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AN ASSESSMENT OF THE EFFECT OF FASKARI DAM WATER ON COMPRESSIVE STRENGTH OF CONCRETE

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ABSTRACT

In dry season, Faskari town experiences scarcity of water. This resulted to difficulty in sourcing water for domestic use as well as for construction works. This necessitates the community in Faskari town to depend on Faskari Earth Dam Water in dry season for construction works though, its physical appearance looks rowdy. This paper evaluates the suitability of Faskari Earth Dam Water for concrete work. Physical properties such as colour, odour, etc, as well as Chemical characteristics of the water were examined. A concrete was produced using the tap water and Faskari Dam water where the workability and compressive strength of the concrete were evaluated. . The study revealed that Faskari Earth Dam Water has a pH value of 7.3, Chloride concentration of 0.22 mg/l, Sulphate concentration of 0.00 mg/l which are within the permissible limit stipulated for water to be used for concrete production. It was also found out that the water is dark brown in colour and has a smelling odour. The slump test results of the concrete mix produce with Faskari Earth dam water was found to be 11mm this indicates low workable concrete mix. Also, the 28 days compressive strength of concrete produced with Faskari Earth Dam Water is approximately 96.67% of the control sample. Hence, based on the test carried out it was concluded that Faskari Earth Dam Water is suitable for concrete work. Therefore, water source from Faskari Earth Dam Water can be used for concrete production.

KEYWORDS: *Compressive strength, Concrete, Faskari Earth Dam, Water, workability.*

INTRODUCTION

Concrete is one of the most widely used construction materials for both building and civil engineering construction works (Kosmatka, 1988; Spelman & Lee, 2022). Concrete is made up of cement, aggregates and water. All the constituents play vital role in determining concrete properties (Shetty 2005). Water initiates hydration process, determines the workability of concrete mix and is use for curing. It has been established that water that is fit for drinking and free from impurities should be used for concrete works (Shetty 2005; Neville 2006).

Production of concrete involves; batching, mixing with water, transporting and compacting (Obande, 1990). Concrete has two important states (fresh and harden), water plays important role in the two stages. Fresh or plastic concrete is a freshly mixed material which can be moulded into any shape. At fresh state, consistency, cohesion and workability are the most important properties of concrete.

Workability facilitates compaction and transportation without segregation (Oktar, 1996). Workability of concrete is the property that determines the effort required to manipulate a freshly mixed quantity of

concrete with minimum loss of homogeneity ASTM C125 (2000). Slump test is one of the commonest methods of determining concrete workability. The quality of hardened concrete can be said to be dependent on the properties at its fresh stage. It is therefore, important that properties of fresh concrete should be checked and ensured compliance with specified requirement. Quantity and quality of mixing water have a major role in determining these properties.

At hardened state, it is imperative that the compressive strength of concrete satisfied its designed strength. Hence, compressive strength is usually considered in judging the quality of concrete as it is directly related to its density, permeability, tensile strength and chemical resistance. It is important to note that adequate curing is one of the key factors for achieving optimum compressive strength. Also, water pay a major role in hydration process, mixing, finishing and curing of concrete.

There are three (3) major sources of water in Faskari town namely; wells, boreholes, and Faskari earth dam. Faskari earth dam was constructed in the year 1973 for agricultural activities. The Dam is located in the eastern part of Faskari town of Katsina state. It has length of about 400metres with a breadth of 250metres and the depth is about 7 metres. The people in Faskari town depends on the wells and boreholes water for their domestic and other uses, while the Faskari earth dam is used for irrigation and livestock drinking. However, during dry season (February to April), water table drops in the wells and boreholes. Therefore, the water from the Faskari Earth dam is commonly used for construction works. As a result of the large number of animals that use the dam as compared with its size, the colour and odour of the water changes. This among other reasons makes the quality of the water for construction work questionable. Caribbean (2013) recommended that water suspected to contain some impurities should be tested to determine whether the impurities can affect the concrete strength development. Based on this there is need to investigate the properties of the Faskari Earth Dam Water and its effect on fresh properties and compressive strength of concrete.

