Workability of Concrete Having Used Petrol Engine Oil and Banana Fibers

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Abstract

The quality of work and strength factors are directly dependent upon the concrete's property of workability. The objective of this study is to assess the workability of specimens having a 9.4% quantity of used petrol engine oil (UPEO) and varying the proportions (0.0%, 0.5%, 1.0%, 1.5%, 2.0%, and 2.5%) of banana fibers (BF). For this purpose, the slump cone test method is adopted to investigate workability. Proportions for the UPEO and BF are added by taking the mass of cement. The values of the slump of all admixed specimens are compared with normal plain concrete. The addition of UPEO and BF have done by taking the percentage of the mass of cement. It is observed from the results that the addition of UPEO increases the value of slump. On the other hand, the influence caused by the BF is the reduction of the slump value. This study concluded that the workability of concrete depends upon ingredients and admixed additional raw materials which are needed use to achieve the specific property. This study contributes towards the development of sustainable construction material with improved properties of concrete.

Keywords: *Admixture, Banana Fibers, Concrete's Workability, Fiber Reinforced Concrete, Used Petrol Engine Oil*

I. INTRODUCTION

The trend of the addition of natural fibers as reinforcement, to enhance the mechanical properties of the concrete, is increasing in developing countries. This growing interest in the utilization of natural fibers within the concrete is key to an issue which is less workability of concrete [1]. Workability is an important factor that controls the strength and quality of the mix. Workability reduces due to the addition of fiber within the concrete. An increase in the value of lignocellulose natural fibers, like banana fibers (BF), results in an increment in water absorption properties [2]. More water absorption property of fiber within the fresh reduces the slump value of concrete. The addition of all types of agricultural natural fiber significantly may decrease the property of workability [3]. Increase in the quantity of natural fiber within the indicated reduction in the slump of fresh concrete [4]. In the laboratory or at construction sites, the workability of concrete is determined by performing the concrete slump test during the construction work process [5, 6]. The workability property of concrete relies on the slump test and its value. Workability is normally controlled by the raw ingredients and w/c used for the mix design. The addition of natural fiber plays important role in the reduction of the slump of concrete. To overcome this situation, plasticizers and superplasticizers are incorporated to overcome the issue of less workability.

Used petrol engine oil (UPEO) can be used within the concrete, as a chemical admixture. Used engine oil does not leave a significant adverse effect on the load deflection and ultimate load behavior of flexural members [7]. Used engine oil can be added as an air-entraining agent in concrete. Utilization of UPEO did not leave worse the strength of hardened the concrete, but, caused an increase in a slump and air-entrained percentage of the fresh concrete [8]. Used engine oil approximately fulfills all the characteristics of type A water-reducing admixture according to ASTM standard C494 [9]. On the other hand, the researchers investigated the additive influence of agricultural waste/fibers on the properties of composites [10]. By the addition of jute fibers in concrete, resistance against impact loading improved [11]. Now a days, the combination of the fibers and admixture is being used to investigate and improve the properties of the construction materials. It was observed that the strength and ductility with combined addition of fibers and admixture were more than compared to composite prepared by the only addition of admixture [12]. Mechanical properties of cementitious composite enhanced by the addition of nanotube admixture and nano-fibers [13]. Many researchers performed investigations on the fresh properties and observed improvement in the hardened properties of concrete admixing the fibers and admixture simultaneously [14–16]. There are several studies reported on the workability and enhancement of strength and mechanical properties of the concrete by incorporating artificial fibers and admixture during the production of the concrete [17–19]. The toughness index and energy absorption properties were enhanced to resist the cracking with the usage of fibers and admixture in the concrete at the same time [20]. Workability helped in assessing and reducing the risk of segregation of lightweight aggregate concrete having steel and polypropylene fibers [21]. The good mechanical properties can be achieved of composite composed of fiber and mineral admixture by considering the workability property of the fresh concrete [22].

