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Concrete Compressive Strength Evaluation: Water from the Marikina River as Mixing Water and Rice Husk Ash and Coir Fibre as Admixture

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Abstract:
The water acquired from the Wawa Dam of the Marikina River was utilised as a portion in the mixing water, and the Rice Husk Ash, and Coir Fibre as admixtures in the experimental concrete samples. The aim of the study was to produce a concrete sample that would surpass the compressive strength of a standard concrete following the standards of a 1:2:3 cement, sand, and gravel ratio, and with a 1:1 water to cement ratio. The researchers had a total of 18 cylindrical concrete samples, wherein nine samples used the said admixtures and substitutes, which were labelled as the experimental samples, and another nine samples were made from the materials used in producing standard concrete, which were labelled as the controlled samples. The samples which followed the 7, 14, and 28- day curing periods were tested by the Universal Testing Machine. In conclusion, the 7, 14, and 28-day experimental samples failed to exceed the compressive strength of the controlled samples since the values of the 7, 14, and 28-day controlled samples were 10.32, 24.24, and 10.23 MPa, while the experimental samples were 7.73, 10.06, and 7.73 MPa respectively.

Keywords*: ASTM C192, ASTM C39, Water, Marikina River, Compressive Strength, Admixtures.*

INTRODUCTION

I. BACKGROUND, MOTIVATION AND OBJECTIVE

Concrete is a fundamental material for construction, its strength, durability, and versatility are what make it an ideal foundation for infrastructures. According to reference [1], the stressed part about concrete is its compressive strength. The compressive strength is the capability of a medium to keep its shape intact in observance to compression. Testing the compressive strength are obtained from a standard, this serves as vital for engineers and researchers since this serves as their guideline for knowing the overall quality of the concrete. In this study, the use of water from the Marikina River would be used as a substitute for the mixing water, alongside with coir fibre and rice husk ash as a substitute for the aggregates. Marikina River is approximately 31 kilometres, and it drains the 582 square kilometer Marikina River Basin towards the Pasig River [2]. Due to negligence, urbanisation, and industrial growth, the condition of the water in the Marikina

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River declinedover time. The consequence of the problems is the decline in the ability of the river basin to provide the goods and services it should supposedly provide if it were in a desirable state or condition [3].

Considering the current circumstances that circulate around the river, this research study aimed to utilise the water in the Marikina River as the medium for mixing together with Rice Husk Ash and Coir Fibre as admixtures in producing concrete, to produce a concrete mixture that is better than ordinary concrete, and to evaluate the impact on the quality in terms of its compressive strength compared to the typical mixing water and aggregates applied in producing concrete.This study aimed to determine the potential of incorporating the said substitutes will produce a higher quality of concrete in terms of compressive strength.

In compliance with the ASTM, the study strictly used 152.40 x 304.80-millimetre cylinder casts and a total of 9 samples, 3 for each curing period namely 7, 14, and 28-day periods. Alongside with the substitutes, the concrete samples were made with Portland Cement Type 1, and the ratio for cement, sand, and gravel is 1:2:3. Regarding the water used for the samples, it is a mixture of 90% tap water and 10% water from the Marikina River. The samples were then subjected to the Universal Testing Machine (UTM) in order to acquire the data.

II. II.Literature Review

A.Coconut Husk Fibre

Commonly known as coir, is an organic material that is found on the outer shell of a coconut, it is comprised of cellulose, lignin, pyro ligneous acid, gas, charcoal, tar, tannin, and potassium. Coconut fibres have the capability to carry strain four-six times more compared to other fibres [2]. The utilisation of coconut fibres as an additive for the 150 x 150 x 150-millimetre concrete cubes was proven to be successful, in terms of its compressive strength. The addition of 0.5% coconut husk fibre into the mixture has increased the compressive strength of the concrete by 35.8% respectively [3].