Water in concrete

After mixing and placement, concrete loses its plasticity, solidifies and hardens due to a chemical reaction known as hydration. For concrete production, hydration occurs when water reacts with the cement, thus binds the aggregates together and eventually forming a stone like material (Isabella, 2015). This reaction is responsible for the properties and quality of the final concrete. Hence, the quality of the cement paste determines the characteristics of concrete. Also the strength of the paste, in turn, depends on the mixing water and water cement ratio (Sahu, 2004). High quality concrete is produced by lowering the water-cement ratio, provided the concrete is properly mixed, placed, consolidated and cured. Thus, the quantity of water should be adequate to initiate hydration and give adequate workability (Shetty, 2005). Cement requires time to fully hydrate before it acquires expected strength and hardness, thus concrete must be cured once it has been placed for optimum hydration. Curing is the process of keeping concrete under a specific environmental condition until hydration is relatively complete (Tsivilis, 2000). Water is very essential for this process, thus quality of water for this process has to be ensured.

Moreover, the quality of water can further affect some important properties of concrete, such as setting time, workability, compressive strength and durability (Nikhil *et al*, 2014). Generally, water which is fit for drinking may be considered suitable for making concrete. However, some water may not be fit for drinking but suitable for use in concrete.

In order to define the quality of water for making concrete, it is necessary to understand the effects of various impurities on the concrete properties. Excessive impurities in water for mixing and curing of concrete affect not only its setting time but also its strength, workability and durability. Based on this, Neville (2006) recommended some limits of impurities of water to be tolerated for concrete production.

Neville (2006) opined that water with pH range of 6.0 to 8.0 is good for concreting. Furthermore, mixing water with high content of suspended solids needs to be tested before use in concrete work. According to ASTM C1602 (2018) compressive strength and setting time are the concrete performance requirements of mixing water. Natural waters that are slightly acidic are harmless, but water containing humus or organic acids may adversely affect the hardening of concrete (Neville, 1996). Chatveera *et al* (2006) observed that the use of recycled sludge water as mixing water for concrete reduces workability and strength of concrete. Su *et. al* (2002) investigate the effect of various types of mixing water on the properties of mortar and concrete and reported that wash water is good for concrete mixing.

However, the basic requirement of water for concrete is that it should be fit for drinking. The question that comes to mind is the availability of potable water for concrete work. But in developing countries like Nigeria, only a few percent of the populace has access to adequate potable water for their domestic consumption. This implies that it will be difficult for an average contractor to afford potable water in construction works (concrete) all the time. Therefore, there is a need to investigate the suitability of the alternative sources of water for concrete production.

MATERIALS AND METHODS

Materials

Water: Two water samples were used for the research. Public tap water fit for drinking as a control sample and Faskari Earth Dam Water as test specimen. Faskari Earth Dam Water was collected at the point where the water is more disturbed.

Cement: The cement used was Dangote brand of Portland Limestone.

Clean air-dried river sand obtained from Shika area was used as fine aggregate.

crushed granite stones of 20mm maximum size were used as coarse aggregates.

Methods

Physical properties of the water were investigated by observations as shown in Table1. Chemical analysis of water sample from the Faskari Earth Dam was carried out in the Multi User Research Laboratory of Department of Chemistry, Ahmadu Bello University Zaria the result is presented in Table 2. Initial and final setting time of the cement were tested using both tap water and Faskari earth Dam water by use of vicar apparatus in accordance with NIS 447 (2003) and ASTM 191 (2004) provisions the result shown in Table 3.

