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Effect of Cement-Water Ratio on Compressive Strengthand Density of Concrete

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***Abstract*— Variable compressive strength of concrete mixes with cement-water ratios ranging from 1.3 to 1.8, within 7 to 28 days of curing time, were experimentally investigated in this paper. The experiment was carried out to investigate the effect of cement-water ratios on the compressive strength and density of concrete. Compressive strength of concrete mixes were found to increase with both age and cement-water ratio. Any increase in cement-water ratio leads to increase in compressive strength, however, increase in cement-water ratio leads to decrease in aggregates content followed by decrease in density of concrete mix.**

From the finding of this research, cement-water ratio plays significant rule and consider the most factor used to increase the strength of concrete mix and to decrease the density of concrete mix. By considering cement-water ratio, light, economical and appropriate strength of concrete structures can be achieved.

Keywords — Cement-wate ratio ; compressive strength of concrete; concrete density; aggregates content;

I. INTRODUCTION

Concrete is considered the most used materials in construction work. It has been predicted that concrete will continue to be the most popular industrial material [1]. It is a composite materials resulting from a mixture of cement, water and aggregates, used alone or with steel depending on the design of the structure. It makes any shape when casting in any formwork and form a solid mass when cured by a suitable temperature and humidity.

Compressive strength of concrete is eight times greater than its tensile strength [2]. The tensile strength of concrete is commonly neglected and required addition of steel bars or other materials to use in the design of some structures when tensile strength is taken into consideration. Ordinary concrete should be strong enough to carry its designed loads during all it anticipated life.

Aggregates (fine aggregates, coarse aggregates) are commonly natural crushed or uncrushed materials (artificial materials). Aggregates constitute about one-quarter to two-third of the total volume of concrete. Using aggregates in concrete greatly affect all the properties of either plastic or hardened concrete. Selection of suitable aggregates improves the volume stability and the durability of hardened concrete [3].

The compressive strength of concrete is determined by performing compression test on standard sizes of concrete either cubes or cylinders. The proportions of concrete affect partly the strength of concrete, however, water-cement ratio consider the most important factor affecting the strength of concrete [3]. There is an optimum amount of water in which maximum strength from a particular mix of proportion of concrete can be achieved [4]. It has observed that compressive strength decreased as water-cement ratio decreased [5].

However, the present work aims at experimentally comparing the compressive strength, aggregates, and density of concrete mixes under varied cement-water ratio.

II. METHODOLOGY

A. Work Materials and Specimens Preparation

The materials used in this investigation are cement, gavel and water. All-in aggregates size distributions, mixed sand and gravel, were determined by sieve analysis from which grading limit was achieved. The grading limits of all-in aggregates confirm a suitable grading distribution which leads to suitable workability and durability.

B. Experimental Test Procedures

Mix proportions of 1:1.5:3 was determined by using cement, fine aggregates and coarse aggregates respectively. A 4 kg of cement was added to 6 kg and 12 kg of fine and coarse aggregates. Water was added to cement by weight to form cement-water ratios of 1.3, 1.4, 1.5, 1.6, 1.7 and 1.8. The whole was mixed into paste. Meanwhile, the cubic moulds of concrete were oiled to ease the de-molding process late.

The concrete was then poured into cubes according to its cement-water ratio and placed for 2 minutes on vibration machine to remove the tapped air from the concrete. The cubes were then covered with polythene to prevent evaporation process.

After 24 hours of sitting time, the cubes were de-molded and placed in curing water tank for 7, 14, 28 days respectively. At each specified period of days, the cubes were crushed using crushing machine to determine the compressive strength of concretes.

III. RESULTS AND DISCUSSION

Table I shows the variation of the strength of concrete mixes with cement-water ratios. It was observed that the higher cement-water the higher the strength of concrete. However, the higher cement-water ratio leads to the less density and weight of concrete. In addition, the compressive strength was observed to increase with age of curing days. As a result, the cement-water ratio is considered the main factor of determination the compressive and weight of concrete.