B.Rice Husk Ash

Rice Husk Ash (RHA) is porous in nature and because of this, it possesses the ability to absorb, retain, and release water during the hydration of cement [4]. The incorporation of the Rice Husk Ash to the concrete mixture has been proven to improve the quality of the concrete, in terms of its compressive strength and modulus of elasticity; however, there is a limit to how much Rice Husk Ash could be added to the mix [4]. The utilisation of Rice Husk Ash as a partial for Type I Portland Cement, it was found that at using 10% of the Rice Husk Ash in the concrete mixture outperformed the controlled samples in the 28- day curing period in terms of their compressive strength [5].

C.Influence of Water Quality on Concrete

The workability is affected by the water content, the amount of cement paste in the overall mix and the physical characteristics such as maximum size, shape, and grading of the aggregates. Each of the valuable characteristics requires the use of water that will support not hinder the complex reactions that ensure the concrete manufacturing process is successful [6]. The reaction between the water and the cement varied with different constituent of cement. The impurities in the water reacted such that, the produced concrete improved concrete properties or the produced concrete did not have any development in terms of its strength and quality. Environment, time, place, and procedures that utilised the water were considered as factors that diversified the results for the strength and the quality of the concrete. In addition, it was seen that using impure water was favourable to the concrete at early ages for strength development but will subsequently reduce its long-term strength [7].

D.Utilisation of Different Water Sources

With the water scarcity present in areas around the world, water sources that exhibit discolouration, briny, low or high pH values, and foul smells are not to be excluded instantly, and water that had become of use of cities and industrial operations and have been discarded can be used as mixing water for concrete production [8]. The use of mixing water that came from different sources of water will bare results based on their impurity content. The use of 100 millimetre cube samples were cast with the water samples and subjected to the compressive strength test, it was concluded that the use of different water sources as mixing water could be

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applied where tap water is scarce, however the characteristics of the product should be put into consideration before mass production [9].

III.Methodology

The instructions provided must be followed in order to successfully produce the experimental sample. The materials are considered as the focus for this experiment. After obtaining the materials, the exact measurements should be used. The materials used for the experiment are the following: Marikina Water, Coir Fibre, Rice Husk Ash, Portland Cement Type 1. The coir fibre was collected by hand, and the rice husk ash were pulverised in a contained space. In this experiment ASTM C39 and ASTM C192 were strictly followed for the samples to meet standard regulations.

One tailed t-test: Two-sample assuming equal variances was used in interpreting the raw data from the Universal Testing Machine laboratory test. The α value used in the one tailed t-test was 0.05 with the confidence level of 95%. It was stated that the null hypothesis (Ho) is the mean value of the experimental samples is greater than or equal to the mean value of the controlled samples and the alternative hypothesis (Ha) is the mean value of the experimental samples is greater than the mean value of the controlled samples. The hypothesis is expressed as follows:

Ho: $\bar{X}E \leq \bar{X}C$ (1)
and
Ha: $\bar{X}E > \bar{X}C$ (2)

IV.Results and Discussion

In this part, the results of the study were presented and discussed in order to know the influence of the substitutes to the compressive strength, the experimental samples were significantly weaker than the controlled samples. The compressive strength of the samples was recorded with the Universal Testing Machine (UTM) in accordance to with the American Society for Testing Materials (ASTM) International by implementing 7, 14, and 28 curing days. For the data, the controlled samples depicts the samples that were made with the standard materials for concrete and stands as the controlled data, and experimental samples depicts the samples that were made with the standard materials alongside with the substitute materials and stands as the experimental data. The statistical treatment applied in this study is the T-test: Two-sample assuming equal variances.

As seen in Table 1, this states that the in comparing the samples for the 7-day compressive strength test the values fell within the acceptance region thus the researchers had to accept the null hypothesis which is the statement that the experimental samples are less than or equal to the controlled sample.

As seen in Table 2, this states that the in comparing the samples for the 14-day compressive strength test the values fell within the acceptance region thus the researchers had to accept the null hypothesis which is the statement that the experimental samples are less than or equal to the controlled sample.

As seen in Table 6, this states that the in comparing the samples for the 28-day compressive strength test the values fell within the acceptance region thus the researchers had to accept the null hypothesis which is the statement that the experimental samples are less than or equal to the controlled sample.

