Effect Of Curing Age On The Compressive Strength Of Concrete Made From Local Granite Chippings

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***Abstract*—This study was undertaken to investigate and model the effect of curing age (total number of days of curing) on the final compressive strength of concrete. Concrete cubes of size 150mm were prepared and cured for 0, 3, 6, 9, 12, 15, 18, 21, 24, 27, and 30 days. The test was conducted under controlled environmental conditions with the same mix ratio of 1:2:4 (by volume) of cement, fine aggregates, and coarse aggregates. The coarse aggregates were of uniform grade size 20mm. The cubes were later crushed and the graph of concrete strength against curing age plotted. The variation in concrete strength with curing age from the graph showed that there was a steady increase in strength of concrete with number of days of curing. A regression analysis was performed on the results. This showed a linear relationship between concrete strength and curing age validating the observed phenomenon. The result showed that concrete gains approximately 0.385N/mm^2 per each day of curing and that there is need to cure concrete for at least 20 days in order to achieve the target 28 day strength.**

Keywords—curing age, concrete strength, aggregate size

INTRODUCTION

Concrete strength and durability are affected by the properties of materials used, mixing, placing, compaction, curing procedures and many more. Curing is the process used for promoting the hydration of cement and consists of a control of temperature and of the moisture movement from and into the concrete [1,2]. This is done in order to keep the concrete saturated or as nearly saturated as possible until the pore space in the fresh cement paste has been filled to the desired extent by the products of cement hydration [3,4]. Concrete cured continuously in water is observed to be 40% stronger than the one no cured at all [5]. Proper curing of concrete reduces the porosity of concrete [6,7]. During the curing of concrete, compressive strength gain is significant after the first six days [8]. Concrete however continues to harden via cement hydration for over 30years.

A survey in many African countries showed poor curing as a detrimental practice. Good curing practice is not followed because the exercise is left at the discretion of nonprofessionals who are not aware of the significance of good curing or might feel that the effort spent in providing adequate curing conditions and curing age is not worth the increase in concrete quality. In this work the strength gain of concrete on curing is investigated to determine the minimum duration of curing required in obtaining target strength.

METHOD

The materials used in the experiment or research study were Portland cement, fine aggregate, and 20mm coarse aggregate well graded, and water. The fine aggregate also known as sharp sand was got from Ezu river (in Anambra state) and the coarse aggregate used was supplied from Abakaliki (In Ebonyi state) to retailers in Awka. A particle size distribution analysis was carried out on the fine and coarse aggregate to enable an easy classification of the soil. Using a mix of 1:2:4 by volume of cement, sand and coarse aggregate a total of 33 cubes were cast. A water-cement ratio of 0.6 by weight was used. Both the fine and coarse aggregates were thoroughly dry before mixing. The first 3 cubes were not cured at all. Another 3 was cured for 3 days only and then left in the open air. Another 3 cube was cured for 6 day only and then left in the open air. In this manner some cube were cured for 9, 12, 15, 18, 21, 24, 27 and 30 days. A curing tank was fabricated and used for the experiment.
At the end of 30 days the cubes were all crushed and their compressive strength documented.

RESULTS AND DISCUSSION

The particle size distribution analysis carried out on the fine and coarse aggregate shows that they are uniformly graded (see Figure 1 and 2). Table 1 shows the average crushing strength of the cube for different curing ages. From the table a graph of concrete strength at 30 day against curing age (number of days of curing) was plotted and presented in Figure 3. The graph shows that there was a steady increase in the strength of concrete (at 30days) with curing age. A regression analysis showed that the relationship between concrete strength and curing age can be expressed mathematically as

$$f_{cu} = 0.385d + 13.61 \quad (1)$$

where fcu is the concrete strength and d the curing age. The coefficient of determination was 0.98 which shows a good fit.

From the equation above it would be seen that the target strength of 21N/mm^2 will be obtained after 20 days of curing.

$$f_{cu} = 0.385\ x\ 20 + 13.61 = 21.3N/mm^2. \quad (2)$$

CONCLUSION AND RECOMMENDATION

The result of the experiment shows that concrete gains additional strength for every extra day of curing. From equation 1 it is clear that concrete gains about 0.385N/mm^2 for each day of curing. There is therefore need to ensure that concrete cast at construction sites are cured for as long as 28 days. The target strength of concrete of mix 1:2:4 is 20N/mm and this experiment shows that a minimum of 20 days of curing is required to achieve this target strength.

