E-PROCEEDINGS

INTERNATIONAL TINKER INNOVATION & ENTREPRENEURSHIP CHALLENGE (i-TIEC 2025)

"Fostering a Culture of Innovation and Entrepreneurial Excellence"

23 January 2025
PTDI, UiTM Cawangan Johor
Kampus Pasir Gudang

ORGANIZED BY:

Electrical Engineering Studies, College of Engineering
Universiti Teknologi MARA (UiTM) Cawangan Johor
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PREFACE

It is with great pleasure that we present the e-proceedings of International Tinker Innovation & Entrepreneurship Challenge (i-TIEC 2025), which compiles the extended abstracts submitted to the International Tinker Innovation & Entrepreneurship Challenge (i-TIEC 2025), held on 23 January 2025 at **PTDI, Universiti Teknologi MARA (UiTM) Cawangan Johor, Kampus Pasir Gudang.** This publication serves as a valuable resource, showcasing the intellectual contributions on the invention and innovation among students, academics, researchers, and professionals.

The International Tinker Innovation & Entrepreneurship Challenge (i-TIEC 2025), organized under the theme "Fostering a Culture of Innovation and Entrepreneurial Excellence," is designed to inspire participants at various academic levels, from secondary students to higher education students and professionals. The competition emphasizes both innovation and entrepreneurship, encouraging the development of product prototypes that address real-world problems and have clear commercialization potential. By focusing on technological and social innovations, i-TIEC 2025 highlights the importance of turning creative ideas into viable, market-ready solutions that can benefit users and society. The extended abstracts in this e-proceedings book showcase the diverse perspectives and depth of research presented during the event, reflecting the strong entrepreneurial element at its core.

We extend our sincere gratitude to the contributors for their dedication in sharing their innovation and the organizing committee for their hard work in ensuring the success of the event and this publication. We also appreciate the support of our collaborators; Mass Rapid Transit Corporation Sdn. Bhd. (MRT Corp), Universitas Labuhanbatu, Indonesia (ULB), Universitas Riau Kepulauan, Indonesia (UNRIKA) and IEEE Young Professionals Malaysia, whose contributions have been instrumental in making this event and publication possible.

We hope that this e-proceedings book will serve as a valuable reference for researchers, educators, and practitioners, inspiring further studies and collaborations in both innovation and entrepreneurship. May the knowledge shared here continue to spark new ideas and market-ready solutions, advancing our collective expertise and fostering the growth of entrepreneurial ventures.

A-ST142: POLYURETHANE MODIFIED COLD MIX ASPHALT ROAD PATCHING (PU-ASPHALT PATCHING)

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ABSTRACT

The durability of cold mix asphalt continues to pose challenges in road patching applications, especially under real-world environmental conditions. PU-Modified Asphalt is an innovative solution designed to address the durability challenges of conventional cold mix asphalt (CMA), which is prone to cracking, rutting, and moisture damage, resulting in frequent maintenance and higher costs. Combining polyurethane (PU) with traditional asphalt, it enhances the mechanical properties such as tensile strength, elasticity, and bonding strength. The material is developed using customizable polyol-to-isocyanate ratios to optimize performance and adaptability for diverse applications. The main advantages of PU-Modified Asphalt include better durability, exceptional moisture resistance, and reduced maintenance, ensuring longer-lasting and safer roads. Its eco-friendly design, which lowers resource consumption and carbon emissions, aligns with sustainability goals. This innovation offers significant socioeconomic benefits by reducing traffic disruptions, improving road safety, and lowering long-term maintenance costs. By offering cost-effective and high-performance solutions, PU-Modified Asphalt has the potential to transform road infrastructure, driving economic growth while supporting environmental preservation.

Keywords: PU-Modified Asphalt, Polyurethane (PU), Durable Pavement, Moisture Resistance, Interfacial Bonding, Sustainable Road Infrastructure

1. Product Description

PU-Modified Asphalt is an innovative pavement material that combines traditional asphalt with polyurethane (PU) to deliver better durability and performance. This modification enhances the material's resistance to cracking and deformation making it ideal for high-traffic and demanding environments. With its superior bonding properties, PU-Modified Asphalt ensures strong adhesion between aggregates and the binder, reducing the risk of delamination and structural failures. Its excellent moisture resistance protects against water infiltration which is a common cause of pavement deterioration, making it particularly effective in wet and humid conditions. This material is an environmentally friendly material by reducing the need for frequent maintenance, contributing to lower carbon emissions and resource consumption throughout its lifecycle. PU-Modified Asphalt is suitable for a range of applications, including road patching, overlays, and new construction projects due to its strength and durability.

