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Concrete Release Agent from Waste Material for Sustainable Concrete Casting

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Abstract

Concrete was a fundamental material in modern construction, and its efficient casting and demoulding processes depends on the use of release agents. However, conventional release agents posed significant environmental risks. This study investigated the potential of waste-based alternatives by formulating and evaluating blends of used cooking oil (UCO) and used engine oil (UEO). The performance of these blends was assessed through infrared analysis, rebound hammer tests, and compressive strength evaluations. The findings revealed that blends consisting of 100% used engine oils, particularly when applied to steel formworks, can effectively replace conventional agents while preserving structural integrity. Based on these results, the use of 100% Used Engine Oil applied on steel formworks is recommended to enhance sustainability in the construction industry.

1. Introduction

Concrete, primarily composed of cement, water, and aggregates, serves as a fundamental material in modern construction. The shaping of concrete structures relies on the use of formworks, which require release agents to facilitate smooth and efficient demoulding. According to Aravindan (2020), in concrete construction, formwork acts as a crucial temporary mould, shaping the poured concrete into beams, columns, slabs, and various configurations. Available in different sizes to match project needs. Formwork materials include timber are affordable and easy to use but limited reuse and prone to warping, steel formwork is strong, durable, and reusable but expensive and requires specialized handling, and plastic formwork is cost-effective for simple shapes and smaller pours but may have limited strength and reuse. Beyond material selection, factors like desired surface finish, and structural complexity influence formwork choice, with reusable systems accelerating construction compared to on-site building (Damla *et al*, 2023).

This research investigates the possibility of developing a sustainable release agent for concrete formwork using waste materials like used cooking oil, and vehicle engine oil. This innovation could significantly impact the construction industry by reducing environmental pollution through diverting waste oils from landfills and improper disposal. Additionally, utilizing readily available waste materials has the potential to lower production costs compared to traditional release agents. However, ensuring its viability requires thorough evaluation of the agent's effectiveness on various aspects. This includes testing its compatibility with different formwork materials such as timber, steel, and plastic to guarantee smooth removal without compromising the concrete surface quality. Furthermore, a life-cycle assessment is crucial to confirm a positive overall environmental impact despite the focus on waste repurposing. By successfully addressing these considerations, this research has the potential to introduce a groundbreaking and eco-friendly solution for the future of concrete construction.

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1.1 Problem Statement

Release agents are crucial for concrete casting, creating a barrier between formwork and concrete. This thin coating offers smoother finish by preventing adhesion, leading to easier demoulding, faster project completion, and potentially eliminating the need for additional finishing work. However, some release agents can negatively impact the concrete, for example is Silicon oil and liquid wax-based release agents can affect concrete surface colour variation and formwork surface roughness, affecting the appearance of the formed concrete surface (Giedrius & S. Juočiūnas *et al*, 2021).

The study aims to investigate the potential of using readily available waste liquids, such as used cooking oil, and engine oil as sustainable alternatives to conventional release agents. These waste materials hold due to their liquid form, but a thorough investigation is necessary to address their potential. Additionally, compatibility with various formwork materials such as plywood, steel, and plastic will be assessed to determine their overall suitability as compared to current release agents.

1.2 Scope

This research investigates the viability of using used cooking oil (UCO) and used engine oil (UEO) as release agents for Grade 25 concrete, by using locally sourced waste materials and various types of moulds. The collected liquids were then meticulously inspected from foreign materials, with filtering employed if necessary to ensure optimal performance of the resulting release agent.

Importantly, the specific waste liquids and their combinations used in testing were determined based on initial evaluations, potentially involving two or all three materials. This approach allows to identify the most effective and environmentally friendly waste-based solution for concrete release agents.

1.3 Significance

Adopting waste oils as release agents can reduce environmental pollution, lower costs, and improve worker safety. These innovations have the potential to foster sustainable practices across the construction industry.

2. Literature Review

Literature review explores the concrete release agents, focusing on their impact on aesthetics, surface quality, and the environment. It begins by looking at traditional release agents and how they affect both formwork and concrete. Recognizing the environmental challenges associated with these conventional options, the chapter also examines eco-friendly alternatives and how they interact with concrete and formwork. This chapter provides practical insights into choosing the right release agents for concrete construction while emphasizing the growing shift toward more sustainable and environmentally friendly solutions. Overall, it offers a balanced perspective on both conventional and green practices.

