IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

Transforming Concrete Production: A Greener Approach Utilizing Waste Engine Oil and Fly Ash Blends

Prashant[a] Ravi Kant Pareek[b]

[a]M.tech Scholar, Department of Civil Engineering, Vivekananda Global University, Jaipur
[b]Associate Professor, Department of Civil Engineering, Vivekananda Global University, Jaipur

Abstract:
The research aims to find an alternative to expensive and environmentally damaging cement in the construction industry by investigating the impact of incorporating waste engine oil (WEO) and fly ash (FA) on the engineering properties of green and hardened concrete. The study found that the addition of FA and WEO improved properties such as workability, air content, and porosity, but adversely affected compressive strength. The optimum content of FA and WEO was found to be 40% and 0.5%, respectively, with the least decline in compressive strength. The proposed modification also diminished segregation, bleeding, and the effect of freeze-thaw cycles.

This research has significant implications for the construction industry and the environment. By finding a viable alternative to cement, it could potentially reduce the demand for cement and subsequently decrease the carbon emissions produced during its production. The use of waste materials such as WEO and FA can also help reduce waste and provide a more sustainable solution for the construction industry. The findings of this research could inspire further investigation into the use of alternative materials in the construction industry to mitigate its environmental impact.

Key Words: Fly Ash, Waste Engine Oil

Introduction

The construction industry is rapidly expanding, leading to a surge in demand for cement, a costly and environmentally harmful material. Cement production is responsible for a significant portion of carbon emissions worldwide, and its use is expected to increase in the coming years. To address this issue, engineers are seeking alternative, eco-friendly materials with comparable cementing properties. Agricultural and commercial waste products have emerged as viable options, as they can be repurposed to reduce the environmental burden.

The present study explores the use of fly-ash and waste engine oil as partial substitutes for cement in concrete production. The properties and potential of these materials are examined, with a focus on porosity, workability, air content, and compressive strength. The resulting modified concrete, made from an optimal blend of fly-ash and waste engine oil, is compared to conventional concrete in terms of these key properties.

In a recent study, Shafiq Nasir et al. (2021) explored the use of waste products, such as used engine oil, in cement production to reduce the negative impact of waste on the environment. The authors highlighted the difficulties of disposing of waste products in compliance with strict regulations and suggested that using waste products in cement production could be an effective solution. The authors proposed that the engine oil inadvertently mixing with cement during grinding of clinker could result in concrete with similar properties as air-entrained concrete, which has good freeze and thaw resistance. To validate their proposal, the authors conducted an investigation and tested the properties of both green concrete and hardened concrete with varying dosages of an air-entraining agent, used engine oil, and new engine oil. The study focused on workability and air content, with the results showing that used engine oil led to higher values for both properties, with a 38% increase in slump value and a 58% increase in air content. However, it should be noted that this theory has not been supported by strong evidence from past practices.

Ali Mohammad Okashah et al. (2020) proposed an alternative to the disposal of industrial wastes, such as used engine oil (UEO) and silica fume (SF), by incorporating them into the modification of concrete. They found that the properties of both green and hardened concrete were improved by using SF as a partial substitute for cement and UEO as an additive. The researchers replaced 10-15% of cement with SF and added 0.6-0.8% UEO. Their experimentation revealed that a combination of 15% SF content and 0.6% UEO improved the compressive strength of the concrete by 37%, without compromising any other properties.

