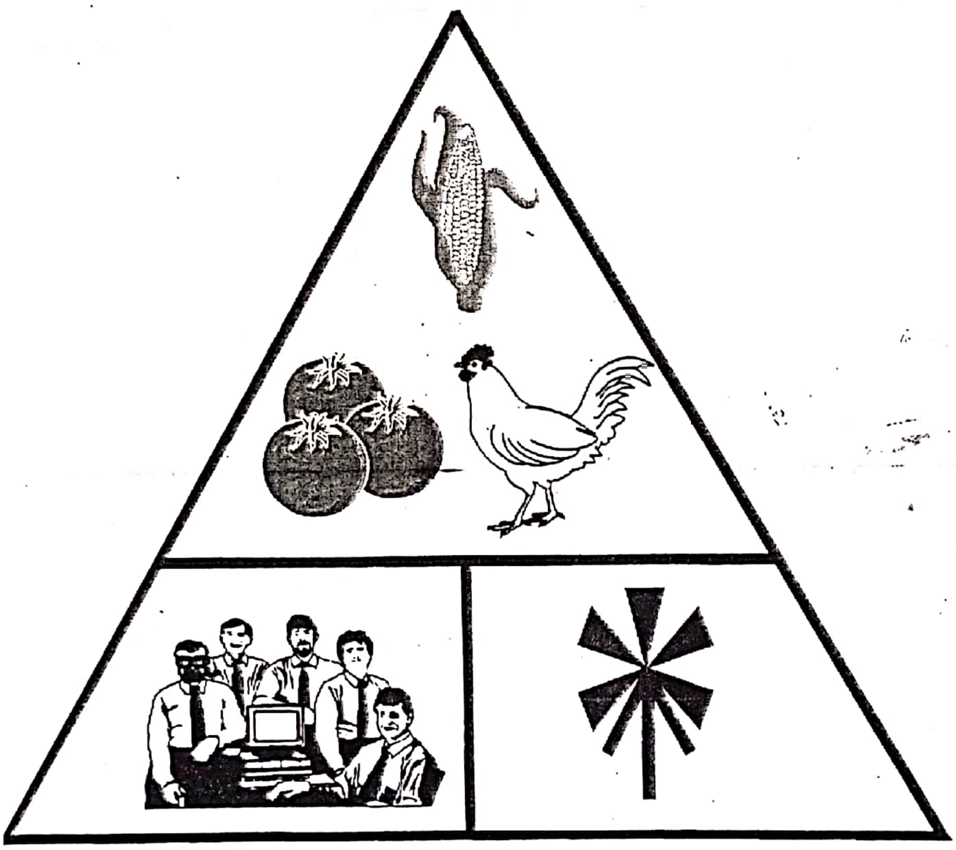
Agriculture, Business and Technology

A Publication of the Society for Agriculture, Business and Technology

Volume 8 (2): 2010 ISSN 2006- 0807



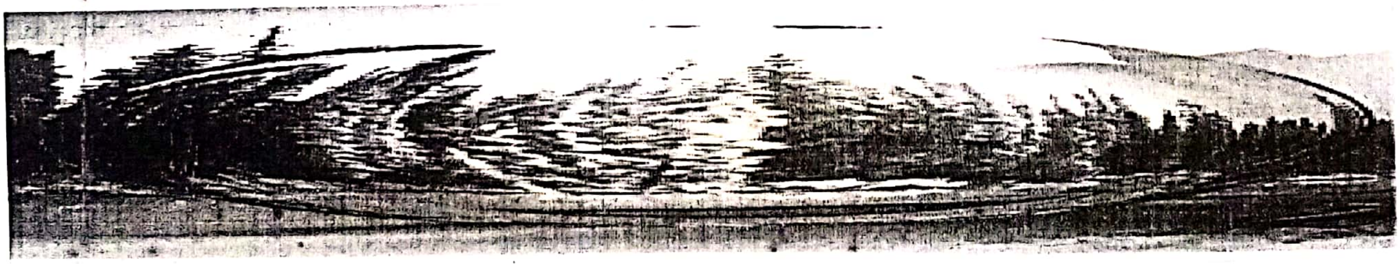


TABLE OF CONTENTS

Agric. Bus and Tech Vol 8 No 2 pp 61-76 (2010)

ISSN 2007-0807

Agriculture, Business and Technology Journal

Comparative Analysis of the Effect of Water Treatment Chemicals on the Properties of Concrete