2.1 Concrete Release Agent

Concrete release agents serve to prevent adhesion between freshly cast concrete and the formwork surfaces. Conventional release agents, such as silicone oils and waxes, are widely used. However, their application can sometimes lead to undesirable effects on both the aesthetic quality and structural integrity of the concrete. Figure 1 shows the effect on the concrete surface when a release agent is not applied.

***Fig. 1*:** Effect on the concrete surface when a release agent is not applied (Qian Jiang et al, 2023).

2.2 Eco-Friendly Alternatives

Vegetable oils and bio-waxes have demonstrated potential as biodegradable and VOC-free alternatives to conventional release agents. Similarly, waste oils, including used cooking oil (UCO) and used engine oil (UEO),

present significant sustainability benefits; however, their performance requires thorough evaluation to ensure effectiveness and reliability.

2.3 Challenges

Effectively implementing waste oils as release agents necessitates addressing the presence of contaminants and ensuring their compatibility with different types of formworks. These factors are critical to achieving reliable performance and maintaining the quality of the finished concrete.

3. Methodology

The research methodology consists of several systematic steps to achieve the study objectives. Initially, a desk study was conducted, which involved a literature review and expert consultations to gather foundational knowledge and practical insights. Following this, waste material was collected and prepared for the experimental process. The collected oil was filtered to ensure it passed a 100 μm filter. Only the oil that met this criterion was used for further experimentation.

The filtered oil was blended at different ratios to create a suitable release agent. This release agent was then applied to three types of formworks: plastic, steel, and timber. Concrete was subsequently mixed, cast, and demoulded using these formworks.

The concrete samples underwent various tests, including surface finishing evaluation, rebound hammer tests, thermal diameter variation rate measurements, and compressive strength analysis. The results from these tests were analyzed to derive meaningful insights. Finally, conclusions and recommendations were drawn based on the findings.

3.1 Material

The main material for this study is used cooking oil (UCO) and used engine oil (UEO) as a waste-based release agent release agent for sustainable concrete casting. These materials are collected from nearby restaurants for UCO and workshop for UEO. To ensure that the oil was free from any contamination, the filtration process are conducted by using iron mesh size 100 micrometers by following ISO 16889 (test method for evaluating performance of used oil). This process is important to remove any impurities for the suitability of used oil as a release agent. This study provides six ratio of oil mixtures with different percentages each liter. The ratio is control (using hydraulic oil); 100% UCO; 100% UEO; 50% UCO + 50% UEO; 70% UCO + 30% UEO; and 70% UEO + 30% UCO. Table 1 below shows the different ratios of oil as a release agent.

Table 1: Different ratios of used oil as a release agent

Sample	Mixtures Material	Total (L)
1.	**Control**	**1**
2.	**100% Used Cooking Oil**	**1**
3.	**100% Used Engine Oil**	**1**
4.	**50% UCO + 50% UEO**	**1**
5.	**70% UCO + 30% UEO**	**1**
6.	**70% UEO + 30% UCO**	**1**

The concrete used in this study was Grade 25, it was used of Ordinary Portland Cement (OPC) as the binder, along with standard following JKR specifications of aggregate (fine and coarse) and water. The concrete was mixed to investigate whether the release agent affects the strength of the concrete or not. In this study, the preparation of Grade 25 concrete involved a mix designed to produce sufficient material for testing purposes. Each batch of the concrete mix had a total weight of 24.84 kg, containing 4.14 kg of cement, 6.21 kg of fine aggregate, 12.42 kg of coarse aggregate, and 2.07 kg of water. Additionally, an extra 200 grams of water was included for the characteristics of the coarse aggregate used in the mix. The inclusion of this additional water was necessary to ensure the proper workability and consistency of the concrete, as the type of coarse aggregate

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selected required a slight adjustment in the water content for optimal mixing and hydration. Figure 2 below shows the preparation of concrete.

(a) **(b)**

***Fig. 2*:** Figure description (a) Filtering of oil using 100um iron mesh; (b) Preparation of concrete

3.2 Mould Preparation

The preparation of moulds in this study, three different types of moulds were utilized: plastic, steel, and wood. Each mould is designed as a cube, featuring six equal surfaces, each measuring 100 mm x 100 mm x 100 mm following BS 1881-108 for testing compressive strength concrete sample. Figure 3 below shows three different types of formworks.

