EFFECTS OF DYEING WASTEWATER ON THE QUALITY OF CONCRETE

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ABSTRACT
This research work presents the effects of dyeing wastewater on the quality of concrete. Dyeing wastewater from Marina area, Sokoto town, was used in the study. The setting time of cement paste mixed with dyeing wastewater, the chemical composition of dyeing wastewater, and the workability of grade 20 concrete made with wastewater and portable water, were tested. The compressive strength of grade 20 concrete at different ages of curing was tested after the cubes were cast and cured in both dyeing wastewater and portable water. The results showed that, the workability of concrete made with dyeing wastewater is lower than that of concrete made with portable water and, there is a significant effect on water type on the strength of concrete produced. The compressive strength of concrete made with dyeing waste water decreased with age of curing, and the 28 days strength fell lower than the designed strength, while the compressive strength of concrete made with portable water increased with age. It was therefore concluded that the dyeing wastewater should not be used for mixing and curing of concrete.

1. INTRODUCTION

Concrete is a mixture of coarse [stone, brick or chips] and fine aggregates [generally sand or crushed stone] with a binder material [usually Portland cement]. Typical concrete has high resistance to compressive stresses. Concrete is strong in compression but weak in tension; it is a very variable material having a wide range of strength and stress-strain curves, therefore, the ultimate strain for most structural concretes tend to be a constant value of approximately 0.0035, irrespective of the concrete. However much research has been carried out in the area of concrete materials to be introduced and added to the production of concrete in order to achieve high strength concrete. Among them are: fibers, fly ashes, rice husk and other pozzolans.

Cement is one of the oldest manufactured construction materials used in the construction of concrete structures around the world (Syed *et al*, 2008). It is a material with adhesive and cohesive properties which is capable of binding stones, sands, bricks, building blocks etc. into a compact whole. Cement used in construction can be characterized as being either hydraulic or non-hydraulic depending on its ability to set in the presence of water. The properties of concrete depend on the qualities and quantities of its components. Since cement is the most active component of concrete and usually has the greatest unit cost, its selection and proper use are important in obtaining the most economically balance of properties desired for any particular concrete mixture (Syed et al, 2008).

In many parts of the world, storage of water in the households for consumption is routine occurrence, especially in homes that lack a connected source for portable water (Mintz, 1995). Pure water is colourless, tasteless, and odorless. It is an excellent solvent that can dissolve most minerals that come in contact with it. This is the reason that there is really no such thing as “pure water” in nature; it always contains chemicals and biological impurities. Natural waters may contain suspended and dissolved inorganic and organic compounds and microorganisms.

These compounds may come from natural sources and leaching of waste deposits. Municipal and industrial wastes also contribute to a wide spectrum of both organic and inorganic impurities.

However, safe and clean water is very essential to concrete construction (Syed *et al*, 2008).

The Objectives of this research work are to determine:

(i) The effect of dyeing waste water on setting time of concrete
(ii) The chemical composition of dyeing waste water
(iii) The workability of concrete using slump test method
(iv) The compressive strength of concrete using curing ages: 7days, 14days, 21days, and 28days respectively.

2. MATERIALS AND METHODS

2.1 Materials

The cement used in this research is the Sokoto cement brand of the ordinary Portland cement. It was obtained from a local cement dealer. Care was taken to ensure that the cement was of recent suppliers and free from adulteration.

Naturally occurring fine aggregate was used and it was obtained from a dealer along IPP road Sokoto. It was sieved to remove larger particle of stone and other harmful substances like leaves and wooden particles. The coarse aggregate was the crushed granite obtained from a dealer too; it was of the 20mm maximum size crushed granite. Water obtained from Sokoto dyeing company was used for mixing the concrete, and the pure and clean water was used for control.

2.2 Methods

The specific gravity of a material is defined as the ratio between the mass of dry solid and the mass of distilled water displaced by the material particle. The mean value of specific gravity of fine aggregate, coarse aggregate and cement was obtained in the laboratory using standard methods. **Gs** $= \frac{(W2-W1)}{(W4-W1)-(W3-W2)}$ the test was done in accordance with BS 8500 (2000)**.**

Concrete mix design consist of selecting the correct proportion of cement, fine and coarse aggregate and water, which on combination and through mixing produces concrete having the specified properties. The mix design method used in this research was carried out for grade 20 concrete.

The materials batched for the concrete was mixed manually in the laboratory. The mixture was then cast in to the mould of size 150 x 150 x 150mm and compacted manually by using tamping rod to the design density of 2400kg/m^3. A total of 12 cubes were cast and cured with the dyeing water and also for control 12 additional cubes were cast and immersed in clean water for curing.