[1]C. H. Balla (Mrs), [1]N.A. Keftin, [1]W.E.Dzasu and [2]C. Ayegba
[1]Department of Building, Modibbo Adama University of Technology Yola, Nigeria.
[2]Department of Building Federal University of Technology Minna, Nigeria

Abstract

The study examined the effect of water- treatment chemical on the properties of concrete; using two different brand of ordinary Portland cement. The compressive strength of the concrete as the important property is taken as the index of its quality and the physical properties such as abrasion was checked. Concrete cubes were cast with Dangote and Ashaka Portland cement, cured in the solution of water –treatment chemicals (aluminium sulphate and calcium hypo-chloride) and crushed to obtain their compressive strength. The results obtained were compared with the result of the compressive strength of control cubes cast with the two brands of ordinary Portland cement cured in water for 28 days. The control cubes cast with Dangote cement attained 29.6N/mm^2 at 28 days hydration wile 29.1N/mm^2 was attained for cubes cast with Ashaka cement. Concrete cubes made with Dangote cement and cured in water treatment chemicals attained the average strength of 29.4N/mm^2, 29.2N/mm^2 and 28.9N/mm^{2}at 7 days, 14 days and 28 days curing age respectively while the strength of 28.6N/mm^2 28.4N/mm^2 and 28.3N/mm^2 at 7, 14 and 28 days curing age was attained for the cubes made with Ahsaka cement. The strength of the Dangote cubes cured in chemicals decreased from the control cubes by 0.8%, 1.5%,2.1% from the control cubes at 7,14,and 28 days curing while for the Ashaka cubes there was decrease in strength from the control cubes by 1.7%,2.3%and 2.85 of the control cubes at 7,14 and 28 days curing age respectively
KEYWORDS: Ashaka cement, Portland cement, aluminium sulphate, calcium hypo chloride physical properties

Introduction

There are two commonly used structural materials which include concrete and steel in the construction of buildings, bridges, highways, or dams. They sometimes complement one another and they sometimes compete with one another, so that many structure of similar type can be built in either of these materials (Neville, 1996).

Concrete as the most widely used man made construction material is second to water as the most utilized substance on earth (Gambhir, 2005). It is obtained by mixing cementations material, water and aggregate (and sometimes admixtures) in required proportion. The mixture when placed in forms and allowed to cure hardens into a rock like mass known as concrete.

In its hardened state it should have properties of strength, durability, impermeability and it should have minimum dimensional changes. The strength, durability and other characteristics depend on the properties of its ingredients, on the proportion of mix the method of compaction and other controls during placing, compaction and curing. (Gambhir, 2005).

Among the various properties of the concrete its compressive strength is considered to be the most important and is taken as index of its overall quality. It has almost no tensile strength (usually measured to be about 10 to 15 of its compressive strength) and for this reason it is almost never used without some form of reinforcing (Portland cement association, 2005)

Though concrete is a durable material requiring a little or no maintenance in normal conditions or environment, but when subjected to highly aggressive or hostile environment such as the presence of organic matter in the aggregates and the presence of aggressive chemicals or/ and aggressive chemicals initiating substances in the environment, it has been found to deteriorate resulting in pre-mature failure of structure or reached a state requiring costly repairs (Moskin, 1980 and Taylor 1977)

Concrete as stipulated by (Gambhir, 2005) is not entirely impervious to moisture and other soluble salts and one of the main characteristics influencing the durability of concrete is it's impermeability to ingress of water, oxygen , carbon dioxide chloride, sulphate and other potentially deleterious substances

Engineers have taken the advantage of concrete superior engineering properties and have used it to build water retaining structure. These water treatment tanks or dams are constantly exposed to an environment containing dissolved salts and chemicals used for water treatment. These chemicals include aluminum sulphate, calcium hypo-chloride and calcium hydroxide (Andrew, 1976).

According to (Edwards 2002) aluminum sulphateAl2 (SO4)2 is a widely used industrious chemical and is sometimes referred to as alum. It is used in water purification to cause impurities to coagulate which are removed as the particles settle to the bottom of the container. The process is called coagulation or flocculation and particles are removed by the sedimentation or filtration (Alexander 1976).

calcium hypo-chloride Ca(ClO)2 also known as bleach is applied to water in treatment plants to react and destroy pathogens which also reduce bacteria's in water. This chemical reacts in water to form hypo-chloros and calcium hydroxide (American concrete institute, 2000)

Calcium Hydroxide Ca (OH)2 also known as hydrated limes is used in the treatment of portable water because of its strong basic properties for pH correction (Halstead 1957).