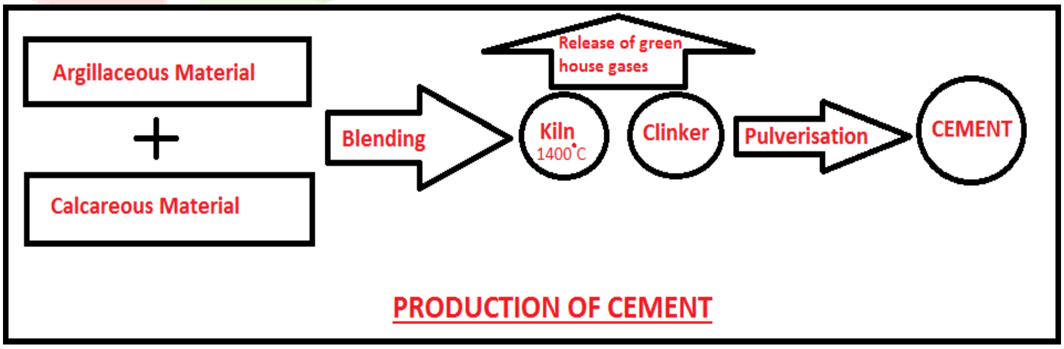
In 2019, Trino Baloa Montilla et al conducted research on the utilization of Automotive Residual Oil (ARO) in concrete production. Their objective was to address the issue of ARO pollution, which poses a significant environmental problem. A small amount of ARO has the potential to contaminate large volumes of potable water and render soil unproductive. In their study, the researchers varied the content of ARO in concrete from 0.10% to 0.80% by weight of cement. The concrete specimens were subjected to compression, tensile, ultrasonic pulse velocity (UPV), absorption, and adhesion tests. The optimal ARO content was found to be 0.14%, which provided consistent results in all the tests. The researchers recommended this mix for use in pavements and areas where superior structural features and heavy impact resistance are required.

Based on Salahaldein Alsadey's (2018) research, it was found that using waste engine oil as a chemical admixture in concrete can improve the workability of the mixture. However, there was a slight decrease in compressive strength observed. Four different compositions of oil were used in the study, ranging from 0.6% to 1.2% by weight of cement. The study was motivated by the need to find a more environmentally-friendly way to dispose of waste engine oil, given the stringent regulations on waste disposal. Overall, the study suggests that using waste engine oil in concrete can be a viable option, as long as the appropriate composition is used to balance workability and compressive strength.

It is important to note that Abdullah Anwar et al's (2014) research focused on the use of fly ash as a partial substitute of cement, and not on the use of waste engine oil or other industrial waste products. Their study sought to investigate the potential of using fly ash as a cost-effective and environmentally-friendly alternative to cement in concrete production. By replacing up to 30% of cement with fly ash, they found that the strength of concrete increased while the water-to-binder ratio decreased. This suggests that the use of fly ash can lead to more efficient and sustainable concrete production.

Material Used

Cement is an inorganic material used as a binder in concrete mix. The most commonly used type of cement is Portland cement, which hardens when mixed with water, making it a hydraulic cement. It is composed of oxides of calcium, silicon oxide, aluminum oxide, iron oxide, and alkalis. Raw materials such as limestone and clay, or minerals rich in lime, silica, and alumina, are combined and heated to around 1400 degrees Celsius to create clinker, a solid solution of these minerals that forms cement compounds. The clinker is then ground and mixed with approximately 5% gypsum to regulate its setting properties.



Production of Cement

Production of cement is as harmful for ecosystem as it is beneficial for construction industry. The main harm is emission of greenhouse gases in ample during production of cement.

The cement used in the present investigation is Ultratech cement OPC43, collected from a nearby construction site. The cement underwent two tests in the field: it was rubbed between fingers and felt smooth, indicating it was free from impurities, and it passed the float test by sinking completely in water.

Waste Engine Oil: Lubricants are used in various processes such as transmission, insulation, and greasing. However, engine oils are partly used in engines and the rest becomes waste due to the inability to give 100% efficiency. This waste engine oil may get contaminated with dust, rust, water, lead, metal particles, carbon, or other by-products of combustion. If disposed of improperly, it can penetrate the ground and interfere with ground water. Even 1 ml of engine oil can contaminate 100 L of pure water and about 43 square feet of land. Contaminants in waste engine oil such as lead, chromium, arsenic, biphenyls, zinc, cadmium, magnesium, etc., can turn highly productive land into barren land. Water pollution, especially due to oil spills, is a major issue in the 21st century. To prevent water pollution, this investigation proposes an easy and inexpensive method to safely dispose of engine oil by using it in concrete production, which improves its properties compared to conventional concrete.

Fly Ash: When solid materials are burned, ash is produced. Thermal power plants use coal as fuel to heat water in boilers, which generates steam that runs turbines to produce electricity. The residue left from burning coal is pulverized ash, known as "fly ash," which is collected by electrostatic precipitators from the gas flowing out of the chimney. 73% of total power production is catered to by thermal power plants, and 90% of thermal power stations use coal as fuel. Currently, 60% of total fly ash produced in India is used by various industries construction industry in partial replacement of cement, but the target is to use 100% fly ash, so as to revert positive effect to environment.

