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Effect of Mix Parameter, Aggregate Size, And Curing Age On Property of Concrete

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1. Abstract

Concrete is a composite material and it is mostly widely used in construction purpose, because it is very cheap than other materials. Curing is one of the important Factors for concrete to obtain desired strength and other important factoris water cement (w/c) ratio. In this work, the experimental investigation are presented on the concrete specimens made with different sizeand Maximum size aggregate (MSA) of aggregates and have been subjected to different types of curing ages. The concrete specimens have been prepared by using different types of cements at different water-cement (w/c) ratios. The different types of cement have been used are Ordinary Portland Cement (OPC) and Portland Pozzolana cement (PPC). The w/c ratios used in this experimentis 0.45 and 0.5, and normal type of curing is adopted in this experiment. The different types of MSA aggregate used in experiment is 10mm MSA and 20mm MSA. The curing ages adopted was 28days curing and 90days curing, under normal water Curing Condition. The slump test and compression test have been conducted on the test specimens prepared from different concrete mixes at the age of 28days and 90days. Finally on the basis of the results obtained relevant conclusions have been drawn.

Keywords: Curing age, Slump test, Compressive strength.

2. Introduction

Concrete is used worldwide as construction material. It is used to make residential buildings, commercial building, bridges etc. When a concrete is prepared it is in plastic state and can be easily moulded in various shapes. Concrete is prepared by mixing binder, coarse aggregate, fine aggregate and water in proper amount. Certain admixtures are also added. Concrete should have good workability so that it can be easily transported from one place to another place on site.

The aggregate is mainly coarse aggregate such as granite or limestone of size 4.75mm and more, along with fine aggregate like sand. For binding purpose cement like Portland cement, and various cementiousMaterial like flyash and slag cement is used. In concrete, cement paste is formed by mixing of water and cementious materials, which is used to fill the voids

of fine aggregates by coating the external surface of fine aggregate and coarse aggregate, and hardening of concrete is due to chemical reaction between cementious materials and water, and ultimetly concrete grow strength with age.

Concrete have high compressive strength and low tensile strength, so reinforcement is done to provide high tensile strength, it is widely used in making pavement, bridge, dam, brick wall, e.t.c. generally OPC and PPC is used in making concrete, Ordinary Portland Cement (OPC) is very largely produced and most commonly available around us. It is main ingredient of motar, concrete, grout. It consist of 90% Portland cement clinker, and small amount of calcium sulphate.Portland cement clinker is prepared by heating raw material up to very high temperature of 1450 °C. Iron oxide and aluminum oxide are used as flux and participate very little to strength.Portland Pozzolana Cement is generally called new generation cement, it increase performance of concrete because it contain high reactive silica. PPC contain burned OPC clinker having 16-36 % pozzolana and small percentage of gypsum.

Generally 0.4 to 0.6 water-cement ratios is kept in concrete and this ratio gives required strength. Excess amount water causesbleeding of concrete, and deficiency of water cause improper hydration reactions of concrete.

Aggregates are sand, gravel blast sand, stone, broken stone etc. They are major constituents of concrete .It minimum size shrinkage and provide body to concrete, 65-70 % volume of concrete mainly aggregate natural aggregate are obtain from sedimentary metamorphic and igneous rock size of aggregate also play vital role in providing strength to concrete in providing strength to concrete. Aggregate is mainly of two types,Coarse aggregate and Fine aggregate.

Admixtures are the Material that is added in concrete before or during mixing. It enhanced quality strength and durability of concrete. Chemical admixture like Plasticizer and super plasticizer are used largely to provide good strength to concrete they are called water reducer. Admixture's also alter initial and final setting of concrete and also remove minor hair crack developed on concrete.

Workability is that property of concrete which influence durability and strength of concrete. It also affect appearance of final product. When concrete is very transported, placed and compacted without segregation and bleeding, it is said to be workable.

One of the most important Properties of hardened concrete is compressive strength. It bears inverse relation with water/cement ratio. As w/c ratios increase Compressive strength

decreases and as w/c ratios decrease Compressive strength increases. Compressive strength depends upon many factors like age of concrete, temperature, admixture, size of concrete, cement type, w/c ratio and air entrainment. Compressive strength of concrete is defined as maximum load applied on 150mm concrete cube specimen in laboratory before it crush under certain condition, it is measured in N/mm^2

3. Research methodology

In experimental task for preparation of concrete specimen by using different type of binder, w/c ratio, different aggregate size and varying curing ages, The test carried out are presented below.

3.1 Materials

Cement, coarse and fine aggregate are used for preparing concrete specimens.