The water treatment chemicals which are soluble in water produce ions which create an entirely new chemical environment for the concrete. Investigation of the effect of the chemicals on the properties of the concrete enables a wider knowledge on the resultant effect of their reaction at an early stage and over a long period of time (Shetty 2004)

OBJECTIVES

I. Identify the chemicals used for water treatment.

II. Prepare the solution of these chemicals to treat the water at the worst torpidity.

III. Prepare concrete cubes and cure them in the chemicals

IV. Determine the strength of concrete in 7, 14 and 28 days

V. Compare the result with the control cubes

Material and Method

Concrete cubes were cast with two brands of ordinary portrland cement (OPC) which include Ashaka cement and Dangote cement. The cubes were cured in chemicals used for water treatment. The water treatment chemicals are Aluminum sulphate and Calcium hypo chloride this does not include calcium hydroxide which would not be used due to the fact that the pH value of the water lies between 6.7 and 8.5. Compressive strength test was carried out on the concrete cubes cured in water treatment chemicals at intervals of 7days, 14 days and 28 days. The result of the compressive test was compared with the result of the compressive strength test for the controlled concrete cubes which were casts with the two different brands of ordinary Portland cement and cured in portable drinking water for 28 days.

The test is essentially a laboratory based research therefore concrete specimen are prepared using two brands of ordinary Portland cement namely: Dangote and Ashaka cement.

Aggregate

Aggregate used are classified as coarse and fine aggregate. The fine aggregate are those that pass through the 4.75mm BS (British Standard) test sieve while those that are retained on the 4.75mm BS sieve are referred to as coarse aggregate. The aggregate were obtained from local suppliers within Yola metropolis and both complying with grading requirement of 882 part 2 (1973).

i. Fine aggregate

The sand used for the concrete falls under the classification of S.U that is uniformly - graded sand. The fine aggregate was thoroughly cleaned and any deleterious material likely to affect the properties of concrete removed.

ii. Coarse aggregate

Natural stones were used as coarse aggregate in the study. The coarse aggregate was evaluated according to BS 882 part 2 (1973). The aggregate conforms to the requirement of the nominal size of graded aggregate

Water

Portable drinking water was used for mixing and curing the concrete specimen.

Preparation of specimen

For the purpose of this study, concrete mix design of 1 : 2 : 4 with water/cement ratio of 0.5 was used. The materials used were batched by volume and mixing was carried out manually and separately for each of the Ordinary Portland Cement (OPC) under laboratory conditions.

150mm x 150mm x 150mm metal moulds with oil smeared on the inside of the mould to avoid sticking was used for casting the concrete specimen after obtaining a uniform and consistent mixture. Vibration to remove entrapped oids was done manually and the concrete specimen were left in the mould for 24 hours after casting before they were removed from the mould.

Sample Techniques

For each of the brand of Ordinary Portland cement, OPC, 12 cubes of concrete specimen were cast and cured at three different ages in the prepared water – treatment chemical.

Table I: Number of Cubes vs Brand ordinary Portland cement (opc)

Curing Age	Dangote Cement	Ashaka Cement
7 days	3 cubes	3
14 days	3	3
28 days	3	3
Controlled cubes	3	3
Total	12 cubes	12 cubes

From Table I a number of total 24 cubes were cast

i. Three concrete cubes were casts as control specimen for each of the brand of ordinary Portland cement (opc) and cured in portable drinking water for 28 days. Their compressive strength was determined

ii. The concrete specimens were cured in water treatment chemical prepared for worst turbidity. All the cured samples were subjected to compressive strength test.

Water – Treatment Chemicals

Aluminium sulphate (Alum) and calcium hypo-chloride (chlorine) were used essentially for the research. For the purification of water, at 160 NTU (Nepheametric turbidity unit), i. e the worst turbidity, the alum dose is 300kg alum mixed in 9000 litre of water. Therefore for I litre of untreated/unpurified water, the alum dose will be equal to:

$$\frac{300 \times 1000}{9000} = 33.3333 \text{ g/l}$$

100 liters of untreated water was used for curing. The required alum dose = 3333.3333g = 3.3kg.

The chlorine dose is 5mg/litres. Therefore for the 100 liters, of chlorine dose will be = 100 x 5 = 500mg.

Compressive Strength of Concrete

Compressive strength test was carried out on the concrete in Order to ascertain the concrete strength of the concrete subjected to the presence of aluminium sulphate and calcium hypo-chloride. The concrete specimens were weighed in the laboratory and their density determined before they were crushed to obtain the compressive strengths.

