

EFFECT OF WATER-CEMENT RATIO ON COMPRESSIVE STRENGTH OF CONCRETE

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Abstract— Variable compressive strength of concrete mixes (M20) with water-cement ratios ranging from 0.66 to 0.54, within 7 to 28 days of curing time, were experimentally evaluated in this paper. The experiment was carried out to investigate the effect of water-cement ratios on the compressive strength of concrete. Compressive strength of concrete mixes was found to increase with decrease in water-cement ratio. Any decrease in water-cement ratio leads to increase in compressive strength.

This research illustrates that; cement-water ratio plays a significant role in determining the compressive strength of a concrete mix and is also an important factor for preparing design mixes. By considering a suitable water-cement ratio, effective, economical and appropriate strength of concrete structures can be achieved.

Keywords — water- cement ratio, compressive strength of concrete, design mix, M20 .

I. INTRODUCTION

Concrete is considered as the backbone of any construction work both economically and mechanically. It is a composite material resulting from a mixture of cement, water and aggregates (both fine & coarse), used alone or with steel depending on the design of the structure. It makes any shape when casted in any formwork and form a solid mass when cured at a suitable temperature and humidity.

Compressive strength of concrete is eight to ten times greater than its tensile strength. The tensile strength of concrete is usually neglected in the design and required addition of steel bars is made to account for the tensile strength of concrete commonly called as RCC structure. Ordinary concrete should be strong enough to carry its designed loads during its 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.

The compressive strength of concrete is determined by performing compression test on standard sizes (150mm×150mm×150mm) of concrete cubes. The proportions of concrete affect partly the strength of concrete, however, water-cement ratio is considered the most important factor affecting the strength of concrete. There is an optimum amount of water at which maximum strength from a particular mix of proportion of concrete can be achieved. It has been observed that compressive strength of concrete decreases as water-cement ratio increases.

However, the present work aims at experimentally comparing the compressive strength, of concrete mix (M20) under varied water-cement ratio at 7 days, 14 days and 28 days is evaluated.

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 respectively. 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 converted to paste. Meanwhile, the cubic moulds of concrete were oiled to ease the de-molding process later. The concrete was then poured into cubes according to its water-cement ratio and placed for 2 minutes on vibration machine to remove the trapped 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 universal testing machine to determine the compressive strength of concrete cubes.

III. RESULTS AND DISCUSSION

Table I shows the variation of the strength of concrete mix with varying water-cement ratios. It was observed that the lower the water-cement ratio higher is the compressive strength of concrete. It was also noted that, the compressive strength was observed to increase with age of curing days. As a result, the water-cement ratio is considered the main factor for determination of the compressive strength and weight of concrete.

The plot of compressive strength of concrete mixes with variations of water-cement ratio at 7 days, 14 days and 28 days is shown in Figure (1), Figure (2), and Figure (3) respectively.

It was observed that the optimum compressive strength is achieved at 28 days after casting.

TABLE 1

W/C RATIO	AGE (DAYS)	WEIGHT OF CUBE (g)	CRUSHING LOAD (Kg)	COMPRESSIVE STRENGTH (Kg/m ³)
0.66	7	8172	24520	109
0.62	7	8156	26090	116
0.58	7	8132	29000	129
0.54	7	8116	30500	136
0.66	14	8364	33500	149
0.62	14	8352	35400	157
0.58	14	8352	36550	162
0.54	14	8334	38000	169
0.66	28	8480	42800	190
0.62	28	8462	44900	200
0.58	28	8448	48750	217
0.54	28	8432	52830	235