The compressive strength of the samples were also tested on different timeframes. The compressive strength of the controlled and experimental samples was measured by the use of the Universal Testing Machine (UTM) for each of the curing periods. The curing periods are comprised of 7,14, and 28-day. Tables 4, 5, and 6 show the gathered data for the compressive strength of both the controlled and experimental samples.

In summary of the findings, all the three curing periods for the experimental samples had failed to achieve the desired values of the compressive strength regarding the controlled concrete samples.

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Variable	Mean (MPa)	Variance	t-value	t-critical	p-value	α	Decision
Controlled	24.24	7.08	-8.45	2.13	0.0005	0.05	Did not reject H_o
Experimental	10.06	1.35					

Variable	Mean (MPa)	Variance	t-value	t-critical	p-value	α	Decision
Controlled	10.32	5.62	3.42	2.13	0.13	0.05	Did not reject H_o
Experimental	7.73	0.042					

Curing Period	Sample No.	Controlled Samples			Experimental Samples		
		Max. Force	Max. Stress	Max. Stress	Max. Force	Max. Stress	Max. Stress
		kN	kN/mm^2	MPa	kN	kN/mm^2	MPa
7-day	1	145.984	0.008	8	143.703	0.00788	7.88
	2	186.484	0.01022	10.22	136.813	0.0075	7.5
	3	232.344	0.01274	12.74	142.625	0.0782	7.82

Curing Period	Sample No.	Controlled Samples			Experimental Samples		
		Max. Force	Max. Stress	Max. Stress	Max. Force	Max. Stress	Max. Stress
		kN	kN/mm^2	MPa	kN	kN/mm^2	MPa
28-day	1	376.281	0.02063	20.63	277.359	0.0152	15.2
	2	357.906	0.01962	19.62	263.641	0.01445	14.45
	3	309.875	0.01699	16.99	204.797	0.01123	11.23

Curing Period	No. of Samples	Controlled Samples			Experimental Samples		
		Max. Force	Max. Stress	Max. Stress	Max. Force	Max. Stress	Max. Stress
		kN	kN/mm^2	MPa	kN	kN/mm^2	MPa
14-day	1	275.875	0.02693	26.93	195.5	0.01072	10.72
	2	210.391	0.02161	21.61	196.031	0.01075	10.75
	3	266.813	0.02417	24.17	159.109	0.00872	8.72

6 Conclusion

In this research study, nine concrete samples were made using alternatives and admixtures such as the water from Wawa Dam of the Marikina River as mixing water along with Rice Husk Ash and Coir Fibre as admixtures and compared it to nine controlled concrete samples under the concordant curing periods of 7, 14, and 28-day, while using three concrete samples each curing period. In accordance to the results in the compressive strength test, the experimental samples did not meet the appropriate compressive strength of concrete. The researchers hypothesised that the water from Wawa Dam of the Marikina River in addition with the Rice Husk Ash and Coir Fibre as admixtures does not have a principled reaction to each other which resulted in the weak compressive strength of the concrete samples. As observed, all concrete samples with the administration of the water from the Wawa Dam of The Marikina River as an alternative mixing water did not achieve the desired value of compressive strength mandated by the American Society for Testing and Materials (ASTM International). It is therefore concluded that the experiment using the water from Wawa Dam of the Marikina River as the mixing water and the addition of Rice Husk Ash and Coir Fibre admixtures reduced the compressive strength of concrete.

The researchers of this study would like to endorse the following objectives to be filled in and examined: (a) obtain an in-depth knowledge and

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familiarisation of the procedures and practices applied in concrete mixing as instructed by the American Society for Testing and Materials (ASTM), (b) increase the number of concrete samples to acquire a more accurate result in the compressive strength of the concrete samples which would subsequently give precise numerical values when statistical treatment is applied, (c) efficiently manage and interpret the gathered raw data by means of the appropriate statistical analysis since results drawn from this mathematical treatment can accommodate researchers to establish a valid and a credible conclusion, and (d) find a biodegradable waste material that is convenient to obtain and that ecological waste material exist abundantly. Furthermore, (e) the future researchers should change the process of carbonisation of the Rice Husk Ash in terms of the duration, temperature, and sieve process.

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