Presentation and Discussion of Results

SIEVE ANALYSIS

The results of the sieve analysis for the fine coarse aggregate are tabulated in table 2 and 3 respectively.

: 2: Sieve Analysis of fine Aggregate

	0.00	999.90	0.00	100
	0,80	999.00	0.10	99.90
	3.50	995.50	0.40	99.50
	7.90	987.60	0.80	98.70
	32.30	995.40	3.20	95.50
n	206.20	749.20	20.62	74.90
n	604.40	144.80	60.40	14.50
n	136.30	8.50	13.60	0.90
	8.50	-	0.90	-

l Mass of material = 999.9g =
)g

Table 3: Sieve analysis of coarse aggregate

Sieve size (mm)	Weight of material retained (g)	Weight of material passing (g)	Percentage of material retained (%)	Percentage of material passing (%)
37.50	0.00	997.50	0.00	100
19.00	12.69	984.81	1.27	98.73
13.20	94.25	890.50	9.45	89.28
9.50	265.50	625.06	26.62	62.66
6.70	623.20	1.86	62.48	1.86
Pan	1.86	-	1.86	-

Total mass of material = 997.50g

Table 4: compressive strength of concrete cubes made with Dangote and Ashaka ordinary Portland cement (opc) at seven days curing water – treatment chemicals

	DANGOTE			ASHAKA		
Water-cement ratio	0.50			0.50		
Samples	1	2	3	1	2	3
Weight	8768	8820	8650	8440	8680	8450
Density	2.60	2.61	2.56	2.50	2.57	2.50
Dial Reading	655	666	662	650	646	638
Compressive Strength	29.1	29.6	29.4	28.9	28.7	28.3
Average Compressive Strength		29.2			28.6	

Table 5: compressive strength of concrete cubes made with Dangote and Ashaka ordinary Portland cement (opc) at fourteen days curing water – treatment chemicals

	DANGOTE			ASHAKA		
Water-cement ratio	0.50			0.50		
Samples	1	2	3	1	2	3
Weight	8475	8335	8520	8210	8300	8320
Density	2.51	2.45	2.52	2.43	2.48	2.47
Dial Reading	659	662	655	645	637	639
Compressive Strength	29.3	29.4	29.1	28.6	28.3	28.4
Average Compressive Strength		29.2			28.4	

Table 6: compressive strength of concrete cubes made with Dangote and Ashaka ordinary Portland cement (opc) at twenty eight days curing water – treatment chemicals

	DANGOTE			ASHAKA		
Water-cement ratio	0.50			0.50		
Samples	1	2	3	1	2	3
Weight	8850	8430	8430	8280	8330	8475
Density	2.62	2.49	2.50	2.45	2.47	2.51
Dial Reading	657	648	645	635	635	639
Compressive Strength	29.2	28.8	28.6	28.2	28.2	28.4
Average Compressive Strength		28.9			28.3	

Table 7: compressive strength of concrete cubes made with Dangote and Ashaka ordinary Portland cement (opc) at twenty eight days curing in portable drinking water

	DANGOTE			ASHAKA		
Water-cement ratio	0.50			0.50		
Samples	1	2	3	1	2	3
Weight	8960	8730	8980	8782	8320	8965
Density	2.65	2.59	2.66	2.60	2.61	2.66
Dial Reading	664	657	675	648	653	666
Compressive Strength	29.5	29.2	30	28.8	29.0	29.6
Average Compressive Strength		29.6			29.1	

Discussions

The compressive strength of concrete cubes made with Dangote and Ashaka Portland Cement, cured in portable drinking water for the period of 28 days is presented in table 4.6. Compressive strength of 30N/mm² was targeted for the cubes, but the average compressive strength of three samples of concrete cubes made with Dangote Portland Cement is 29.6N/mm² while the average compressive strength of the cubes made with Ashaka Portland Cement is 29.1N/mm². It has been observed from this test that there is a slight difference between the compressive strengths of the concrete cubes made with Dangote and Ashaka. This can be due to the quality difference of the cement produced by these companies.

The concrete cubes cured in water – treatment chemicals for the duration of 7 days were observed to have dissolved salts i.e a whitish appearance on the surfaces and there was no visible abrasion on the concrete surface. Consequently, for the cubes cured at the age of 14 days, the dissolved salt was noticed on the surfaces and there was no visible abrasion on the surfaces. But for the 28 days curing in chemicals, slight abrasion was noticed on the concrete edges as well as dissolved salts on the surface.