IEECP'21, July 29-30, 2021, Silicon Valley, San Francisco, CA – USA

DOI : *https://dx.doi.org/10.6084/m9.figshare.14737965*

Several studies can be found on the workability of artificial fiber reinforced concrete having some amount of admixture. But there is very limited research work on the workability of natural fibers and chemical admixture. This so natural fiber can be affected by chemical fiber due to its acidic/basic properties. To the best of the authors' knowledge, no work has been reported on workability of concrete made by the BF as reinforcement and UPEO as an admixture. As workability plays important role in the hardened properties of concrete. So, it is required to investigate the workability of the concrete made of natural fibers and waste chemical materials as an admixture like UPEO. To evaluate the fresh properties of concrete, different mix designs are casted having the varying proportion of BF and a fixed amount of the UPEO. Both BF and UPEO's contents are added by taking the mass of the cement being used for the production of the composites. A slump test is performed to analyze the workability of the fresh concrete. The undesirable workability of concrete is a deviation from the desired properties of concrete. Other than the basic ingredients can affect the workability of concrete adversely. A low slump means less workable concrete. Less workable concrete cannot be placed and poured into the formwork properly, ultimately leads to a decrease in the strength and improper shape of members. This study will help in controlling the workability while using the fibers and admixture. So, that it cannot be compromised with the desired properties and modeling of the members. It will also help to think about the utilization of waste materials and production of the good mechanical properties by keeping a special focus on the fresh properties of the concrete.

II. METHODOLOGY

A. Raw Materials

Ordinary Portland cement and Margalla crush along with locally available sand were used in the production of normal plain concrete. The maximum size of the aggregate 20 mm used for the manufacturing of both plain concrete and fiber reinforced concrete (FRC). For the preparation of FRC, banana fiber was used. The fixed length of 5 mm of the fiber was used in the preparation of the FRC. UPEO was used within plain concrete to prepare used petrol engine oil plain concrete and FRC. Normal temperature tap water used for preparing the plain concrete (PC), used petrol engine oil plain concrete (PU) and used petrol engine oil and banana fibers plain concrete (PUB). PC and PU are prepared with a 0.5 water cement ratio (W/C) and 0.6 W/C used for the production of all types of PUBs.

B. Mix Design and Concrete Preparation

For the manufacturing of plain concrete, cement, sand and aggregates ratio for mix design 1, 2 and 4, respectively, used with a 0.5 water cement (W/C) ratio. The same mix design is used for producing the used petrol engine oil plain concrete (PU) with a minor change which is the addition methodology of UPEO. After the half time of mixing elapsed, the UPEO is added after stopping the mixture time. To the best of the authors' knowledge, there is no specific or standard method available for the mixing of fiber reinforced concrete, so the layers methodology is used for the production of all PUBs likewise filling of slump cone by layers with a little difference. The W/C ratio is increased from 0.5 to 0.6 for the making of all the PUBs. The increment in the W/C ratio is taken to ensure acceptable compaction with a workable mix to achieve better strength could be achieved. In the methodology of mixing of PUB, 1/3 layer of aggregates is placed following by sand with same, fibers and cement. Then second and third layer is placed in the same manner of placing the first layers. Water is added in portions to avoid the bleeding effect in PUBs. After time elapsed for the mixing, the UPEO is admixed at last. The addition of UPEO is made at last and after spending some time on mixing is just to avoid the sticking of UPEO to a specific portion of the concrete or with its ingredients.

Figure 1. Measuring the value of slump of PUB.

C. Workability Test

The slump cone test is used to investigate the workability or consist of the manufactured PC. The slump test for the PC, PU and PUB is always performed before the pouring in molds. According to ASTM standard C143/C143M-15a, a slump cone test is performed to evaluate the workability of the fresh concrete [23]. Slump cone of a bottom diameter of 200 mm (8 in), bottom diameter of 100 mm (4 in) and height of 300 mm (12 in) is used to perform the test. The cone mold should be non-absorbent. Temping rod is hemispherical from both ends with a diameter of 16 mm (5/8 in) and length not more than 600 mm (25 in). The cone is filled with three equal volumetric layers of concrete. After placing the first 1/3 layer, compaction is done by a total of 25 times randomly dropping temping rod on the surface of the layer from a height of 25 mm (1 in). Similarly, further two layers of the cone are filled and compacted with the help of temping rod. Removed the extra amount of concrete by striking off the temping rod and made it smooth by screeding and rolling the rod over it. Later, the slump cone is lifted vertically upward. The cone is placed upside down beside the concrete of the slump cone's mold. Temping rod is placed over the up-turned slump cone in such a way that its length could reach over the slumped concrete as shown in [Figure 1]. With help of the ruler, the value of the slump is measured carefully. As per the best of the authors' knowledge, there is no such standard test is available to find out the workability of fresh UPEO-PC and UPEO-BFRC. Hence, the same procedure and test standard are used for the determination of the workability of PU and PUB.