For the production of the concrete ratio 1:2:4 was adopted for the concrete mix. Also, materials were batched by weight, mixed and compacted manually. For both the control and test samplea concrete mixes, workability test was carried out by use of slump test based on ASTM 143 (1994) guidelines. Slump test was carried out in the Laboratory of Department of Building, Ahmadu Bello University Zaria. Forty numbers (40) of 100mm x 100mm x 100mm concrete cubes where produced, cured and tested for compressive strength test at 7 days, 14 days 21 days 28 days. At each testing period five (5) cubes were selected and crushed. The compressive strength test result is on Figure 1.

RESULTS AND DISCUSSION

The results of the tests carried out on the Faskari Earth Dam Water samples were presented in Table 1 and 2. Also the properties of mortar and concrete produced by use of Faskari Earth Dam water and the tap water were shown on Table 3, 4 and Figure 1.

Properties of Faskari Earth Dam Water

Physical Properties of Faskari Dam Water

Table 1: Physical properties of water

	Properties	Faskari Earth Dam Water	Tap Water (control)
I	Test	tasteless	tasteless
II	Smell	odour	odourless
III	Colour	dark brown colour	colourless
IV	Boiling point	boils at 100^0C	boils at 100^0C

Table 1 shows the physical properties of Faskari Earth Dam Water and the water from Ahmadu Bello University, Zaria Water main. It can be observed from Table1 that the colour and odour of the Faskari Earth Dam Water vary with that of control water sample. However, most of the other physical properties tested are similar. Therefore, change in colour and odour of Faskari Earth Dam Water is an indication of impurities in the water. Caribbean, (2013) states that using water in concrete mix that contain some impurities may have negative effects on concrete properties.

Chemical properties

The result of the chemical analysis of water from Faskari Earth Dam is presented in Table 2 along with the permissible limits as prescribed by Neville (2006).

Table 2: Chemical characteristic

S/N	Elements	Average Concentration for Faskari Earth Dam Water	Maximum allowable Limit. Neville (2006)
1	Chloride	0.22 mg/l	10,000 mg/l
2	Sulphite	0.00 mg/l	400 mg/l
3	Iron salt	0.74 mg/l	40,000 mg/l
4	TDS	70.4 mg/l	15,000 mg/l
5	Oil and grease	773.3 mg/l	40,900 mg/l
6	Bicarbonate	252.5 mg/l	1000 mg/l
7	Carbonate	167 mg/l	1000 mg/l
8	Calcium	85 mg/l	32,700 mg/l
9	Sodium	20.00 mg/l	1000 mg/l
10	Potassium	80.00 mg/l	1000 mg/l
11	Total suspended solids (TSS)	210 mg/l	2000 mg/l
12	Conductivity	165.9 us/cm	250 us/cm
13	PH value	7.3	6 - 8

Table 2 present element concentration of chemicals in Faskari Earth Dam water. From the Table it can be seen that the concentrations of all the parameters examined are below the permissible limits for water to be use in concrete production as specified in Neville (1996). The PH value of Faskari Earth Dam Water is 7.3 which is greater than 6 as recommended in IS456-2000 for water to be use in concrete production. However, Kucche *et al* (2015) reported that water that contains not more than 2000 ppm dissolved solids is suitable for concrete work. Therefore, the Faskari Earth Dam Water is found to be suitable for use in the concrete production.

Properties of Concrete made with Faskari Earth Dam Water

Fresh Properties; Table 3 shows the setting time period of cement paste made with Faskari Earth Dam Water. Table 4 presents the workability of concrete mix made with Faskari Earth Dam Water.