The results of the compressive strength test of the concrete cubes cured in water – treatment chemicals are shown in table 4.3, 4.4, and 4.5 for the curing age of 7 days, 14 days and 28 days respectively. From the data presented in the tables, it can be deduced that there was slight difference between the strength of the controlled concrete cubes cured in water and these in water– treatment chemicals. At the age of 7 days curing in water–treatment chemicals, for the concrete cubes made with Dangote Portland Cement it was observed that there was a loss of strength of up to about 0.8% of the controlled cube. For Ashaka Cement, there was about 1.7% loss of strength from the controlled cube. At the age of 14 days curing in the chemicals, it has been found that for concrete cubes made with Dangote there has about 1.5% of the average strength of the controlled cubes the reduction or loss of strength was about 2.3% of the controlled cubes. At the age of 28 days curing in chemicals, it has been observed that for the Dangote concrete, the loss of compressive strength is about 2.1% from the strength of the controlled cube. Similarly, there was about 2.8% loss of strength from the controlled cube for the Ashaka cement concrete.

From the above results, it can be deduced that there is an effect of the water – treatment chemicals on concrete in terms of the compressive strength of concrete and its physical properties. But this effect has been observed to be very small or slight with respect to the ages or duration of the concrete in the chemical environment.

The concrete cubes made with Ashaka Portland Cement have also been observed to have less resistance to the chemicals as the percentage strength reduction is higher between the interval of 7 days, and 28 days than the cubes made with

Dangote Portland Cement. It can be concluded that the type and quality of cement is one of the important factors that affect the properties of concrete especially when the concrete are constantly subjected to hostile environment. The result also shows that the strength of the concrete gradually decreases with increase of the curing age, that is the longer the curing age or period of time the concrete remains in the water-treatment chemicals the lesser its compressive strength.

Conclusions

The average compressive strength of the three samples of concrete cubes made with Dangote Portland cement and cured in water for 28 days is 29.6N/mm², while the three samples of concrete cubes made with Ashaka ceme[illegible] attained the average com[illegible]sive strength of 29.[illegible] nm². There is a slight difference between the compressive strength made with Dangote and that of Ashaka cement due to the quality difference of the cement produced by these companies.

The concrete cubes cured in water-treatment chemicals were observed to have dissolved salts, that is a characteristic whitish appearance on the surfaces. There was no visible abrasion on the concrete surfaces except for the cubes cured in water-treatment chemicals for the duration of 28 days.

At 7 days curing in water-treatment chemicals, the compressive strength of concrete cubes made with Dangote cement was observed to decrease from 29.6 N/mm² to 29.4 N/mm², which is ut 0.8% loss of strength from the trolled cubes. While the cubes made 1 Ashaka cement decreased in strength n 29.1N/mm² to 28.6 N/mm² which bout 1.7% loss of strength from the trolled cubes.

14 days curing in water-treatment micals, the compressive strength of the es made with Dangote cement reased to 29.2N/mm² which is about % loss of strength from the controlled es. While for the cubes made Ashaka nent, the compressive strength reased to 28.4N/mm² which is about % loss of strength from the controlled es.

the age of 28 days curing in chemicals, compressive strength of the Dangote bes decreased to 28.9N/mm², which is out 2.1% loss of strength. While for the Ashaka cube, the strength decreased to 28.3N/mm², which is about 2.8% loss of strength from the controlled cubes.

References

Andrew S.D. (1995).reeinforced an prestressed concrete design, longman and technical, England

American Concrete instuttuition, (ACI): manual of concrete practice (2000) part I: Material and General properties of concrete.

Edwards, s. (2002). Handbook of Public Water system second edition HDR enginnering Inc Omaha

Gambhir M.L. (2005) concrete technology. Third edition Tata McGraw-

Hill publishing company limited. New delhi.

Moskvin, V. (1980) concrete and reinford concrete deterioration and protection, Mir publisher, Moscoe.

Neville A.M (1996) properties of concrete, Addition Wesley Longman Ltd, Edinburg Gate, Halow, Essex CM20 2 JE Portland

Portland cement association, P.C.A (2005) design and control of concrete mixture. 14th Edition.

Shetty, M.S. (2004). Concrete technology: theory and practical .S chand and company Ltd Delhi, India.

Received for publication 31/07/10

Accepted for publication30/08/10

Corresponding authors

C. H. Balla (Mrs) and W.E Dzasu

Department of Building Federal University of Technology Yola, Nigeria.