Portland pozzolanic cement (PPC) and ordinary Portland cement (OPC) are used for this experiment.OPC with respect to IS: 8112-1989.PPC with respect to IS: 1489-1991.Coarse aggregate of size 10mm MSA and 20mm MSA (Maximum Size of Aggregate) are used for preparing concrete specimens.Sieve analysis of 10mm MSA coarse aggregate and 20mm MSA coarse aggregate are done. The results obtained by sieve analysis are presented below in Table 3.1 and table 3.2

TABLE 3.1 Sieve analysis of 10mm (MSA) coarse aggregate

Sieve size	Weight retained (gm.)	Percentage weight retained (%)	Cumulative percentage retained (%)	Cumulative Percentage passing (%)
12.5 mm	7	0.116	0.116	99.884
10mm	415	6.917	7.003	92.967
6.3mm	2495	41.617	48.65	51.35
4.75mm	1584	26.4	75.05	24.95
2.36mm	943	15.717	90.767	9.233
Pan	554	9.233	100	0

TABLE 3.2 Sieve analysis of 20mm (MSA) coarse aggregate

Sieve size	Weight retained (gm.)	Percentage weight retained (%)	Cumulative percentage retained (%)	Cumulative Percentage passing (%)
25 mm	2005	8.02	8.02	91.98
20 mm	6834	27.336	35.356	64.644
16 mm	6396	25.584	60.94	39.07
12.5 mm	6255	25.02	85.96	14.04
10 mm	973	3.892	89.852	10.148
4.75mm	2241	8.964	98.816	1.184
Pan	296	1.184	100	0

Sieve Analysis Of Sand

As per IS: 2386-1963 (PART I) [12] sieve analysis of is done. Total weight of sand was 500gm Result is given in table 3.3. As per IS: 383-1970 [13] percentage passing value is seen, sand is of zone 2. **Table 3.3** Sieve analysis of sand

S.NO	SIEVE SIZES	WEIGHT RETAINED IN(gm)	PERCENTAGE MASS RETAINED IN(gm)	CUMULATIVE PERCENTAGE RETAINED	PERCENTAGE FINER
01	**4.75 mm**	10	2	2	98
02	**2 mm**	12	2.4	4.4	95.6
03	**1.18 mm**	26	5.2	9.6	90.4
04	**1 mm**	15	3	12.6	87.4
05	**600 micron**	179	35.8	48.4	51.6
06	**300 micron**	123	24.6	73	27
07	**150 micron**	83	16.6	89.6	10.4
08	**75 micron**	44	8.8	98.8	1.6
09	**PAN**	8	1.6	100	0

Mix Proportion

DOE (British Method) with a little modification was used for mix proportion of concrete constituents. Portland Pozzolana Cement and Ordinary Portland Cement was used for this experiment, with w/c ratio 0.45 and 0.5 were used for studyConcrete specimen made by the combination of 10mm MSA aggregate and 20mm MSA aggregate in the following proportion. 10mm MSA aggregate = 33%of total coarse aggregate content by mass. 20mm MSA aggregate = 67% of total coarse aggregate content by mass.Concrete mix obtain by different W/B ratio is given in table 3.4

Table 3.4 Concrete mix quantities

w/c ratio	**Water content (Kg/m3)**	**Cement content (Kg/m3)**	**Fine aggregate (Sand) (Kg/m3)**	**Coarse aggregate (For concrete made with 20mm MSA)**		**Coarse aggregate (For concrete made with 10mm MSA)**
				10 mm MSA (Kg/m3)	**20mm MSA (Kg/m3)**	**10 mm MSA (Kg/m3)**
0.45	205	455.6	614.015	345	700.417	1045.417
0.5	205	410	630.85	354.79	720.35	1075.14

150mm×150mm×150mm sized concrete cube specimen was prepared by using different concrete mixes, 2 types of cement binder was used OPC and PPC, 2types of W/c ratios 0.45 and 0.5, and 2 types maximum coarse aggregate size as 10mm MSA and 20mm MSA.2 curing age 28 days and 90 days,and total number of concrete cube specimen prepared was 48. After 24 hours of preparation, cube was demoulded.After demoulding, only one type of curing was done on cube specimen that is normal water curing throughout complete duration. The varying curing age was 28days, and 90days. Detail of curing is described below in table 3.5

TABLE 3.5 Preparation of cube specimen

Water cement ratio	CEMENT CONTENT							
	OPC				PPC			
	28days curing		90days curing		28days curing		90days curing	
	10mm MSA	20mm MSA	10 mm MSA	20mm MSA	10mm MSA	20mm MSA	10 mm MSA	20mm MSA
0.45	3	3	3	3	3	3	3	3
0.5	3	3	3	3	3	3	3	3

4. Result and Discussion

In this investigation, mix parameter effect, curing age, aggregate size and coarse aggregate condition of fresh and hardened concrete is studied, as previously mentioned three cube specimen for each concrete mix was prepared. In this test compressive strength test are presented.