The slump test was conducted in accordance with BS1881 – 2 – 1970. After casting and identifying the cubes, they were left for 24 hours before removal from moulds. The concrete cubes were placed in a curing tank in the laboratory with dyeing water and the control in clean water for 7days, 14days, 21days, and 28days respectively. After 7days curing, the cubes were removed from the water and air-dried, and the density of each concrete cube was noted before testing for compressive strength. The procedures were applied to all the concrete cubes when their curing periods were due.

These tests for compressive strength of hardened concrete was done according to BS1881: part 116, 1983 “Method of Determination of Compressive Strength of Concrete”. At the end of 7, 14, 21, and 28 days respectively, the compressive strength tests were carried out on each cube. The failure load of each cube was determined by using a compression testing machine. The machine applied load by compression on the cube specimens at a constant rate until a maximum load which corresponds to the ultimate compressive load of the cube is reached, after which the cube specimen fails by crushing. The load corresponding to the maximum load is taken as the failure load for the cube.

3. RESULTS AND DISCUSSION

Table 3.1 shows the chemical composition of dyeing wastewater. From the table, it is seen that the parameters that were tested are not within the limits of W.H.O. standard for drinking water; therefore, it may affect the quality of concrete because of their chemical contents.

Table 3.1: Chemical composition of dyeing wastewater

S/N	Parameter	Result (mg/L)	WHO standard for drinking water (mg/L)
1	Calcium	110	75
2	Magnesium	85	30
3	Fluoride	1	2.0
4	Iron	0.15	0.1
5	Sulphate	80	200
6	PH	12.6	6.5 – 8.5
7	Turbidity	1305NTU	5NTU
8	Nitrite	4.5	
9	Nitrate	3.01	20
10	Color	Black	Colorless
11	Total hardness ($Caco_3$)	195	250

3.1 Measurement of workability of mix concrete

The measurement of workability (Slump) of concrete made with portable water (control) and dyeing water are presented in Table 3.2.

Table 3.2: Slump Concrete

Water used	Slump (mm)

Portable water (control)	20
Dyeing wastewater	15

The workability is within the specified slump of 10 – 30mm of grade 20 concrete mix designed.

3.2 Compressive Strength of Concrete

The strength of the concrete made with dyeing wastewater decreased with age as evidenced in Table 3.3, and the 28-day strength fell lower than designed strength while, that made with portable water increased with age. This indicates effects of water type as a result of chemical contents.

Table 3.3: Summary of results of compressive strength of grade 20 concrete

Age (days)	Water type	Mean compressive strength (N/mm^2)	Mean density (Kg/m^3)
7	Portable water	17.78	2626.35
	Dyeing wastewater	20.06	2312.00
14	Portable water	26.08	2459.85
	Dyeing wastewater	18.52	2500.15
21	Portable water	27.11	2444.45
	Dyeing wastewater	16.44	2479.60
28	Portable water	30.22	2433.09
	Dyeing wastewater	14.22	2490.27

Table 3.4 shows the difference in strength between control samples and samples made with the dyeing wastewater. The results show that the early age compressive strength of concrete made with dyeing wastewater is higher than that of control samples. The compressive strength of control samples increased with age, with 28-day strength of 30.22N/mm^2. The reduction in strength of concrete samples made with dyeing wastewater is due to the effect of nitrates and other deleterious substances present in the wastewater.

Table 3.4 Difference in strength of concrete made with dyeing wastewater and that made with portable water

Age (days)	Portable water (N/mm^2	Dyeing wastewater (N/mm^2)	Difference in strength (N/mm^2)	% difference in strength
7	17.78	20.06	+2.28	+12.82
14	26.08	18.52	-7.56	-28.99
21	27.11	16.44	-10.67	-39.36
28	30.22	14.22	-16.00	-52.95

4. CONCLUSION AND RECOMMENDATION

4.1 Conclusion

Based on the experiment, calculations, analysis and observations of the research, it can be concluded that the workability of the concrete made with dyeing wastewater is lower than that of concrete made with portable water. The strength of the concrete made with dyeing wastewater decreases with age of curing, and the 28-day strength falls lower than the designed strength. There is significant effect of water type on the strength of concrete produced.

4.2 Recommendation

Based on the findings of the research, the following recommendations are made:

1. Dyeing wastewater should not be used for mixing and curing of concrete.
2. Local authorities should educate the populace on the dangers of using dyeing waste water for concrete production and enforce penalties for the defaulters.

5. REFERENCES

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