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Effect of Different Mixing Water on Compressive Strength of Concrete

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ABSTRACT

The research focused the effect of different qualities of mixing water on the compressive strength of concrete. It aims to prove that the usage of different mixing water will be suitable for making concrete providing similar strength as conventional tap water. The concrete design mix of Grade 35 with water cement ratio of 0.5 was prepared with Ordinary Portland Cement using water samples, such as river water, rain water, lake water and factory waste water collected from various sources were used to cast 150 mm³ concrete cubes. The cured concrete cubes were tested on 1, 3, 7, 14 and 28 days for compressive strength evaluation. The results showed that the compressive strength of concrete cubes made with lake water and river water increased with days and have almost equal strength as conventional tap water.

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EFFECT OF DIFFERENT MIXING WATER ON COMPRESSIVE STRENGTH OF CONCRETE

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Abstract

The research focused the effect of different qualities of mixing water on the compressive strength of concrete. It aims to prove that the usage of different mixing water will be suitable for making concrete providing similar strength as conventional tap water. The concrete design mix of Grade 35 with water cement ratio of 0.5 was prepared with Ordinary Portland Cement using water samples, such as river water, rain water, lake water and factory waste water collected from various sources were used to cast 150 mm³ concrete cubes. The cured concrete cubes were tested on 1, 3, 7, 14 and 28 days for compressive strength evaluation. The results showed that the compressive strength of concrete cubes made with lake water and river water increased with days and have almost equal strength as conventional tap water.

Keywords: Concrete, Compressive, Strength, Water, Qualities

1. Introduction

Water plays a significant part in the formation of concrete as it vigorously participates in the chemical reaction with cement. The quality and quantity of water is necessary to be looked into very cautiously. In practice, very frequently properties of aggregate and cement is exercised but the control on the quality of mixing water is repeatedly ignored. There are various types of water namely river water, rain water, lake water and factory waste water which are easily accessible that were used for making the concrete cubes specimen of size 150mm³ as per BS EN 1008:2002 [1] and tested at 1,3,7,14 and 28 days to find the compressive strength.

2. Literature Review

In Malaysia, multiple sources of water are accessible in different part of the country to be used for mixing concrete. If water is fit for drinking it is fit for making concrete [2]. The assumption that if water is fit to drink it is suitable for making concrete is not always correct [3]. Two criteria should be considered in evaluating the suitability of water used for mixing concrete [4]. One

is the impurities in the water will have an effect on the properties and quality of concrete and the other is the degree of impurity which can be tolerated. Impurity in water samples can impair the strength of compressive strength of concrete [5]. Impurities and deleterious substances which are present from water used in mixing concrete are likely to interfere with the process of hydration, preventing effective bond between the aggregates and matrix. The impurities sometimes reduce the durability of the aggregate [6]. Although, some criteria states the suitability of water for mixing concrete oblige that the water be clean and free from harmful material, these specifications may not always be right. Some waters which do not meet these criteria have been found to produce concretes of satisfactory quality [4]. Acid waters may be accepted as mixing water based on their pH values. However, water with pH value lesser than 4 should be avoided for mixing concrete.

3. Research Methods

The concrete mix of Grade 35 with water cement ratio of 0.5 were prepared, and by using different qualities of mixing water

such as river water, rain water, lake water and factory waste water to cast 150 mm concrete cubes.

3.1. Materials

i. Ordinary Portland Cement (OPC)

Ordinary Portland Cement (OPC) Type 1 was utilized for the research work in accordance to BS EN 197-1 (2000) [8].

ii. Water

Figure 1 shows few samples of selected waste water obtained from different sources are collected for this research such as river water, lake water, rain water and factory water in order to test for the effects of using different types of mixing water on the strength of concrete.



Figure 1. Water samples – lake water, river water, factory waste water, rain water (from left to right)

iii. Coarse Aggregate

Crushed stone of with nominal maximum size of 12.5mm was used as coarse aggregate. The coarse aggregate met the grading requirements of BS EN 932 (1999)[9] with water absorption 0.81% and specific gravity 2.64.

iv. Fine Aggregate

Local mining sand with water absorption of 0.6% and specific gravity of 2.65 is used for this project work as fine aggregates according to requirements of BS EN 932 (1999)[9].

