25.55 | 3.21±0.93 |

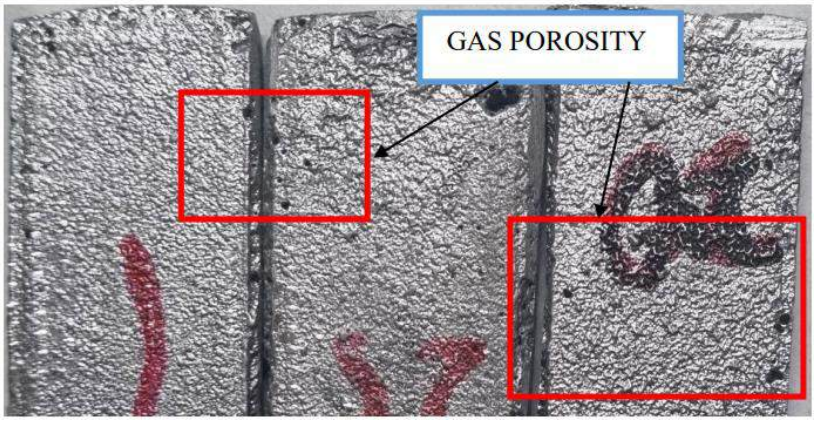



**Figure 4.** Gas porosity defect

## CONCLUSIONS

This study confirms that runner size significantly affects the tensile performance of AA6063 aluminium alloy sand castings. The findings show that a larger runner size, specifically 25 mm runner provided the best combination of strength and ductility, suggesting improved metal flow and reduces turbulence, leading to fewer casting defects and higher tensile strength. In contrast, the 15 mm and 20 mm runner specimens showed lower performance, with 20 mm runner likely affected due to defects such as porosity. These findings show the importance of optimizing runner dimensions to enhance mechanical properties in sand casting processes.

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Kelulusan daripada pihak tuan dalam perkara ini amat dihargai.

Sekian, terima kasih.

**"BERKHIDMAT UNTUK NEGARA"**

Setuju.

27.1.2023

PROF. MADYA DR. NUR HISHAM IBRAHIM
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Saya yang menjalankan amanah,

**SITI BASRIYAH SHAIK BAHARUDIN**
Timbalan Ketua Pustakawan

*nar*



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