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Experimental Study on Sustainability on Concrete by Retarding ASR by using Suitable Alkali & Glass Powder

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Abstract— Concrete is the most used building material in the world, as well as the largest user of natural resources with annual consumption of 12.6 billion tons. It fundamentally comprises of coarse and fine aggregates, cement and water, and in some cases also contains additional chemical or mineral admixtures for specific purposes. India uses about 7.3 million cubic meters of ready-mixed concrete each year. Durability aspect of the concrete can be improved by using glass powder along with suitable alkali like lime. The quantity of glass powder is varied in different proportions to arrive at the optimum percentage of glass powder required to produce a concrete of considerable strength based on its grade after 28 days of curing. M25 grade of concrete was considered for the experimental study with specimens prepared along with glass powder and also with glass powder and lime. The control of cracks by using lime along with glass powder is the special focus of this experimental study. The study is to understand the variation of cracks in concrete by the help of controlling ASR with use of suitable alkali lime along with glass powder.

Keywords— **Glass powder, Alkali Silica Reaction, Compressive strength, Durability of concrete**

I . INTRODUCTION

Concrete is the most used building material in the world. Many research works have been initiated and developed to make concrete more sustainable, mainly in reducing its negative impacts on environment and reserve natural raw materials. The present study is on" Sustainability of concrete by retarding alkali silica reaction by using glass powder and suitable alkali". Glass is an amorphous material with high silica content making it potentially pozzolanic when particle size is less than 75µm (Federio.L.M and Chidiac S.E,2001, Jin.W, Meyer.C, and Baxter.S,2000). . The main problem in using crushed glass as powder in Portland cement concrete due to alkali silica reaction wherein expansion and cracking is caused by the glass powder. The retardation of alkali silica reaction is done by using lime.

The interest of the construction community in using waste or recycled materials in concrete is increasing. The waste glass from in and around the small shops is packed as a waste and disposed as landfill. Glass is an inert material which could be recycled and used many times without changing its chemical property(Aimin Xu and Ahmad shayam,2004).Besides using waste glass as cullet in glass manufacturing ,waste glass is crushed into specified sizes for use as aggregate in various applications such as water filtration, grit plastering, sand cover for sport turf and sand

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replacement in concrete (Carpenter,A.J. and Cramer,C.M,1999). Since the demand in the concrete manufacturing is increasing day by day, the utilization of river sand as fine aggregate leads to exploitation of natural resources, lowering of water table, sinking of the bridge piers, etc as a common treat. Attempts has been made in using crushed glass as fine aggregate in the replacement of river sand (Chi sing lam, chi sun poon and Dixon chan,2007).

As a precautionary measure to retard the ASR generated by use of powered glass we have to look into measures to control ASR. The ASR involves the reaction between the reactive silica and the alkali silica from the cement. Several stratergies have been proposed to inhibit the ASR by reducing the alkalis from the cement.In the present lime has been proposed to retard alkali silica reaction.

The study is to understand the variation of cracks in concrete by the help of controlling ASR with use of suitable alkali lime along with glass powder.

A. Materials

The cement is replaced by varying proportions of glass powder starting from 60:40, 70:30 and 80:20 (cement: glass). The remaining coarse aggregate and fine aggregate are the conventional sand and 20mm down size aggregates mixed for a proportion of 1:1:2. Lime powder was mixed at the rate of 5% of weight of cement for all the specimens. Mix design was prepared incorporating the above proportions.

B. Properties of materials

The following material properties are as follows

a. Specific gravity of cement = 3.32
b. Specific gravity of fine aggregate = 2.6
c. Specific gravity of coarse aggregate = 2.6
d. Water absorption of fine aggregates= 1 %.
e. Water absorption of coarse aggregates= 0.5 %.

Sieve analysis of fine aggregate shows that the sand used for the preparation of concrete moulds falls in zone-I and zone-II respectively as per IS: 383 –1997.Sieve analysis of coarse aggregate shows that the coarse aggregate of 20mm size is are according to the recommended condition used for concrete as per IS: 383 – 1997.

Locally available sand confirming to zone II with specific gravity 2.62 as per tests results conforming to Indian Standard Specification IS: 383-1970 was used for preparing the specimens. Coarse aggregate used was 20mm and down size and specific gravity 2.93 as per Indian Standard Specification IS: 383-1970 was used for preparing the specimens.

C. Glass

Waste glass available locally was collected and made into glass powder. to desired size. In this studies glass powder ground in ball/pulverizer for a period of 30 to 60 minutes resulted in particle sizes less than size 150 µm and sieved in 75 µm.