Fly ash is categorized into two classes, namely Class C and Class F, according to ASTM C-618. The classification is based on the type of coal used, as the CaO content varies depending on the type of coal. Class F fly ash is obtained from burning anthracite or bituminous coal, while Class C fly ash is typically produced by burning sub-bituminous or lignite coal. Thermal power plants mostly use bituminous coal to generate electricity, resulting in Class F fly ash. Class C fly ashes contain a high amount of CaO, making them suitable for use as cement itself rather than as Supplementary Cementing Material (SCM). (SCM refers to any material that, when used with Portland cement, contributes to the properties of hardened concrete through hydraulic or pozzolanic activity, or both.)

Methodology & Experimentations

For various experimentations 13 samples were prepared by the mix design. The samples were as follows:

- Specimen No:1- Conventional Control Mix (CM)
- Specimen No:2- CM + 30% FA
- Specimen No:3- CM + 40% FA
- Specimen No:4- CM + 50% FA
- Specimen No:5- CM + 30% FA + 0.5% UEO
- Specimen No:6- CM + 30% FA + 0.75% UEO
- Specimen No:7- CM + 30% FA + 1.0% UEO
- Specimen No:8- CM + 40% FA + 0.5% UEO
- Specimen No:9- CM + 40% FA + 0.75% UEO
- Specimen No:10- CM + 40% FA + 1.0% UEO
- Specimen No:11- CM + 50% FA + 0.5% UEO
- Specimen No:12- CM + 50% FA + 0.75% UEO

- Specimen No:13- CM + 50% FA + 1.0% UEO

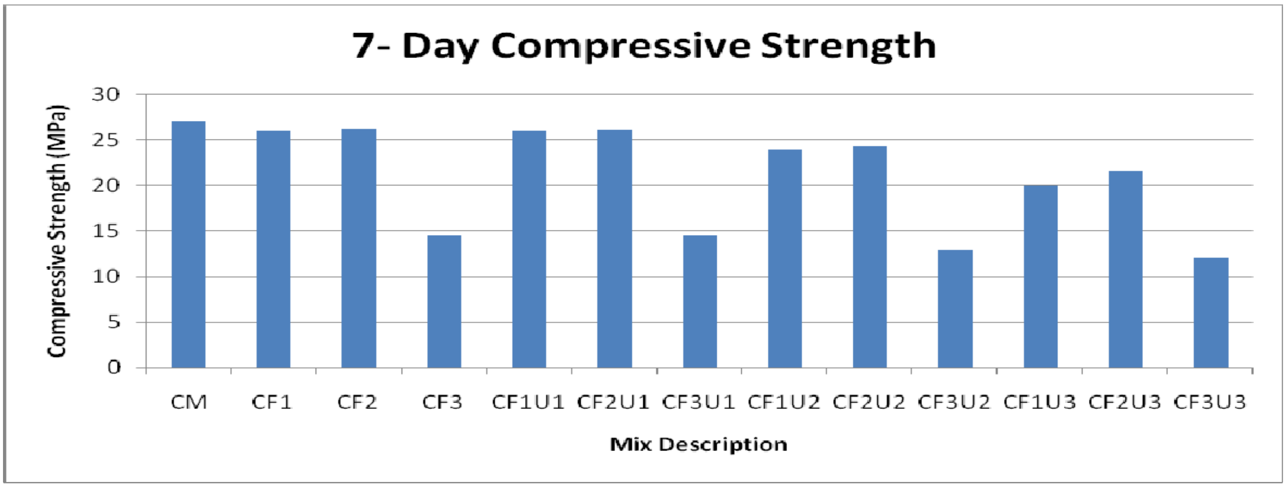
The mix proportions as detailed above are tabulated in table below, were chosen for validation of current investigation.