The plot of compressive strength of concrete mixes with variations of cement-water ratio is shown in Figure (1). Figure (2) shows the plot of compressive strength with variations of ages. It was observed that the optimum compressive strength at 28 days after casting. Figure (3) and Figure (4) show the plots of density and aggregates of concrete versus cement-water ratios.

TABLE I. VARIATIONS OF WEIGHT, DENSITY, AND COMPRESSIVE STRENGTH OF CONCRETRE MIXES WITH CEMENT-WATER RATIO

S/N	Cement-Water Ratio	Age (days)	weight of cube (g)	Density of cube (g/cm^3)	Crushing load (kg)	Compressive Strength (kg/cm^2)
a	1.3	7	8232	2.439	20250	90
b	1.4	7	8215	2.434	23400	104
c	1.5	7	8184	2.425	24570	110
d	1.6	7	8168	2.42	27000	120
e	1.7	7	8151	2.415	29025	129
f	1.8	7	8130	2.409	30375	135
g	1.3	14	8434	2.499	31500	140
h	1.4	14	8427	2.497	32400	144
i	1.5	14	8394	2.487	33750	150
j	1.6	14	8387	2.485	35325	157
k	1.7	14	8387	2.485	36450	162
l	1.8	14	8360	2.477	37800	168
m	1.3	28	8529	2.527	39600	176
n	1.4	28	8512	2.522	41625	185
o	1.5	28	8492	2.516	42750	190
p	1.6	28	8478	2.512	44550	198
q	1.7	28	8461	2.507	48600	216
r	1.8	28	8441	2.501	52650	234

