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RESEARCH ARTICLE OPEN ACCESS

Curing Methods and Their Effects on The Strength of Concrete

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There are a lot of arguments on which method of curing concrete gives good strength. These different opinions results into this study, which aim at investigating the effects of different curing methods on the strength of concrete. Laboratory test was employed for this study. Normal concretes were prepared using specified mix ratio of 1:2:4 and 1:3:6. The cubes tested for compressive strength at 3, 7, 21, and 28 days of curing respectively using four curing methods namely immersion, sprinkling, polythene sheeting and sharp sand coating. Testing indicate that water immersion curing method as well as sprinkling (spraying) methods of curing, provide better results than membrane (polythene sheeting) method of curing. While sharp sand gives least strength. The rate of drying was significant when the specimens were subjected to curing with polythene sheet method of curing. This thus hampered the hydration process and thus affected the compressive strength property of the hardened concrete. The overall findings of this study suggests that concrete should be cured by water immersion or spraying regularly to achieve a better compressive strength in concrete.
KEY WORDS: Curing Methods, Strength, Hydration Process

I. INTRODUCTION

Concrete properties and durability are significantly influenced by curing since it greatly affects the hydration of cement. The hydration of cement virtually ceases when the relative humidity within capillaries drops below 80% (Neville 2002).

Under an efficient curing method such as water curing, the relative humidity is maintained above 80% to continue the hydration of cement. Conversely, the concrete specimens lose water or moisture through evaporation and become dry in absence of a proper curing. The evaporation decreases the relative humidity by reducing the amount of available moisture, and thereby retards the hydration of cement. In severe cases, the hydration is eventually stopped. When the hydration is stopped, sufficient calcium silicate hydrate (CSH) cannot develop from the reaction of cement compounds and water. Calcium silicate hydrate is the major strength-providing reaction product of cement hydration. It also acts as a porosity reducer and thereby results in a dense microstructure in concrete. Without adequate calcium silicate hydrate, the development of dense microstructure and refined pore structure is interrupted. A more continues pore structure may be formed in cover concrete, since it is very sensitive to drying. The continuous pore structure formed in cover concrete may allow the ingress of deleterious agents, and thus would cause various durability problems. Moreover, the drying of concrete surface results in shrinkage cracks that may aggravate the durability problems.

Therefore, an efficient curing is inevitable to prevent the moisture movement or evaporation of water from concrete surface. It can be accomplished by keeping the concrete element completely saturated or as much saturated as possible until the water-filled is space are substantially reduced by hydration products. For this, an extra amount of water must be added to replenish the loss of water due to evaporation. Alternatively, some measures must be taken to prevent the loss of moisture from concrete surface (Neville 200)

A proper curing maintains a suitably warm and moist environment for the development of hydration products and thus reduces the porosity in hydrated cement paste and increases the density of microstructure in concrete. The hydration products extends from the surfaces of cement grains, and the volume of pores decreases due to proper curing under appropriate temperature and moisture. If a concrete is not well cured, particularly at the early age, it will not gain the properties and durability at desired level due to a lower degree of hydration, and would suffer from irreparable loss (Zain et al 2000).

There are several methods of curing concrete which include spraying, immersion, steam curing, hot weather curing, cold weather curing etc. A lot of research works were carried out to identify the suitable curing method for concretes and several methods were suggested by various researchers. According to Goel, A. et al (2013) water curing is the most suitable curing method for concretes. Raheem, A. A. et al (2013) were on the view that moist sand curing method is the most suitable curing method for concretes.

For any concrete, curing acts just like feeding to a newborn baby. If a concrete is not fed with water at the early age, it cannot gain the properties and durability for its long service life. A proper curing greatly contributes to reduce the porosity and drying shrinkage of concrete, and thus to achieve higher strength and greater resistance to physical or chemical attacks in aggressive environments. Therefore, this study is aimed at assessing the effects of the various curing methods on the compressive strength of concrete.

II. MATERIALS AND METHODS

2.1 MATERIALS

The materials used in this research were cement, aggregate, water and polythene sheet.

2.1.1 Cement

Dangote Ordinary Portland cement was used as the main binder. Portland cement is the most common type of cement in general usage. It is a basic ingredient of concrete, mortar and plaster. The cement used was assumed to conform with BS12.

2.1.2 Water

Combining water with a cementitious material forms a cement paste by the process of hydration. The cement paste glues the aggregate together, fills voids within it and allows it to flow more freely. Fresh water fit for was used in the research and was obtained from tap in the concrete laboratory of Department of Building, A.T.B.U Bauchi. It was also used for curing purposes.

2.1.3 Aggregation

The aggregates used in this research were obtained from aggregate supplies within Bauchi town. Single sized coarse crushed aggregate of 20mm was used and the fine aggregate used was of 40% passing 600microns sieve.

2.1.4 Polythene Sheet

The polythene sheet used for the curing purposes was obtained from suppliers in market.

2.2 METHODOLOGY

2.2.2 Mix Proportions

A comparison of the mix proportion adopted is shown in the table below, which also shows the ratio of cement to aggregate (coarse and fine) and the ratio of cement of coarse respectively.

Generally a single mix proportion was used in the design of the mix using granite as the coarse and sand as fine in turn to obtain the two mixes. The mix proportion adopted is in the ratio of 1:2:4 and 1:3:6. This proportion was adopted in order to have basis for comparison and to investigate the behaviour of these materials when subjected to same treatment and conditions in their employment in the manufacture of concrete. The mix proportion of design mix by volume is shown in table 1.