3.2. Preliminary Assessment on Mixing Water

Several methods are performed to assess the quality of mixing water in accordance

to BS EN 1881 [7] requirements. Table 1 below shows the results obtained.

Table 1: Physical characteristic of mixing water

	Results	
Oil and Fats	No visible traces of oil and fats	
Detergents	Foam only present in factory water	
Colour	Tap water	Clear
	River	Lighter than pale yellow
	Rain	Clear
	Lake	Clear
	Factory	Darker than pale yellow
Suspended matter	Lesser than 4 ml	
Odour	Tap water	No smell
	River	Slight smell
	Rain	No smell
	Lake	No smell
	Factory	Strong smell
Acids (pH)	Tap water	8
	River	8
	Rain	6
	Lake	7
	Factory	8

Source: BS EN 1881:2002

3.3. Concrete Design Mix

The concrete design mix of 1:2:4 proposed for this research study is Grade 35 concrete per m³ tabulated as per Table 2 in accordance to BS EN 12390-2.

Concrete mixing shall comply with BS 1881-125 [7]. The mixing shall be persistent until the materials are evenly distributed. In case of segregation after unloading from the mixer, the concrete must be remixed.

Table 2: Grade 35 design mix

Cement (kg)	395
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Water (kg)	205
Coarse Aggregate (kg)	1170
Fine Aggregate (kg)	635

3.4. Workability

Workability refers to the behavior of fresh concrete and it measures the deformability of the fresh concrete. Slump test was conducted to check on the workability of the freshly made concrete prepared with five different types of water samples. Table 3 shows the slump results produced by five different samples.

Table 3: Slump test results

Water samples	Slump (mm)
Tap water	60
River water	80
Rain water	80
Lake water	70
Factory water	90

3.5. Density

The density of fresh normal weight concrete generally varies from 2200 to 2600 kg/m³.

3.6. Water Curing

All specimens of concrete cubes and cylinders were labeled and placed into the water curing tank. The specimens were cured in accordance with BS EN 12390-2 [10]. The samples of concrete cubes and cylinder were cured for 1 day, 3 days, 7 days, 14 days and 28 days respectively.

2.7. Setting Time

The initial setting time tests were conducted for cement. The initial setting time for the mix proportions using tap water, river water, rain water, lake water and factory waste water are analyzed to meet the standard requirements. The BS 3148: 1980[11] for Ordinary Portland Cement stated that the initial setting time of cement must not be less than 45 minutes.

2.8. Compressive Strength Test

Compression test is the most commonly performed test to determine the compressive strength of hardened concrete.



Figure 2. Compression testing machine

The compression test is carried out on concrete cubes specimens. The cube specimens of size 150x150x150mm were used. The cubes were water-cured for 1, 3, 7, 14 & 28 days. The specimens which were removed from curing tank were kept aside for drying until they were ready for testing. The compression testing machine as shown in Figure 2 was used to test the cured specimens. For each day tested, the cubes were placed on the loading apparatus and the load was released at a controlled loading rate. The critical load is reached once the load indicators needle recorded the exact failure point. A total of 75 concrete cubes were casted using five different samples of selected waste water as shown in Table 4.

Table 4: Sample Preparation of cubes specimens

Test	Age of testing (days)	No. of cubes tested	Total
Compression test	1	15	75
	3	15	
	7	15	
	14	15	
	28	15	

4. Discussion and Conclusion

4.1. Setting Time

Table 5 shows the initial setting time results obtained from all five water samples.

Table 5: Initial setting time results

Water samples	Initial Setting Time (min)
Tap water	90
River water	135
Rain water	150
Lake water	105
Factory water	195

The graph pattern from Fig.3 shows clearly that sample consisting the mixture of cement and factory water has the slowest setting time compared to other types of water samples.