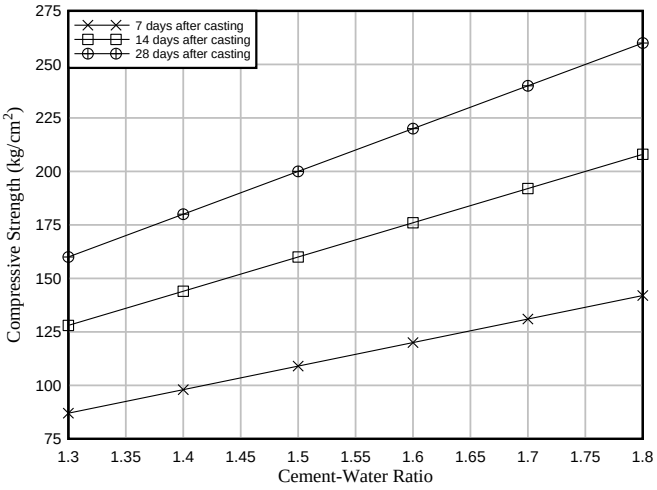

Fig. 1. *Plot of Compressive Strength of Concrete vs. Cemen-Water Ratio*

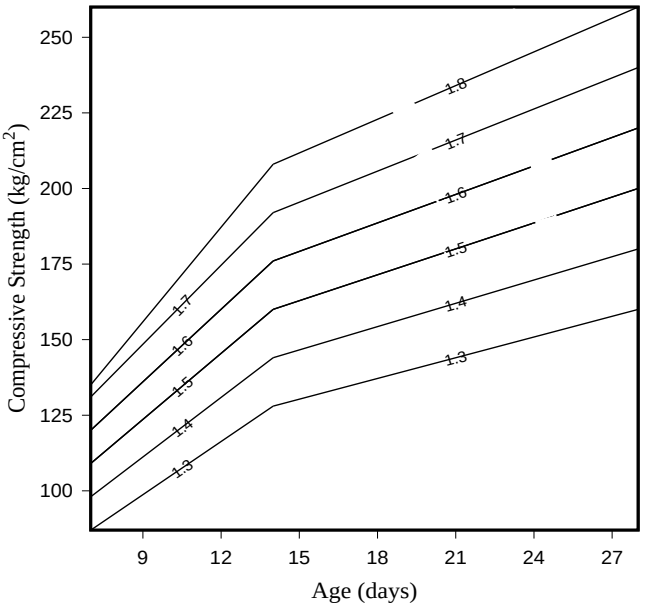

Fig. 2. *Plot of Compressive Strength of Concrete vs. Age*

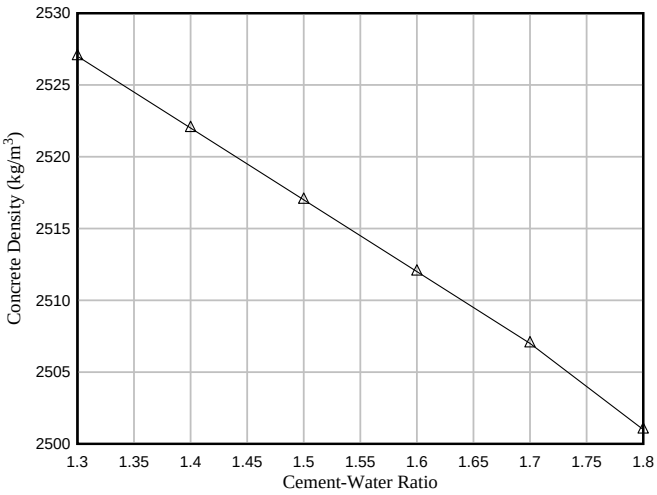

Fig. 3. *Effect of Cement-Water Ratio on Density of Concrete*

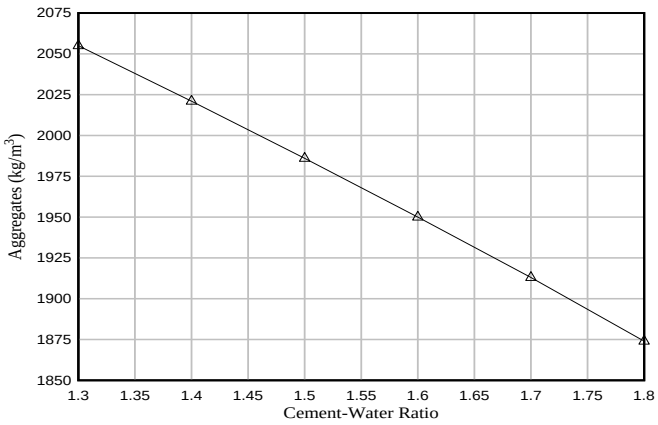

Fig. 4. *Effect of Cement-Water Ratio on Aggregates of Concrete*

IV. RECOMMENDATION

The use of suitable cement-water ratio in concrete mix can determine the expected weight and strength of concrete mix. By this concept, more economical concrete mix is related to cement-water ratio.

REFERENCES

[1] R.J .Detwiler, B.J. Dalgheish, R.B. Williamson (1989),"Assessing the durability of concrete in freezing and thawing," . ACI Mater, J. 1989, 42, 29-35.

[2] W.H. Mosley, J.H. Bungey (2000), Reinforced Concrete Design, 5rd ed., Macmillan Publisher Limited, London, UK, 2000.

[3] L.K.A Sear, J. Dews, B. Kite, F.C. Harris, J. F. Troy (1996),"Abrams rule, air and high water-to-cement ratios," Construction and Building Materials, Vol. 10, No 3, 1996, PP 221-226.

[4] O. Lafe (1986), Elements of Reinforced Concrete Design, Macmillan Publisher , London, UK

[5] P.G. Omotola, O.I. Idowu (2011),"Effect of water-cement Ratios on the Compressive Strength and Workability of Concrete and Lateritic Concrete Mixes", The Pacific Journal of Science and Technology, Vol 12, No 2, November 2011, pp 99-105.M.