Setting Time

Table 3: Result of setting time

water use for mixing	Initial setting time (minutes)	Final setting time (minutes)
Public Main Water	144	180
Faskari Earth Dam Water	146	184
Maximum limit by ASTM C 191 (2004)	**45**	**435**

Table 3 shows both the initial and final setting time of concrete made with public tab water and Faskari Earth Dam Water. However, the initial setting time of mortar made from the two-water sample is above the recommended value stated in ASTM C 191 (2004) with 99 and 101 minutes respectively. The initial and final setting time results of mortar produced using Faskari Earth Dam Water are lower than that of deep well water (Mohe *et al* 2022). The prolong initial setting time can be attributed to the impurities in the water. this can lead to low workability, increase rate of shrinkage cracks, in adequate bond strength and reduced compressive strength. Also, the final setting time of mortar made with Faskari Earth Dam Water is 184 minutes which is less than the maximum limit of 435 minutes. This can facilitate early removal of formwork. To address this issue, consider adjusting the mix design, using retarding admixtures, or controlling the temperature during construction IS 4031 Part 5(1988).

Workability of Faskari Earth Dam Water Concrete mix

Table 4 shows slump values of the concrete mixes made with Faskari Earth Dam Water and control water.

Table 4: Result of Slump Test

Water use for Concrete mix	Slump height (mm).
Control mix made with potable water	12.00
Test mix made with Faskari Earth Dam Water	11.00

Table 4 presents the workability of the control concrete mix and concrete mix made with Faskari Earth Dam Water. The slump test revealed that the two concrete mixes have true slump, with only 1mm difference. Concrete mix made with Faskari Earth Dam Water has lower the workability of concrete. However, for both the two mixes the

workability is very low as the slump value is less than 25mm (Shetty 2005).

Compressive Strength Properties of Concrete made with Faskari Earth Dam Water

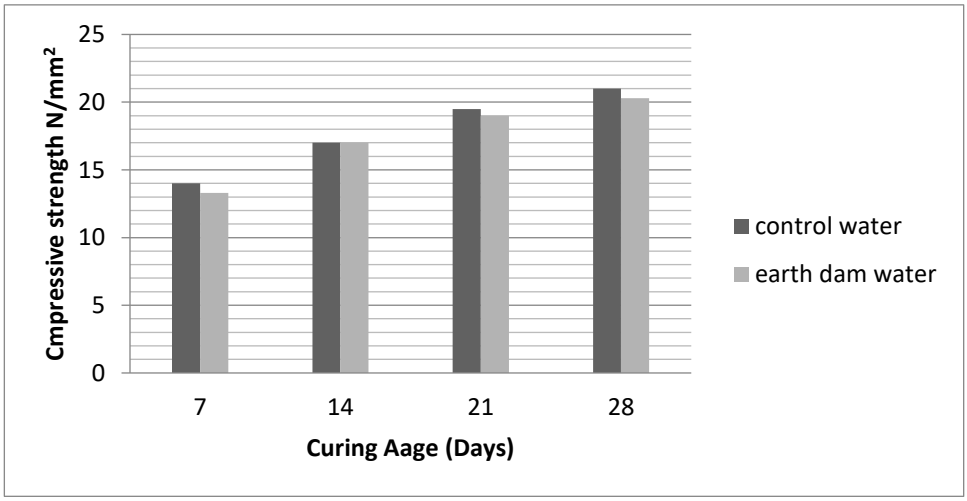

Figure 1: Compressive Strength Value of the Concrete made with Faskari Earth Dam Water

Figure 1 shows that the compressive strength of concrete made with potable water and that of concrete made with Faskari Earth Dam Water. The 28 days' compressive strength of concrete made with Faskari Earth Dam Water and tap water were 20.3N/mm^2 and 21.0N/mm^2 respectively. Faskari Earth Dam Water achieved 96.67% compressive strength which is close to the values obtaind by Mohe *et al* (2022) for river water and deep well water. This indicates that Faskari Earth Dam Water has no negative effect on concrete hydration process therefore, it can be used for concrete work.

CONCLUSION AND RECOMMENDATIONS

Conclusion

The Physical and chemical properties of Faskari Earth Dam Water indicate that the water is suitable for concrete work. Also, workability and compressive strength properties of concrete produced using Faskari Earth Dam Water shows that Faskari earth Dam water has less effect on the concrete compressive strength.