2. Method Flow Chart and Product Model

In real-life applications, PU-Modified Asphalt can be implemented using a straightforward and practical methodology. **Figure 1** illustrates the process of the product application. The aggregate and PU-modified binder are transported separately to the site, ensuring ease of handling. During application, the PU binder is prepared by mixing polyol and isocyanate on-site. It is evenly applied by mixed directly into the cold mix asphalt mixture. The mixture is laid onto the road surface and compacted using standard paving equipment. For optimal performance, the sample is then left for air curing, allowing the material to achieve sufficient bonding and strength quickly. This approach ensures efficient installation, minimal disruption, and enhanced durability in real-world conditions. **Figure 2** shows prototype of PU modified asphalt.

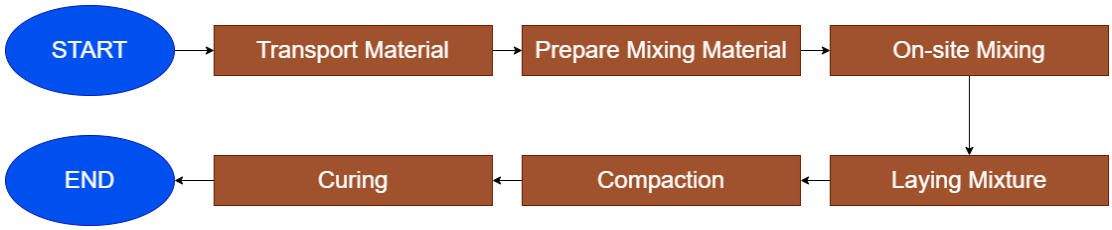


Figure 1. Model Application Flowchart

Figure 2. Prototype of PU-Modified Asphalt patching

Table 1. Relative Comparison Between Conventional CMA and PU-Modified CMA

Aspect	***Conventional***	***PU-Modified***
Durability	Moderate	High
Moisture Resistance	Limited	Excellent
Bonding Strength	Weak	Strong
Maintenance Frequency	High	Low
Environmental Impact	Moderate	Low
Customization	Fixed properties	Customizable
Cost	Low initial cost	Moderate initial cost

3. Novelty and uniqueness

PU-Modified Asphalt is a novel solution in road construction, uniquely combining traditional asphalt with polyurethane (PU) to deliver superior performance and durability. Unlike conventional asphalt, it offers exceptional tensile strength, elasticity, and resistance to cracking, rutting, and deformation under heavy loads or extreme environmental conditions.

A standout feature of PU-Modified Asphalt is its advanced moisture resistance. While traditional asphalt is vulnerable to water infiltration, PU-Modified Asphalt's hydrophobic properties protect it from degradation, making it ideal for regions with high rainfall or freeze-thaw cycles. Its strong interfacial bonding between the binder and aggregates enhances structural integrity, minimizing the formation of potholes and extending pavement lifespan.

The material's versatility lies in its customizable polyol-to-isocyanate ratios, allowing engineers to tailor its mechanical properties for specific applications. From road patching to large-scale infrastructure projects, it delivers unmatched adaptability.

PU-Modified Asphalt also supports sustainability goals by reducing maintenance frequency, conserving resources, and lowering carbon emissions over its lifecycle. Its innovative integration of PU into asphalt mixtures represents a transformative advancement in road construction, providing long-lasting, eco-friendly, and cost-effective solutions for modern infrastructure challenges.

From **Table 1**, PU-Modified Cold Mix Asphalt (CMA) significantly outperforms conventional CMA in durability, moisture resistance, and bonding strength. While conventional CMA is prone to cracking and water infiltration, PU-modified CMA offers enhanced resilience and hydrophobic properties, ensuring long-lasting performance. The stronger interfacial bonding in PU-modified CMA reduces structural failures and lowering maintenance frequency and associated costs. Its environmental impact is also reduced due to fewer repairs and extended service life. Unlike the fixed properties of conventional CMA, PU-modified CMA can be customized through varying polyol-to-isocyanate ratios, tailoring its performance to specific needs. Although it costs more initially, PU-modified CMA proves more economical over its lifecycle.

