EFFECT OF WATER-CEMENT RATIO ON DENSITY OF CONCRETE

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Abstract— Variable density of concrete mix of grade M20 with cement-water ratios ranging from 0.66to 0.54, within 7 to 28days of curing time, were experimentally investigated in this paper. The experiment was carried out to investigate the effect of water-cement ratio on the density of concrete. Density of concrete mixes was found to decrease with decrease in water-cement ratio. Any decrease in water-cement ratio leads to decrease in density of concrete mix. It indicates that any decrease in water-cement ratio leads to decrease in aggregate content which is followed by a decrease in density of concrete mix.
From the finding of this research paper, it is found that water-cement ratio plays a pivotal role in the mix design and governs both physical and mechanical properties of the concrete. Thus by considering a suitable water-cement ratio, light, economical and appropriate density and weight of concrete structures can be achieved.

Keywords — water-cement ratio, density of concrete, M20 grade concrete, mix design, physical and mechanical properties.

I. INTRODUCTION

Concrete is the widely used material in construction industry. It is a composite material resulting from a mixture of cement, water and aggregates, used alone or with steel reinforcement depending on the design of the structure. It can take any shape when casted depending upon the geometry of formwork and forms a solid mass when cured at a suitable temperature and humidity.

Compressive strength of concrete is ten times greater than its tensile strength .The tensile strength of concrete is not taken into account in the design of the structure and thus an equivalent steel reinforcement which is needed to take care of the tensile loads is embedded in the concrete structure with proper spacing and diameter and as per IS specifications.

Aggregates (fine aggregates, coarse aggregates) are commonly natural crushed or uncrushed 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, workability, density and the durability of hardened concrete.

The proportions of concrete partly influence the density of concrete, however, water-cement ratio is considered as the vital factor affecting the density of concrete .There is an optimum amount of water-cement ratio at which maximum density from a particular mix of concrete can be achieved .It has been observed that the density of concrete mix increases as water-cement ratio increases.

However, the present work aims at experimentally comparing the density of concrete mixes under varying water-cement 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 5 kg of cement was added to 7.5 kg and 15 kg of fine and coarse aggregates. Water was added to cement by weight to form water-cement ratios of 0.66, 0.62, 0.58 and 0.54. The whole mix was formed into a paste. Meanwhile, the cubic moulds of concrete were oiled to ease the de-molding process later on.The concrete was then poured into cubes according to its water-cement ratio and placed for 2 minutes on vibratory machine to remove the tapped air from the concrete. The cubes were then covered with polythene to prevent loss of water due to evaporisation.

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 weighed using the weighing machine to determine the density of each cube casted.

III. RESULTS AND DISCUSSION

Table I shows the variation of the density of concrete mixes with varying water-cement ratios. It was observed that the higher water –cement ratio of the mix the higher the density of concrete. As a result, the water-cement ratio is considered as the important factor to have a direct impact on weight and density of a concrete mix.

The plot of density of concrete mixes with varying water-cement ratio for 7 days, 14 days and 28 days is shown in Figure (1), Figure (2) and figure (3) respectively.

It was also observed that the maximum density was achieved at 28 days after casting.

Table 1

W/C RATIO	AGE (DAYS)	WEIGHT OF CUBE (g)	DENSITYOFCUBE (Kg/m³)
0.66	7	8172	2421
0.62	7	8156	2416
0.58	7	8132	2409
0.54	7	8116	2404
0.66	14	8364	2478
0.62	14	8352	2474
0.58	14	8352	2474
0.54	14	8334	2469
0.66	28	8480	2512
0.62	28	8462	2507
0.58	28	8448	2503
0.54	28	8432	2498

Figure 1

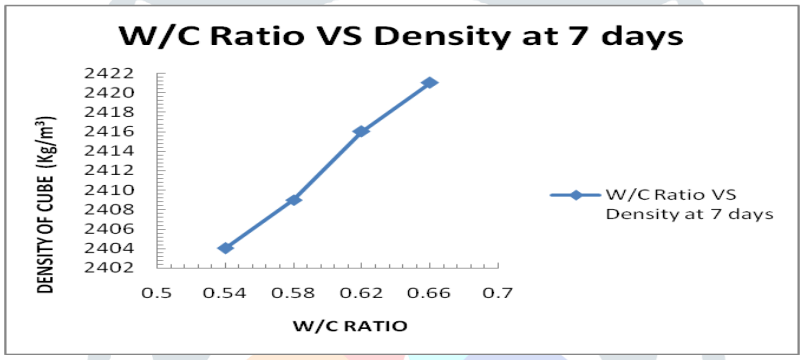


Figure 2

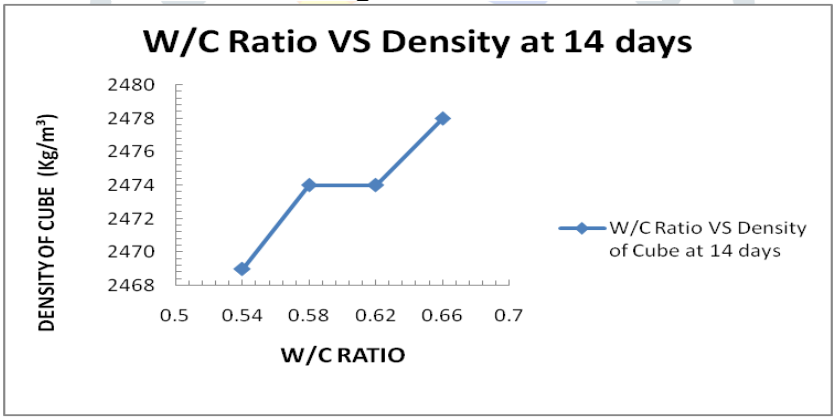
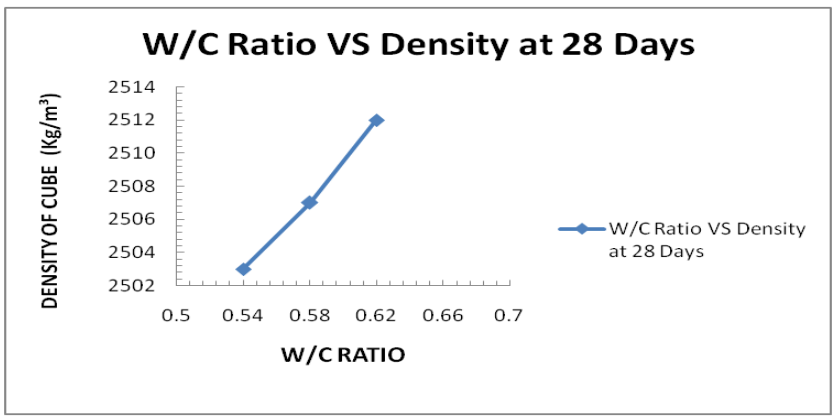


Figure 3



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