Recommendation

Faskari Earth Dam Water can be used for construction work.

REFERENCES

American Society for Testing and Material. (2006). Standard Terminology Relating to Concrete and Concrete Aggregates. *American Society for Testing and Materi*al, West Conshohocken, ASTM C125. USA

American Society for Testing and Material. (1994). Standard Test Method for Slump of Hydraulic- Cement Concrete ASTM C143

American Society for Testing and Material. (2004). Standard Test Method for Time of Setting of Hydraulic Cement by Vicat Needle ASTM C191.USA

American Society for Testing and Material. (2018). Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete ASTM C1602.USA

Chatveera B., Lertwattanruk P, and makul N (2006), Effect of Sludge Water from Ready Mixed Concrete Plant on Properties and Durability of Concrete. *Journal of cement and sand compositions*, Publishers Elsevier, Volume 28. pp. 441-450.

Caribbean Cement Industry (2013): Water for Mixing Concrete. www.caribcement.com/resources/article/.../Water-for-Mixing-Concrete

Isabella S. (2015). The Effect of Hydration on the Microstructural Properties of Individual Phases of Ordinary Portland Cement, (Master's thesis). Department of Physics and Astronomy, University College London.

IS 4031 (Part 5): 1988, "Methods of Physical Tests for Hydraulic Cement", Bureau of Indian Standards.

IS 456 (2000). Plain and Reinforced Concrete Code of Practice Fourth edition

Kosmatka, S.H.P. (1988). Design and control of concrete mixtures, in Portland Cement Association, pp.17, 42, 70, 184.

Kucche K.J, Jamkar S.S and Sadgir P.A. (2015): Quality of Water for Making Concrete: A Review of Literature. International Journal of Science and Resarch Publication, Volume 5. pp 1-10

Mohe N.S, Shewalul Y.S and Agon E.C (2022) Experimental Investigation On Mechanical Properties of Concrete Using Different Sources of Water For Mixing and Curing Concrete. Journal Case Studies in Construction Materials volume 16 pp.1-14. https://doi.org/10.1016/j.cscm.2022.e00959

Neville A. M. (1996). Properties of concrete pitman books limited, London.

Neville, A.M. (2006): "Properties of Concrete Addison." Wesley Longman Ltd, Edinburgh Gate, Harlow Essex CM 20 2jE, England

Nikhil T.R, Sushma R.A, Gopinath S.M and Shunthuppa R.C (2014). Impact of Water Quality on Strength Properties of Concrete. *Indian Journal of applied Research*. Engneering Vol 4. pp 197-199

Nigerian Industrial Standard NIS 447 (2003). Methods of Testing Cement-Determination of Setting Time and Soundness

Obande M.O (1990). Block laying and concreting, second edition, longman Publishes.

Oktar, O.N. Moral H., and Tasdemir M.A., (1996). Factors Determining the Correlations Between Concrete Properties, and Cement. *Journal of Cement and Concrete Research*. Publishers Elsevier Vol 26 pp 1629-1637

Sahu S K., Badger S.E. and Thaulow N. Lee R.J (2004). Determination of Water Cement Ratio of Hardened Concrete by Scanning Electron microscopy. *Journal of Cement and Concrete Composites*. Publishers Elsevier pp. 987-992.

Shetty (2005). Concrete Technology Theory and Practice first Edition, S. Chand & Company India.

Spelman, D and Lee, Y. (2022). Sustainability of Concrete as A Civil Engineering Material. *Engineering Journal*, 26(7). 69-81. Doi: 10.4186/ej.2022.26.7.69

Su. N., Miao B., and Liu B. (2002). Effect of Wash Water and Underground Water on Properties of Concrete. *Journal of*

Cement and Concrete Research. Publishers Elsevier pp. 777-782

Tsivilis, S. (2002). An analysis of the properties of Portland limestone Cement and concrete composites, pp.371-378.