Mix Proportions of specimens prepared

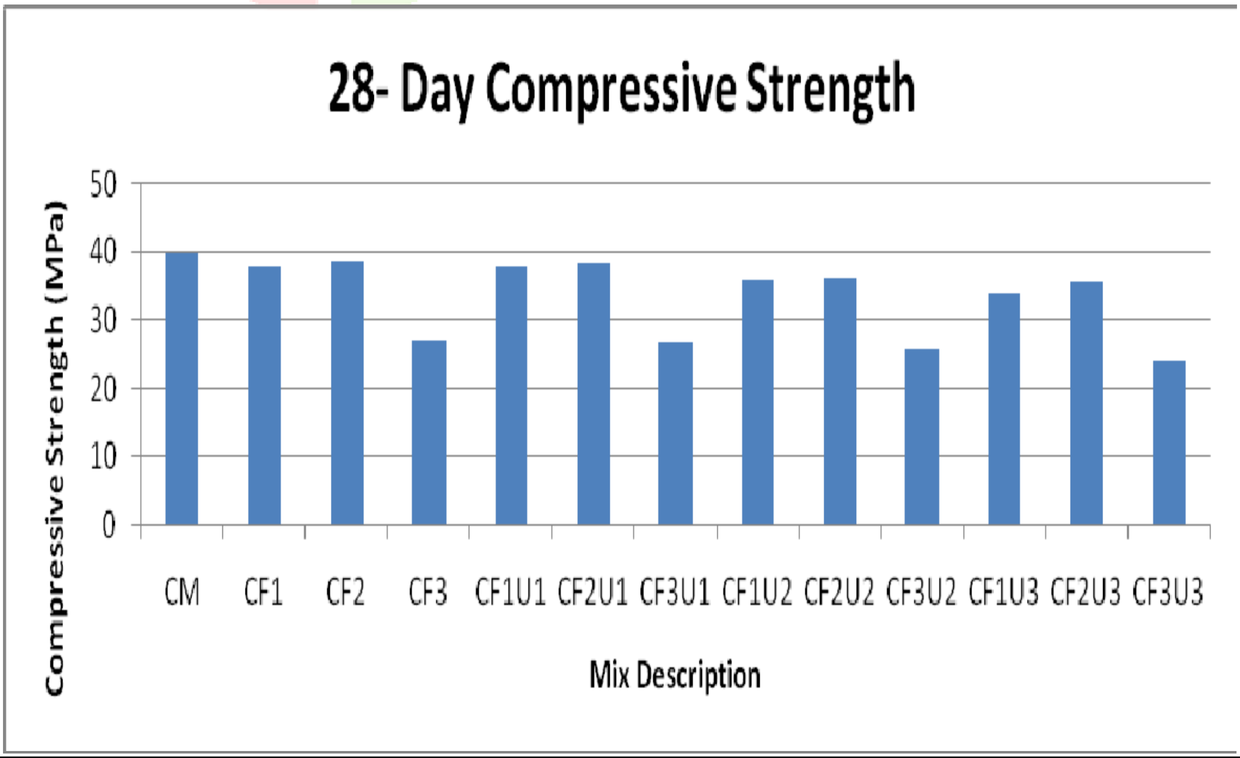
Mix	Cement OPC 43 (Kg/m^3)	FA Kg per cubic meter	Fine aggregate Kg per cubic meter	Coarse aggregate Kg per cubic meter	Water Kg per cubic meter	UEO (%)
CM	450	0	560	1250	162	0
CM + 30% FA	315	135	560	1250	162	0
CM + 40% FA	270	180	560	1250	162	0
CM + 50% FA	225	225	560	1250	162	0
CM + 30% FA + 0.5% UEO	315	135	560	1250	162	0.5
CM + 40% FA + 0.5% UEO	270	180	560	1250	162	0.5
CM + 50% FA + 0.5% UEO	225	225	560	1250	162	0.5
CM + 30% FA + 0.75% UEO	315	135	560	1250	162	0.75
CM + 40% FA + 0.75% UEO	270	180	560	1250	162	0.75
CM + 50% FA + 0.75% UEO	225	225	560	1250	162	0.75
CM + 30% FA + 1.0% UEO	315	135	560	1250	162	1.0
CM + 40% FA + 1.0% UEO	270	180	560	1250	162	1.0
CM + 50% FA + 1.0% UEO	225	225	560	1250	162	1.0

To validate the present research work, a set of 13 specimens were prepared and subjected to a detailed experimental program involving both green and hardened concrete. The tests carried out on green concrete included the Slump Value Test and Air Content Test, while the tests conducted on hardened concrete included the Compressive Strength Test and Test for Porosity. The results and discussion of these tests are presented below.