Compressive Strength-Compressive strength obtained for both OPC and PPC cement, different w/b ratio, different curing age is shown in table 4.1 and 4.2 at the age of 28 days and 90 days.

TABLE4.1:- Compressive Strength in 28 Days (in MPa)

Water/binder	20 mm MSA		10mm MSA	
	OPC	**PPC**	**OPC**	**PPC**
0.45	32.44	28.36	39.7	33.04
0.5	31.56	30.37	37.04	29.78

TABLE4.2:-Compressive Strength In 90 Days(InMpa)

Water/binder	20 mm MSA		10mm MSA	
	OPC	**PPC**	**OPC**	**PPC**
0.45	38.96	38.96	46.51	48
0.5	37.93	33.63	39.26	36.89

From these experiment, it is observed that cube specimen of OPC 20mm MSA and 10mm MSA maximum compressive strength is found in cube of OPC 10mm MSA at curing age of 90 days, at water/cement ratio 0.45. Minimum compressive strength was observed in OPC of size 20mm MSA at curing age of 28days, at water/cement ratio 0.5.Cube specimen of OPC 20mm MSA and PPC 10mm MSA maximum compressive strength is found in cube of PPC 10mm MSA at curing age of 90 days, at water/cement ratio 0.45. Minimum compressive strength was observed in PPC of size 20mm MSA at curing age of 28days, at water/cement ratio 0.5. Cube specimen of PPC 20mm MSA and PPC 10mm MSA maximum compressive strength is found in cube of PPC 10mm MSA at curing age of 90 days, at water/cement ratio

0.45. Minimum compressive strength was observed in PPC of size 20mm MSA at curing age of 28days, at water/cement ratio 0.5.Cube specimen of PPC 20mm MSA and OPC 10mm MSA, maximum compressive strength is found in cube of OPC 10mm MSA at curing age of 90 days, at water/cement ratio 0.45. Minimum compressive strength was observed in PPC of size 20mm MSA at curing age of 28days, at water/cement ratio 0.5. Cube specimen of OPC 20mm MSA 10mm MSA, and PPC 20 mm MSA and 10 mm MSA, maximum compressive strength is found in cube of PPC 10mm MSA at curing age of 90 days, at water/cement ratio 0.45. Minimum compressive strength was observed in PPC of size 20mm MSA at curing age of 28days, at water/cement ratio 0.45.

The higher compressive strength in specimen made with PPC concrete specimen than that in OPC concrete specimen at different curing ages is due to the formation of more C-S-H gel in PPC concrete specimen. Show higher compressive strength further it is seen that compressive strength mostly decreases with increase in w/c ratio at curing ages. Slump value of OPC 20mm MSA and PPC 20mm MSA, it is observed that slump value is high in OPC 20mm MSA at w/c ratio of 0.5. And minimum slump value is observed in PPC 20mm MSA at w/c ratio of 0.45. Slump value of OPC 10mm MSA and PPC 10mm MSA, it is observed that slump value is high in PPC 10mm MSA at w/c ratio of 0.5. And minimum slump value is observed in OPC 10mm MSA at w/c ratio of 0.45. It is observed that overall highest slump value is observed in PPC 10mm MSA at w/c of 0.5

Conclusion

In this work experimental test was done on concrete specimen of size 150mm×150mm×150mm prepared from 20mm MSA and 10mm MSA aggregate, w/c ratio of 0.45 and 0.5, in normal moist curing condition throughout complete duration for 28days and 90 days. Compressive strength test was conducted at 28 days and 90 days.

Following conclusion was drawn from the result obtained from compressive strength.

- OPC provide almost high compressive strength than PPC in 20mm MSA
- In 90 days Compressive strength is higher than 28days , maximum Compressive strength is found in both OPC and PPC in 20mm MSA
- OPC provide almost high Compressive strength than PPC in 10mm MSA
- In 90days Compressive strength is higher than 28days for both OPC and PPC at 10mm MSA aggregate

- Concrete Specimen made by 10mm MSA aggregate with OPC Provide high Compressive strength than OPC concrete specimen of 20mm MSA.
- Concrete Specimen made by 10mm MSA aggregate with PPC Provide almost high Compressive strength than PPC concrete specimen of 20mm MSA.
- 10mm MSA concrete Specimen of PPC have high Compressive strength than 20mm MSA concrete specimen of PPC at w/c 0.45.
- 20mm MSA concrete Specimen of OPC have high Compressive strength than 10mm MSA concrete specimen of PPC at w/c 0.5.
- 10mm MSA concrete Specimen of OPC have high Compressive strength than 20mm MSA concrete specimen of PPC.

High Compressive strength is obtained in w/c 0.45 than of w/c 05.

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