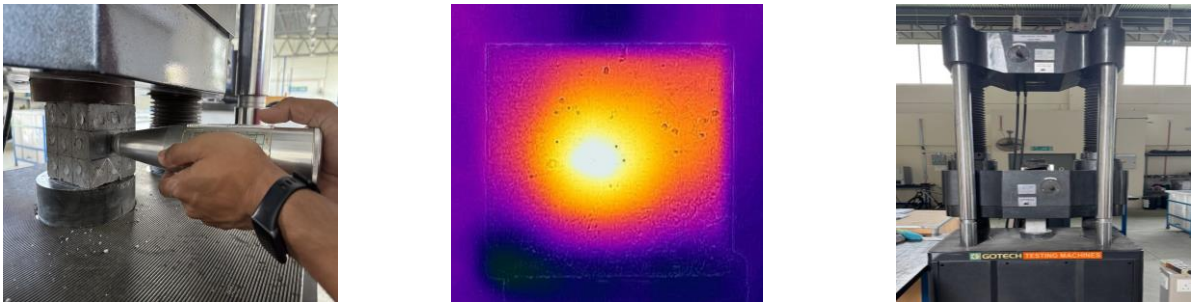
(a) **(b)** **(c)**

***Fig. 3*:** Figure description (a) Plastic formwork; (b) Steel formwork; (c) Timber formwork

3.3 Testing Procedure

The research methods used to evaluate waste oils as environmentally friendly concrete release agents. The study involved collecting used cooking oil (UCO), engine oil (UEO), and hydraulic oil from local restaurants, workshops, and industries near Universiti Tun Hussein Onn Malaysia, Pagoh Campus. These oils were filtered through a 100-micrometer mesh to remove impurities. Six oil mixtures were prepared, varying the proportions of UCO and UEO, along with a control sample. The oils were applied to three types of formwork materials: plastic, steel, and timber. Concrete grade 25 was made using Ordinary Portland Cement (OPC), aggregates, and water.

To assess the effectiveness of the release agents, tests were conducted on surface finish, rebound hammer readings (ASTM C805), thermal diameter variation (TDV), and compressive strength (BS EN 12390-3:2002). Rebound hammer tests measured surface hardness, while thermal imaging assessed heat response. Compressive strength was tested on samples cured in water. The multi-method approach aimed to evaluate the feasibility of using waste oils as sustainable concrete release agents. Figure 4 below shows testing conducted on the concrete cube.



(a) **(b)** **(c)**

***Fig. 4*:** Figure description (a) Rebound hammer; (b) Thermal diameter variation; (c) Compressive strength

4. Result and Finding

The aim of this study is to establish the viability of using waste products in release agents in concrete moulding process. The research on the viability of formulation of products from recycled material such as used cooking oil and wasted engine oil. The first expected result will be the determination of waste derived release agents with appreciable demoulding characteristics while causing little effect on concrete strength. This research also established the level of adhesion of the products on the various formwork surfaces of timber, steel and plastic. If successful then this research can act as guideline for the waste material as a release agent and protect the environment.

4.1 Effect of Release Agent on Formwork Surface

The effect of waste oil as a release agent on different concrete mould materials was observed in plastic, steel, and timber moulds. In plastic moulds, the oil settled unevenly, with a higher concentration accumulating at the bottom due to the applied pressure and the oil's distribution. In steel moulds, the oil spread rapidly and concentrated at the bottom, as the smooth, non-porous surface prevented absorption, resulting in an uneven oil layer. In timber moulds, the oil spread more slowly and partially absorbed into the porous wood surface, leading to a more even distribution without excessive accumulation at the bottom.

These observations highlight how the material properties of the moulds determining the performance of the oil as a release agent, the interaction between the moulds material and the oil significantly influences the demolding process, including ease of demolding, surface finish, and overall concrete quality. Figure 5 below shows the result of these observations on three different formwork surfaces.

(a) **(b)** **(c)**

***Fig. 5*:** Figure description (a) Plastic formwork; (b) Steel formwork; (c) Timber formwork

4.2 Effect of Release Agent on Concrete Surface

The quality of concrete surfaces is significantly affected by the interaction between formwork materials and the release agents applied during casting. This section examines the surface finishes of concrete cubes cast using three distinct formwork materials such as timber, steel, and plastic, in combination with various release agents. Observations focused on key surface quality indicators, including texture, colour consistency, and prevalence of defects. These parameters offer a complete assessment of the effects of release agents on the surface finish for each form of the mould. It again emphasizes the importance of choosing the right formworks material and release agents needed in order to achieve the required texture of the concrete surface. Figure 6 below shows the different finishing of concrete surfaces using plastic formwork and three different types of release agent on this study.