Figure 1

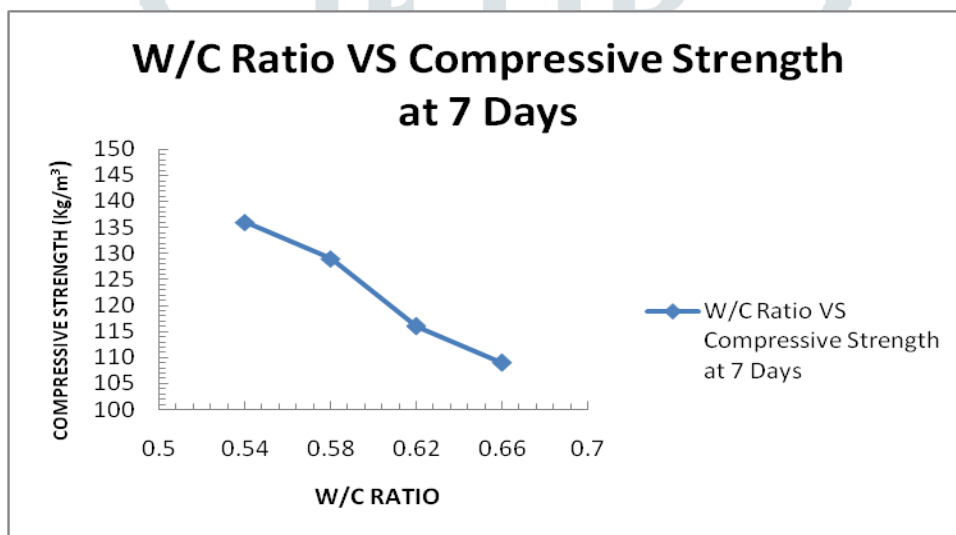


Figure 2

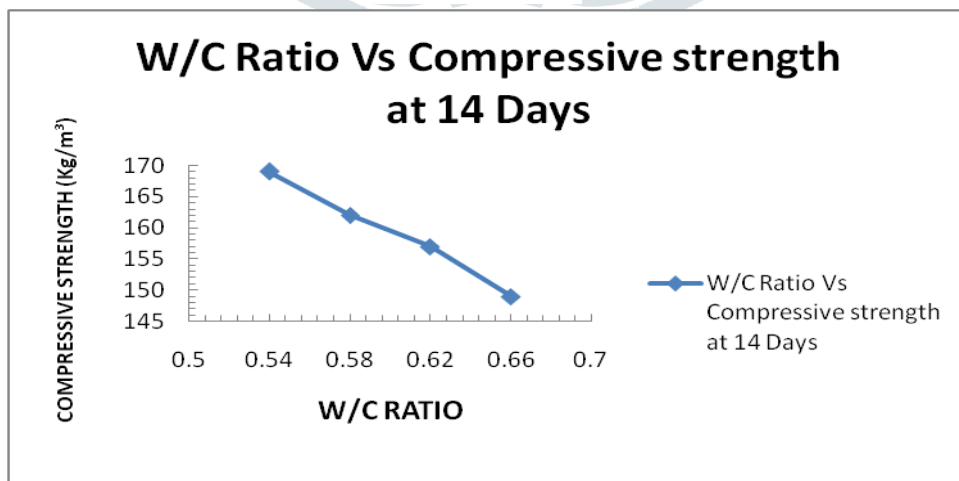
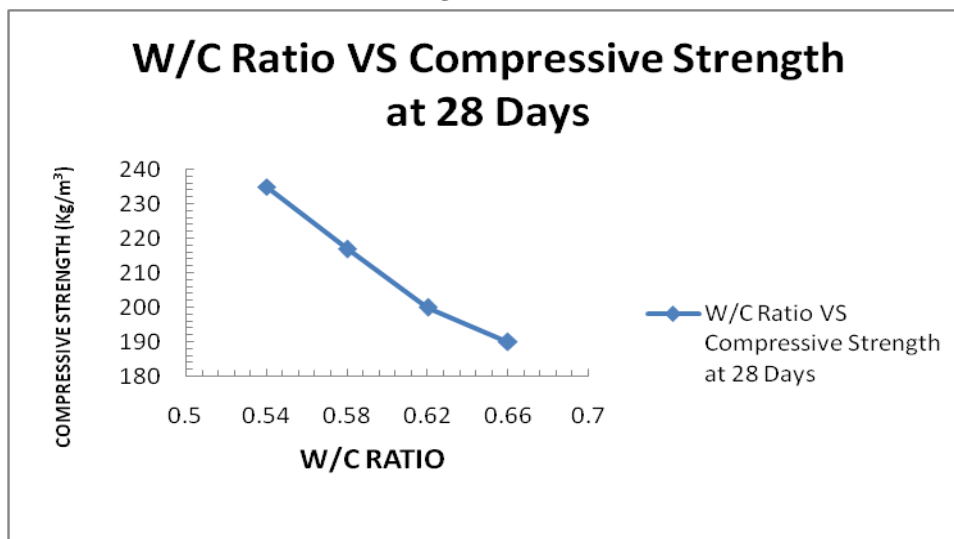


Figure 3

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