Table 1 Mix Proportions of Design Mix by Volume

Mix	**Cement/fine agg./coarse agg.**	**Cement/aggregate ration by vol.**	**W/C Ratio**
M_1	1:2:4	1:6	0.55
M_2	1:3:6	1:9	0.55

Source: Lab. work (2015)

This was done in conformation with CP 110 part 1: 1997 for prescribed mixes of grade 20 concrete. Also the recommended water-cement ratio of 0.55 was used in the design attain the required strength properties and workability.

III. RESULTS AND DISCUSSION

3.1 Specific Gravity

Specific gravity of aggregates refers to as the ratio of weight of the solid compared to that of an equal volume of gas free distilled water taken at a specific temperature. The specific gravity test result is shown in table 2.

Table 2 Specific gravity of aggregates

Aggregates type	**Specific gravity**	**Mean specific**
Crushed granite	2.75	2.73
	2.70	
River sand	2.51	2.54
	2.56	

Source: Lab. work (2015)

3.2 Relative Density

The relative densities obtained are:

- 2.72 for crush aggregate
- 2.69 for fine aggregate

3.3 Bulk Density

The result of the bulk density test carried out on the aggregate is shown in table 3.

Table 3 Densities of aggregate samples

Specimen	Mean sample test value (kg)	Bulk density (KG/M^3)
Crushed aggregate	7.546	1552.70
River sand	8.273	1702.30

Source: Lab. work (2015)

3.4 Workability
The compressive strength test was carried out according to BS 1881: Part 102 (1983) Method for Determination of Slump. The results of the workability test using the slump test method are: mix ratio of 1:2:4 have a slump of 25mm, while mix ratio of 1:3:6 have a slump of 20mm. all the slumps recorded in this test were true slumps and they were the actual slumps observed in the test,
The results show that, though the design workability was in the medium workability range of 10-30mm slump, all the recorded results were in the workability range 0-25mm. this deviation may be attributed to the limitations of the experiments which, were carried out in the laboratory.
3.5 Compressive Strength Test
The compressive strength test was carried out according to BS 1881: Part 116 Method for Determination of Compressive Strength of Concrete Cube. The results are shown in the tale below. The highest mean compressive strength was 44.04N/mm^2 by mix 1:2:4 of immersion curing at 28 days. At the same age, mix 1:2:4 of sharp sand curing recorded the lowest compressive strength of 26.3N/mm^2. The next highest strength following immersion was sprinkling recording 36.33 N/mm^2 and polythene 31N/mm^2 of the same mix.
While for 1:3:6 mix the highest mean compressive strength at 28 days was recorded by immersion with 40.5N/mm^2, followed by sprinkling with 35.1N/mm^2 and polythene next with 20.6N/mm^2 while sharp sand have the lowest with 24.37N/mm^2.
The mean compressive strength results showed that at all ages, curing with water immersion recorded the highest strength than the other curing method. While sharp sand curing method has the lowest mean compressive strength.
The results drawn from the findings: were as tabulated in table 4 and 5 respectively:

Table 4 Average Compressive Strength Result of mix ratio of 1:2:4

Strength (N/mm^2) Curing method	3 days	7 days	21 days	28 days
Water (immersion)	12.60	26.30	35.02	44.04
Sprinkling	10.60	18.63	30.33	36.30
Polythene	9.00	14.40	29.90	31.40
Sharp sand	8.90	10.40	22.00	26.30

Source: Lab. work (2015)

Table 5 Average Compressive Strength Result of mix ratio of 1:3:6

Strength (N/mm^2) Curing method	3 days	7 days	21 days	28 days
Water (immersion)	9.16	21.53	31.14	40.50
Sprinkling	7.93	19.43	26.50	35.10
Polythene	6.50	15.90	20.60	29.30
Sharp sand	4.90	11.27	15.00	24.37

Source: Lab. work (2015)

IV. Conclusion

From the findings of this research, the following conclusion is drawn;That there are different methods of curing concrete that is in use in the industry depending on what occasion serves the user. Method like immersion, sprinkling, polythene membrame and sharp sand curing are mainly used.
It can further be deduced from the study that to determine which method of curing that gives the compressive strength needs in concrete, cubes of concrete should be tested in the laboratory using all available method of curing.
It could be concluded that though production of concrete is mainly handled by the semi slatted labourers especially in Nigeria, and curing which is the final stage of concrete production it should then be given adequate attention for the completion of the full age of concrete, minimum 28 days.
The results of the study from the laboratory analysis of various cubes cast shows that curing by immersion gives the best output in terms of

compressive strength but in practical it could be seen to be expressive on a small scale production, therefore spraying in situ is the nearest available option os wastage of water is minimized.

REFERENCES

[1] British Standard Institution (1983) *Method for Determination of Compressive Strength of Concrete Cube,* BS 1881: Part 116, London, British Standard Institution

[2] British Standard Institution (1983) *Method for Determination of Slump,* BS 1881: Part 102, London, British Standard Institution

[3] Goel, A., Narwal, J., Verma, V., Sharma, D. and Singh, B. (2013). A Comparative Study on the Effect of Curing on the Strength of Concrete. *International Journal of Engineering and Advanced Technology.* Vol. 2

[4] Neville, A. M (2000) *Properties of Concrete* 5th Edition Addison Wesley Longman limited England, 844

[5] Neville, A. M (2002) concrete technology. Pearson Education Limited, England, 438p

[6] Raheem, A. A., Soyingbe, A. A. & Emenike, A. J. (2013). Effect of Curing Methods on Density and Compressive Strength of Concrete. *International Journal of Applied Science and Technology.* Vol. 3, No. 4

[7] Zain M.F.M (2007) Effect of different 5 curing method on the properties of micro silica concrete. Australian Journal of Basic and applied Science, 1(2): 87-95, 2007 ISSN 1991-8178 c 2007, INSI net publication.