III. RESULTS AND ANALYSIS

A. Slump of Fresh Concretes

The values of slump of PC, UPEO-PC and all UPEO-BFRCs is shown in the fifth column of Table 1. It can be observed clearly that a 9.4% addition of the UPEO content in the pc caused an increment in the slump value of the mix [Figure 2]. Even the water cement ratio (W/C) is kept same for the both PC and PU mix. The value of slump of PC and PU 36 mm and 40 mm, respectively. As expected, the addition of UPEO resulted in increment of 11.1% in the value of slump than the value of PC. These slumps of PUBs are less than the slumps of PC and PU. The 0.5% addition of BF has reduced significantly value of slump within the PC. The w/c is increased from 0.5 to 0.6 for the manufacturing of the all PUBs. The slump of the PUBs having fiber content 0.5%, 1.0%, 1.5%, 2.0% and 2.5%

are 23 mm, 19.5 mm, 17 mm, 13 mm and 10.5 mm, respectively. The slump of the is decreased as much the value of the BF is increased within the mix [Figure 2].

Table 1. Water cement ratio (W/C) and slump of PC, PU and all type of PUBs.

Mix	UPEO's addition (%)	BF's addition (%)	W/C (ratio)	Slump (mm)
PC	0	0	0.5	36
PU	9.4	0	0.5	40
PUB_1	9.4	0.5	0.6	23
PUB_2	9.4	1.0	0.6	19
PUB_3	9.4	1.5	0.6	17
PUB_4	9.4	2.0	0.6	13
PUB_5	9.4	2.5	0.6	10

The increase or decrease in optimum length (5 cm) of fiber was lead to a reduction in the slump of the FRC [24]. It can be observed that the incorporation of UPEO content enhances the value of slump PU in comparison with the slump of PC. This indicates the addition of UPEO can lead to the reduction of the water content (W/C ratio).

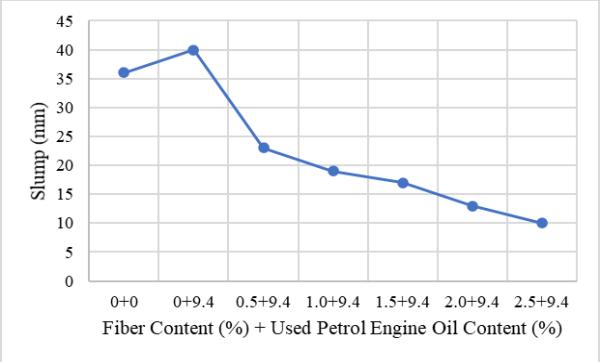

Figure 2. Influence of B.F and UPEO contents on slump

B. Ease with Concrete Handling

The ease with concrete handling means easy to place and transport the concrete, depends upon the workability of the concrete. Generally, it depends upon the W/C ratio of concrete and the size of the aggregate. Compared to PC, it is noticed that PU is more workable and easier to handle having the same w/c ratio. This is due to the increased slump of the PU. The slump value is affected by the addition of UPEO in the concrete mix. It is discovered that placing the PUBs is a little hard than the PC. The ease of handling of PUB is reduced after the incorporation of the fibers. The handling of the PUB became difficult as time passed than the PC. This difficulty is observed due absorption property of the fiber. Handling PUB_5 is much harder than PUB_1. This phenomenon has shown that the incorporation of fiber within the mix has made it harder to handle, place and transport. This is all due to the reduction in the slump caused by the increasing value of fiber in the mix. In general, admixing of natural fibers resulted in the reduction of the slump value of the mix. The values of PUBs were 10-23 mm. Despite these low values of the slump, the PUBs were workable, easy to place and transport and easy with the handling of the concrete but a little hard to handle than PC. It is experienced that the concrete should be poured into molds as soon the mixing is done for ease with concrete handling. As the time duration increased after the mixing, the handling of concrete becomes difficult. Due to less workability, difficulty was faced during the compaction. Ultimately, improper compaction can lead to the opposite direction to the achievement of desired properties of the composite.