(a) **(b)** **(c)**

***Fig. 6*:** Figure description (a) Control (hydraulic oil); (b) 100% UCO; (c) 100% UEO

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4.3 Rebound Hammer

The following figure presents the rebound unit values on day 28, providing an overview of the performance of surface hardness of the concrete. The graph highlights the surface hardness of concrete after 28 days and the consistency of release agents across different formwork types. Figure 7 below shows a rebound unit for 28 days.

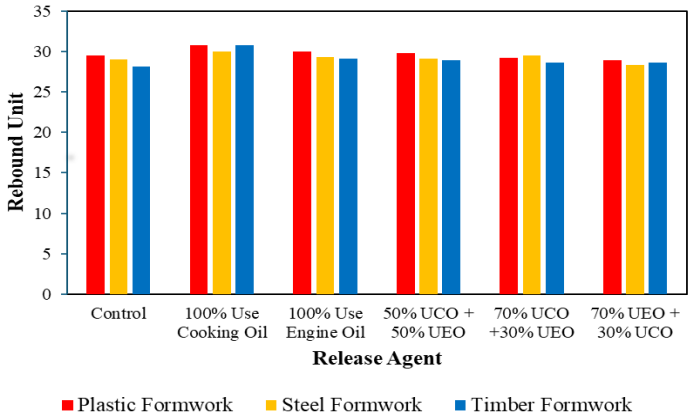

***Fig. 7*:** Rebound unit 28 day

The graph indicates that surface hardness remains relatively unaffected by the type of release agent or its proportion, and all three formwork types (plastic, steel, and timber) exhibit comparable rebound values under various release agents. This suggests that both UCO and UEO, along with their mixtures, can be used interchangeably without compromising concrete surface hardness.

4.4 Thermal Diameter Variation Rate

The Thermal Diameter Variation Rate (TDV) refers to how much the size or diameter of a concrete sample changes when it is exposed to temperature fluctuations. This measurement helps assess the concrete's stability and how it reacts to heat, which can affect its durability and performance over time. Figure 8 below shows the TDV rate for orange diameter for this study.

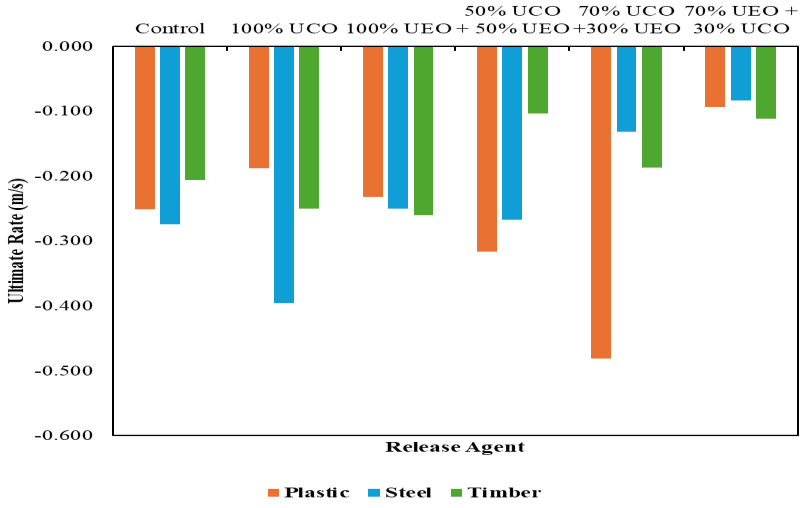

***Fig. 8*:** TDV rate of orange diameter

From the graph above, plastic formwork presents the greater diminution in the diameter, especially to the blend 70% UCO + 30% UEO since the maximum speed reduces almost to -0.550 m/s evidencing intense thermal fluctuation. This implies that while using the Plastic formwork, the improvement achieved by the incorporation of this oil mix for minimizing surface shrinkage is inadequate.

4.5 Compressive Strength

The compressive strength of concrete, focusing on the results obtained from tests conducted after 7 and 28 days of curing. The analysis highlights the impact of different release agents and formwork materials on the concrete's early and final development of strength. This assessment provides valuable insights into how the

choice of release agent and formwork influences the initial structural performance of concrete, which is critical for construction stability. Table 2 below shows the result of 28 days of concrete strength for grade 25.