Compressive Strength Test was conducted to determine the compressive strength of different mixes. The results were recorded and presented in a table, and a bar graph was used to compare the results obtained from different mixes.Result of compressive strength test



Mix Description	Designation	Compressive Strength after 7 days MPa	Compressive Strength after 28 days MPa
CM	CM	27	40
CM + 30% FA	CF_1	26	38
CM + 40% FA	CF_2	26.2	38.6
CM + 50% FA	CF_3	14.5	27
CM + 30% FA + 0.5% UEO	CF_1U_1	26	38
CM + 40% FA + 0.5% UEO	CF_2U_1	26.1	38.5
CM + 50% FA + 0.5% UEO	CF_3U_1	14.5	26.8
CM + 30% FA + 0.75% UEO	CF_1U_2	24	36
CM + 40% FA + 0.75% UEO	CF_2U_2	24.3	36.4
CM + 50% FA + 0.75% UEO	CF_3U_2	13	26
CM + 30% FA + 1.0% UEO	CF_1U_3	20	34
CM + 40% FA + 1.0% UEO	CF_2U_3	21.6	35.8
CM + 50% FA + 1.0% UEO	CF_3U_3	12.1	24.2



Discussion on Compressive Test: The results of the compressive strength test showed that the conventional concrete had a strength of 27 MPa after 7 days and 40 MPa after 28 days. The addition of fly ash had a negligible effect on the strength of the concrete. However, when fly ash was used in combination with waste engine oil, the compressive strength values decreased progressively with an increase in the percentage of fly ash and waste engine oil.

Conclusion & Future Scope:

After conducting a detailed experimental program and discussing the results, the following conclusions can be drawn:

- Waste disposal is challenging due to strict regulations, so finding alternative uses for waste products is preferable. Fly ash (FA) and used engine oil (UEO) are two waste products that can be reused in concrete production.
- The addition of FA and UEO improved the workability of concrete. The slump value of conventional concrete was 25mm, and with the addition of fly ash, there was an insignificant increase in slump value. However, with a combination of 50% FA and 1% UEO, the slump values were significantly improved and almost doubled. This is because UEO has a lubricating effect that increases the fluidity of concrete.
- The addition of FA and UEO significantly reduced the air content values, making the mix more resistant to repeated freeze and thaw cycles in extreme weather conditions.
- The porosity of conventional concrete marked 10.2% after 28 days, and with the addition of fly ash, there was an insignificant decline in porosity. However, with a combination of FA and UEO, the values of porosity were significantly reduced because the lubricating effect of UEO reduced air voids.

In summary, the addition of FA + UEO improved properties such as workability, air content, and porosity, but compressive strength was adversely affected. An FA content of 40% and UEO content of 0.5% showed the optimum properties with the least decline in compressive strength.

Future Scope:

- Further exploration of the properties of UEO and FA blends in structural elements like columns, pavements, etc.
- Exploration of the usage of UEO in modifying asphaltic mix in flexible pavements.
- Consideration of other tests of engineering properties, as this research work only included four tests.
- Exploration of other percentage contents of both materials.
- Investigation of the potential of other prevalent wastes for use in concrete production

References

[1] NasirShafiq, MuhdFadhilNuruddin and Ibrahim Kamaruddin, "Effectiveness of used engine oil on improvement of Properties of fresh and hardened concrete", Proceedings of the Asia-Pacific structural Engineering and constructionconference, (APSEC-2006), 5-6 Sep2006, Kaula Lumpur, Malasia.

[2] Dr. ShathaSadiqHussen, "Using of Industrial Waste as a Green Chemical Admixture in Concrete", Kufa Journal of Engineering, Vol-7,NO-1, Jan 2016, pp 104- 114.

[3] Mohammed Noori Hussein, "Properties of Concrete Containing New and Used Engines Oil",International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064, Volume 4 Issue 12, December 2015, pp 268-272

[4] HeshamDiab," Effect of Mineral Oil on Reinforced Concrete Structures part-1, Deterioration of Compressive Strength", Journal of Engineering Sciences, Assiu University, Vol. 39, No 6, pp.1321-1333, November 2011

[5] NasirShafiq, MuhdFadhilNuruddin and Ibrahim Kamaruddin; Effectiveness of used engine oil on improvement of properties of fresh and hardened concrete", Proceedings of the 6th Asia Pacific Structural Engineering and Construction Conference, 2006, Kuala Lumpur, Malaysia, pp: 150 – 166.ASTM C231;American standards for testing of materials, measurement of air content in fresh concrete