4. Benefit to mankind

PU-Modified Asphalt addresses a critical need for more durable and sustainable road infrastructure. Traditional road surfaces often degrade quickly under heavy traffic, fluctuating temperatures, and moisture exposure, leading to frequent repairs and traffic disruptions. PU-Modified Asphalt's enhanced durability and moisture resistance significantly reduce the frequency of road maintenance, minimizing inconvenience for road users and improving traffic flow. Additionally, its superior bonding properties enhance road safety by reducing the risk of potholes and surface defects, contributing to fewer accidents and a smoother driving experience. The eco-friendly nature of this material, through its long-lasting performance, also reduces resource consumption and carbon emissions, supporting global efforts toward sustainable development.

5. Innovation and Entrepreneurial Impact

PU-Modified Asphalt represents a groundbreaking advancement in road construction materials by integrating polyurethane into traditional asphalt mixtures. This innovation leverages the unique mechanical properties of polyurethane, such as high tensile strength and elasticity, to create a pavement solution that outperforms conventional materials. This novel approach opens opportunities for entrepreneurs and startups to develop specialized production, distribution, and application technologies. It also encourages innovation in related industries, such as the development of machinery and tools tailored for PU-asphalt application. The product's versatility and high-performance characteristics position it as a disruptive force in the construction and infrastructure sectors, driving economic growth and fostering a culture of innovation.

6. Potential commercialization

The commercialization potential of PU-Modified Asphalt is significant, given its wide-ranging applications and performance benefits. Its suitability for urban roads, highways, industrial areas, and airports provides a vast market base. Construction companies, municipalities, and transportation agencies are key stakeholders who would benefit from adopting this advanced material. Furthermore, its ability to reduce maintenance costs and extend the lifespan of road infrastructure creates compelling value propositions for potential buyers. Manufacturers can develop PU-modified asphalt as a premium product line, offering customized solutions tailored to specific project requirements. By partnering with government infrastructure initiatives and leveraging sustainability goals, the commercialization of PU-Modified Asphalt could establish a strong foothold in both domestic and international markets.

7. Acknowledgment

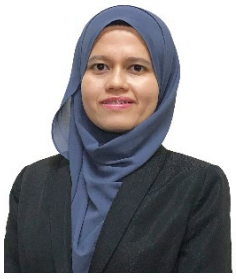
The project is financially supported by the Fundamental Research Grant Scheme (FRGS/1/2024/TK01/UITM/02/10).

8. Authors' Biography

Ahmad Syafiq Iskandar Ahmad Nazri completed his Bachelor's degree in Civil Engineering at Universiti Teknologi Malaysia (UTM) from 2020 to 2024. He is currently pursuing a Master's degree while serving as a Research Assistant at UiTM Pasir Gudang under the supervision of Ir. Ts. Dr. Diana Che Lat. Focusing in pavement engineering, his current research is on investigating polyurethane-asphalt interfacial bonding to enhance long-term pavement durability.

Ainnur Insyirah Haieral is a dedicated student pursuing a Diploma in Civil Engineering at Universiti Teknologi MARA (UiTM) Pasir. Her academic background was in pure science at MRSM Mersing, where she gained a strong foundation in science and mathematics that sparked her passion for engineering and construction. Now, she actively participates in group projects and research assignments that focus on finding innovative solutions to modern infrastructure challenges. She aspires to contribute significantly to the field of civil engineering by specializing in sustainable engineering practices and working on projects that promote environmental conservation while advancing technological innovation.

Nur Mardiyana Maizan is a second-year student pursuing Diploma in Civil Engineering from University Teknologi MARA (UiTM), where she has consistently maintained a Dean's List standing. She completed her high school education at Kuala Selangor Science Secondary School (KUSESS) in 2022 with a good result. She has a deep interest in civil engineering which has shaped her academic and professional journey. Her academic background in pure science makes her have a strong basic and developed an interest in pursuing engineering.



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