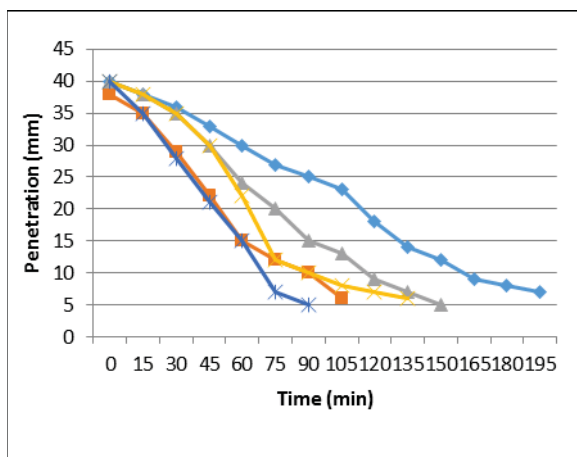


Figure 3. Initial setting of cement

4.2. Compression Test

The compressive strength of concrete cube test was carried out in accordance to the BS 1881-116:1983[7]. The concrete specimens of 150 mm cubes were casted, cured and tested on 1 day, 3 days, 7 days, 14 days and 28 days. A compression machine is used for testing the specimens. A total of 75 concrete cubes were casted using five different samples of selected waste water. The maximum load sustained by the specimen was recorded and calculated respectively. Mean value of compressive strength obtained from five cylinders were taken as the compressive

strength of the concrete as shown in Table 6.

Table 6: Compressive Strength of cube specimens

Water samples	Compressive Strength (N/mm ²)				
	Day 1	Day 3	Day 7	Day 14	Day 28
Tap water	16.80	21.33	28.98	33.33	37.33
River water	15.42	25.42	29.78	32.22	33.91
Rain water	10.00	14.57	26.89	19.87	31.11
Lake water	15.47	23.42	28.31	32.67	35.68
Factory water	18.58	25.56	19.20	26.44	16.22

From Fig.4 and Fig.5, the following conclusions can be summarized as below:

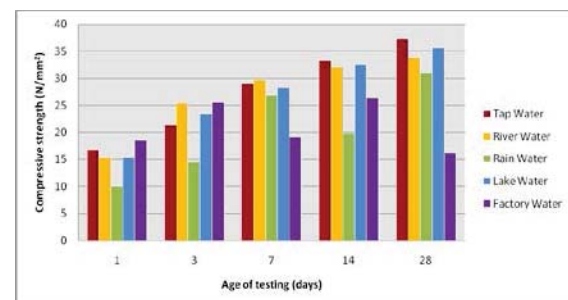


Figure 4. Compressive Strength of concrete at 1, 3, 7, 14 & 28 day

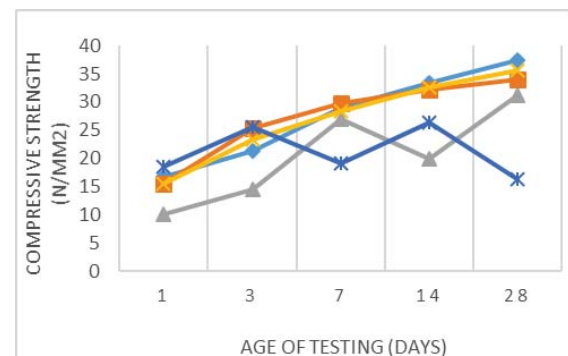


Figure 5: Comparison of compressive strength of cubes at 1, 3, 7, 14 & 28 days

(i) Results shows that concrete made from river water and lake water have compressive strength of 33.91 N/mm² and 35.68 N/mm² which are almost equal to at least 90% of strength made with tap water.

(ii) It was observed that concrete made with factory waste water with a pH of 8, gives 20% less 28 day compressive strength compared to tap water.

(iii) The concrete made with rain water have slightly less 14 day compressive strength compared to other specimens. (10% less compared to tap water).

(iv) Rain water with pH of 6, has an almost equal 28 day compressive strength of 31.11 N/mm² to tap water.

(v) The concrete made with river water has 3% higher 7 day compressive strength compared to tap water.

(vi) It can be concluded that slightly acidic, alkaline, brackish or fetid smelling water should not be discarded outright.

(vii) Therefore, river water and lake water can be safely used as mixing waters for concrete if it meets the required standard.

5. References

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