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APPENDIX

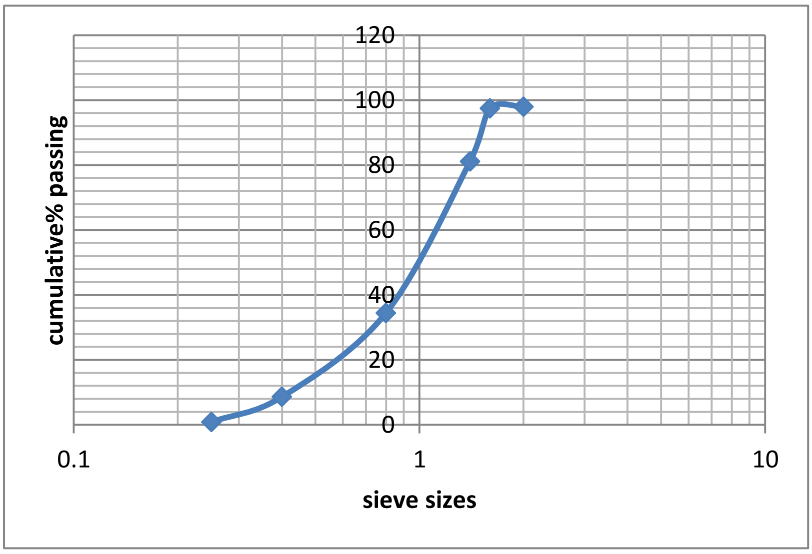

Figure1: Graph of the particle size distribution analysis on the fine aggregate

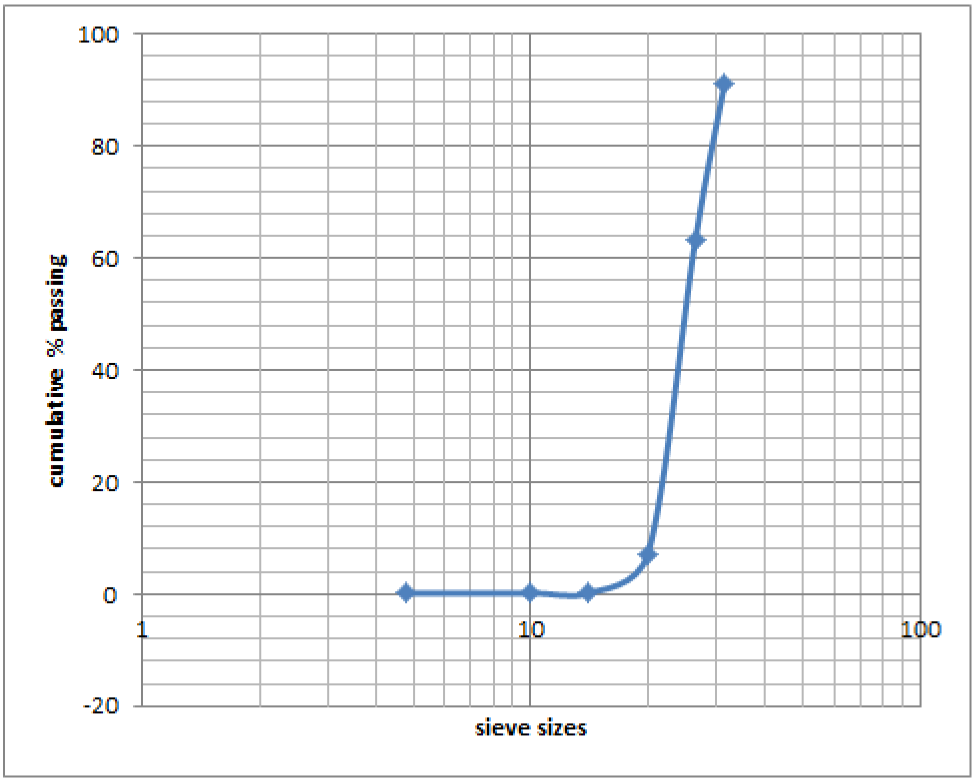

Figure 2: Graph of the particle size distribution analysis on the coarse aggregate