***Table 2*:** Result of compressive strength 28 days

Release agent	Compressive strength (MPa)		
	Plastic formwork	**Steel formwork**	**Timber formwork**
Control	**25.53**	**24.58**	**24.76**
100% Used Cooking Oil	**26.08**	**24.74**	**24.65**
100% Used Engine Oil	**26.89**	**25.87**	**21.85**
50% UCO + 50 UEO	**25.43**	**23.85**	**21.11**
70% UCO + 30 UEO	**25.54**	**24.62**	**23.18**
70% UEO + 30 UCO	**24.92**	**23.56**	**22.58**

From the table above, the use of release agents, particularly UCO, has a generally positive impact on the compressive strength of concrete, especially for plastic formwork. Steel formwork shows moderate variability, while timber formwork is more sensitive to the type and proportion of release agent used. The results emphasize the importance of selecting the appropriate release agent to optimize concrete performance, especially in relation to different formwork materials.

5. Conclusion

In conclusion, the study successfully met the established objectives of creating and evaluating waste-based release agents for concrete casting. The investigation demonstrated that blends of used cooking oil (UCO) and used engine oil (UEO) are viable green alternatives to conventional release agents. The results highlighted that these waste release agents exhibited effective release properties across various formwork surfaces, including plastic, steel, and timber, with superior compatibility observed with steel formwork. The conclusions that can be derived from this study are as follows:

The rebound hammer test and infrared analysis effectively achieved the objectives of this study, offering a thorough evaluation of the surface hardness and thermal properties of concrete. The results demonstrated the significant influence of various release agents and formwork materials on the concrete's performance, highlighting their impact on surface quality and strength. The findings emphasize the importance of selecting appropriate release agents to enhance the overall durability and structural integrity of concrete, with 100% Used Engine Oil proving to be the most effective in improving surface hardness. This outcome concludes the completion of the first objective in this study.

The compressive strength test successfully achieved the second objective of this study, with all results adhering to the required guidelines and standards. The analysis of surface roughness revealed that release agents containing UCO provided smoother surfaces with fewer pinholes compared to those containing UEO. Moreover, the concrete cast using these release agents demonstrate compressive strength within an acceptable range according to industrial standards. This outcome concludes the completion of the second objective in this study.

In alignment with the objectives, the study established that waste oils could be effectively utilized to create sustainable release agents. These agents proved applicable to various formwork materials and maintained concrete strength within industry norms. This research underscores the potential of repurposing waste oils in construction practices, contributing to the advancement of a circular economy within the industry.

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References

[1] Akona. Akona Concrete Form Release - Release Agent for Forms, Tubes, Sculpture Molds, Casting, and More, Liquid, Non-Stick, Non-Staining (1 Gallon): Amazon.com: Tools & Home Improvement. Www.amazon.com, www.amazon.com/AKONA-Akona-Concrete-Form Release/dp/B0BDGH6PXL.

[2] Awogbemi et al. "Advances in Biotechnological Applications of Waste Cooking Oil." Case Studies in Chemical and Environmental Engineering, vol. 4, 1 Dec. 2021, p. 100158, www.sciencedirect.com/science/article/pii/S2666016421000803,https://doi.org/10.1016/j.cscee.2021.100158.

[3] Bo Liang et al. (2022). Research progress of water-based release agent. College of Engineering and Technology, Nantong, 226000, China. https://doi.org/10.1051/matecconf/202235801033.

[4] Bouharoun, S. (2014). Influence of Paste Volume, Type of Release Agents, and Contact Pressure on the Quality of Concrete Surfaces. Arabian Journal for Science and Engineering, 39(4). https://doi.org/10.1007/s13369-014-0966-1.

[5] Chaudhari et al. (2023). Evaluation of Eco-friendly Concrete Release Agents Based on Bio-Waxes. Rilem Bookseries, 570–580. https://doi.org/10.1007/978-3-031-33211-1_51.

[6] GreenTec Energy. (2022, February 14). What types of waste oil are? GreenTec Energy. https://gte.sg/waste-oil-management/what-are-the-types-of-waste-oil/

[7] J. de Brito, R. dos Santos, & Branco, F. A. (2020). Environmentally sound concrete release agents. Magazine of Concrete Research, 52(4), 265–273. https://doi.org/10.1680/macr.2000.52.4.265.

[8] Lu et al. (2023). Study on Release Performance of Concrete Release Agent. https://doi.org/10.23967/c.dbmc.2023.118.