IV. SUSTAINABLE CONSTRUCTION MATERIALS (USED PETROL ENGINE OIL AND BANANA FIBERS) AS PART OF CLEANER PRODUCTION

In the transportation sector, the use of vehicles increasing day by day. The main part of the vehicle is the engine and needs to be lubrication for good functionality. These lubricants are needed to replace after a specific running of motor/engine. Used petrol engine oil (used engine oil) is more dangerous to the environment than crude oil as it contains contaminated heavy particles [25]. It doesn't only have the contamination of the heavy particle but also polycyclic aromatic hydrocarbons (PAHs) that are insignificant in the unused oil. The used engine oil (or used petrol engine oil) badly affects the male reproductive parameter [26]. As there are tons of waste engine oil available, it cannot be stored. The used engine oil should be controlled and avoided its entrance and mixing with the runoff water. Eventually, it may pollute the river and sea environment and may cause danger to the water living life. The damping or used oil needs special treatments which costly. On the other hand, agricultural waste is growing day by day. It has been observed that about 21% of greenhouse gas is emitted by agricultural waste. The adverse effects of agricultural waste on the eco-system, human health and aquatic life have necessitated the appropriate dumping. Dumping of this waste covers a large part of precious land and also this is dangerous to human health [27]. The other method to dump the agricultural waste is to burn it. When a large amount of the agricultural is burnt up it releases a large amount of heat making which is dangerous to the global environment and can boost the global warming effect.

Many researchers had utilized agricultural waste differently in the research works related to the development of sustainable construction materials. Agricultural wastes, like coconut fibers and ropes made of these fibers, were used to develop a sustainable construction material and cleaner production [28]. This design of utilization of UPEO and BF for the development of construction material is eco-friendly as it helps in the dumping of agricultural waste and engine lubricant waste. The dumping of agricultural waste is a cost-effective task and required a lot of valuable lands. As it cannot be dumped in the sea or river to avoid pollution of the aquatic environment. Normal concrete releases a large amount of heat during the sintering process [29]. This effect can be minimized by the replacement of some amount of cement by UPEO [9]. Improved properties material can be developed by using agricultural waste/fibers in concrete instead of dumping. Seismic performance of FRC with added ropes of coconut fibers (agricultural waste) was improved as compared with the normal plain concrete [30, 31]. It was reported that sustainable concrete developed of agricultural waste, coconut fibers, helped in the reduction of the thickness of road making compared with normal concrete [32]. This made it economical as well as the number of costly materials is reduced due to reduction caused in the volume due to thickness. Fiber reinforced concrete made by natural fibers has comparable properties with synthetic fiber reinforced concrete in terms of strength. It depends upon the properties of fiber, like orientation, size and the manufacturing techniques [33]. This study helped in developing a sustainable construction material by using waste materials as raw materials. The dumping and recycling of mentioned above materials are uneconomical as well. So, the use of these materials as raw materials helped in the development of sustainable construction material and cleaning of the environment from the severe materials and in controlling the economy factor.

V. CONCLUSIONS

Used petrol engine oil plain concrete (PU) and used petrol engine oil and banana fibers plain concrete (PUB) are inspected to evaluate the effects of used petrol engine oil (UPEO) and banana fibers (BF)

on workability. For the making of PU, 9.4% of UPEO content by mass of cement is admixed in ingredients of normal concrete during the time of mixing. And for the production of the PUBs fixed amount of UPEO and varying proportions of fibers are used. The length of fiber is kept 5 cm and the addition of fiber is made on the base of the percentage mass of cement. The workability of concrete helps in its proper placing. Segregation of concrete can decrease the strength of the concrete adversely. A good workable mix also reduces the vulnerability of the segregation of concrete. The following conclusions are drawn:

- By the incorporation of 9.4% of UPEO, increased the slump value by 11.1% as compared to that of PC retaining w/c ratio same.
- Incorporation of banana fiber 0.5%, 1.0%, 1.5%, 2.0% and 2.5% in the mix has shown slumps of 23 mm, 19.5 mm, 17 mm, 13 mm and 10.5 mm respectively.
- An increase in fiber content within the mix causes a reduction in the slump of the PUB.
- Compared to PC, the workability of PUB reduces with an increase in the content of banana fibers.
- As much as the mix is less workable, the concrete handling goes harder.
- With the increase in workability of PU, the handling of mix become easier compared to PC.

From the above-mentioned results, workability highly affects the handling of concrete. The addition and quantity of the natural have shown a significantly adverse effect on the workability of the concrete. The use of the UPEO only has resulted in an increase in workability and concrete handling. So, a less W/C ratio is required to achieve high workability while adding UPEO to the mix.

VI. ACKNOWLEDGMENTS

The authors would like to thank all who has helped in this research, especially Engr. M Abrar and Engr M Sultan Sikander. The careful reviews and constructive suggestions by anonymous reviewers are gratefully acknowledged.

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