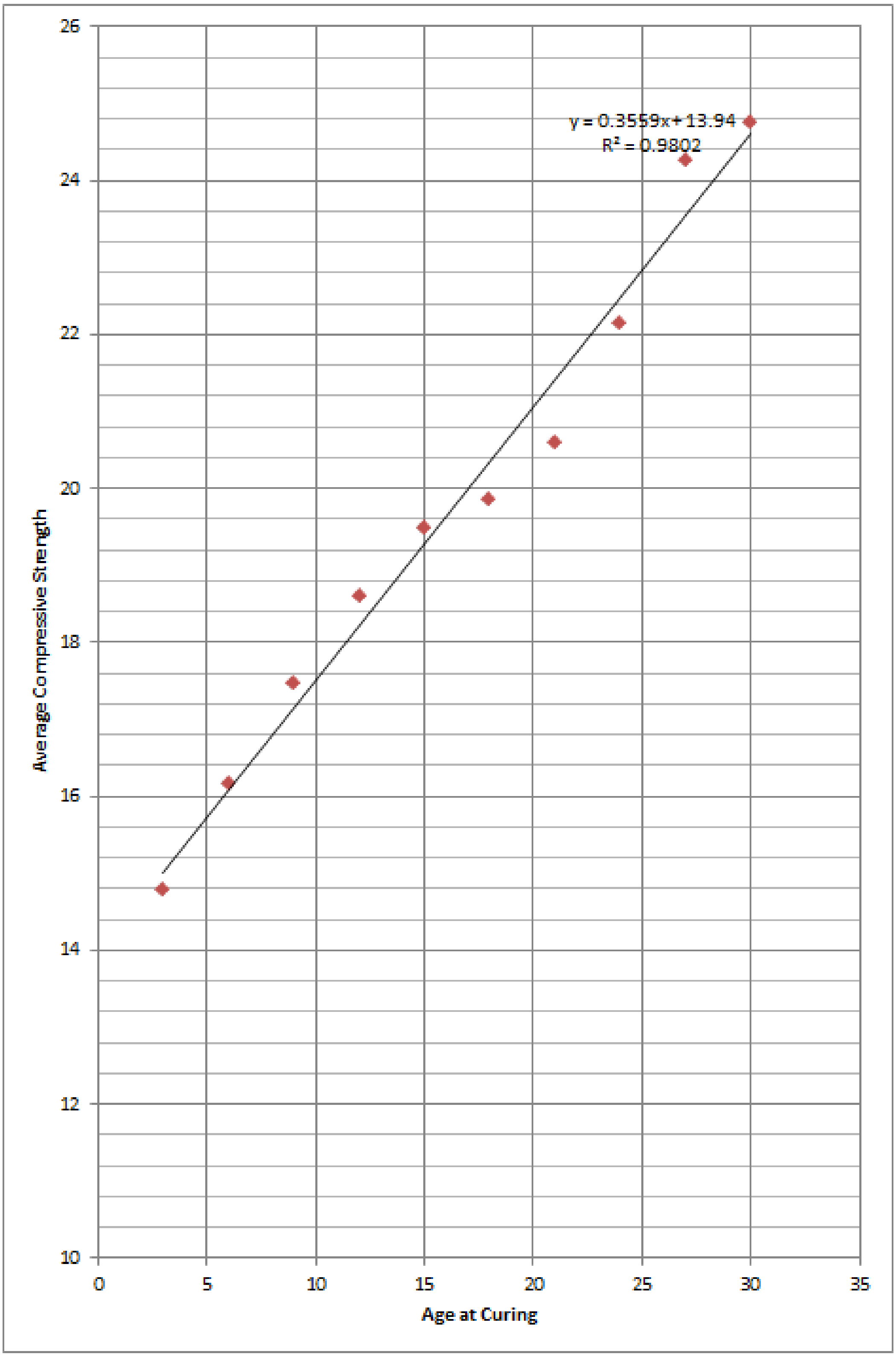

Figure 3: Graph of Compressive Strength against curing age

Table 1: Average crushing strength for different Age at curing

Cube Mark	**Age at curing (day**	**Average crushing strength N/mm^2**
C0	0	11.6
A3	3	14.79
A6	6	16.17
A9	9	17.46
A12	12	18.57
A15	15	19.5
A18	18	19.86
A21	21	20.6
A24	24	22.13
A27	27	24.26
A30	30	24.77