Mix Design

The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required, strength, durability, and workability as economically as possible, is termed the concrete mix design. The proportioning of ingredient of concrete is governed by the required performance of concrete in 2 states, namely the plastic and the hardened states. If the

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plastic concrete is not workable, it cannot be properly placed and compacted. The property of workability, therefore, becomes of vital importance.

The common method of expressing the proportions of ingredients of a concrete mix is in the terms of parts or ratios of cement, fine and coarse aggregates. For e.g., a concrete mix of proportions 1:2:4 means that cement, fine and coarse aggregate are in the ratio 1:2:4 or the mix contains one part of cement, two parts of fine aggregate and four parts of coarse aggregate. The proportions are either by volume or by mass. The water-cement ratio is usually expressed in mass.

A. Proportion of Volume of coarse aggregate and fine aggregate content

Volume of coarse aggregate corresponding to 20 mm size aggregate and fine aggregate (Zone 2) for water-cement ratio of 0.50 =0.62

In the present case w/c= 0.45. The volume of coarse aggregate is required to be increased to decrease the fine aggregate content. As w/c ratio is lower by 0.10, increase the coarse aggregate volume by 0.02 (at the rate of -/+ 0.01 for every +/- 0.05 change in water cement ratio).

Therefore corrected volume of coarse aggregate for w/c of 0.45 =0.63

For pumpable concrete these values should be reduced by 10 percent

B. Mix proportional for Nominal Concrete

Volume of coarse aggregate = 0.63 x 0.9 = 0.567

Volume of fine aggregate content = 1- 0.567 = 0.433

Adopting a mix of M25 grade having a proportion of (1:1:2)

Density of PCC=2400kg/m³

Calculations for total weight of materials

Total weight of material=2400×0.15×0.15×0.15 = 8.1 kg

Cement =2.025kg

Sand = 2.025kg

Coarse aggregate = 4.05kg

Water cement ratio = 0.45

III. Details of Samples

In this research, the concrete will mixed using concrete mixer and for each mixes, total of six of 150x150x150mm cubes will cast. The sample will be cured until the day of testing. The cubes will be tested at ages of 7 day, 14 day and 28 day to study the development of the compressive strength.

Type 1(A) glass concrete is the concrete with 60% cement and 40% glass powder

Type 1(B) glass concrete is the concrete with 60% cement and 40% glass powder and 5% of weight of cement of lime

Type 2(A) glass concrete is the concrete with 70% cement and 30% glass powder

Type 2(B) glass concrete is the concrete with 70% cement and 30% glass powder and 5% of weight of cement of lime

Type 3(A) glass concrete is the concrete with 80% cement and 20% glass powder

Type 3(B) glass concrete is the concrete with 80% cement and 20% glass powder and 5% of weight of cement of lime

III. Experimental Results

The properties of cement like standard consistency, specific gravity, fineness etc, and the properties of fine aggregate & coarse aggregate like specific gravity, grain size, water absorption, etc. is calculated. According to the above properties of materials as per IS 10262 – 1982, the proportions of water: cement: fine aggregate: coarse

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aggregate for M25 grade concrete is executed. Concrete cubes of size 150x150x150 mm are casted in standard ISCM moulds (for both sand and quarry dust) as per obtained mix proportions and respective grades. The concrete cubes are tested under Compressive Testing Machine (CTM) for 3, 7 and 28 days of curing to know the compressive strength.

Table 1 : Compressive strength Results for 7 days

Specimen	Trail no.	Stress (Mpa)	Average stress(Mpa)
Conventional	1	18.68	18.355
	2	18.03	
Type 1 A	1	18.97	17.740
	2	16.51	
Type 1 B	1	18.71	18.510
	2	18.31	
Type 2 A	1	17.50	17.670
	2	17.11	
Type 2 B	1	18.41	19.065
	2	19.72	
Type 3 A	1	17.89	17.970
	2	18.05	
Type 3 B	1	18.37	18.190
	2	18.01	

Table 2 : Compressive strength Results for 14 days

Specimen	Trail no.	Stress (Mpa)	Average stress(Mpa)
Conventional	1	21.33	21.08
	2	20.84	
Type 1 A	1	20.22	20.62
	2	21.01	
Type 1 B	1	26.04	22.65
	2	19.27	
Type 2 A	1	28.44	29.39
	2	30.35	
Type 2 B	1	22.88	25.21
	2	27.50	
Type 3 A	1	29.11	31.38
	2	33.64	
Type 3 B	1	27.04	27.66
	2	28.27	

Table 3 : Compressive strength Results for 28 days

Specimen	Trail no.	Stress (Mpa)	Average stress(Mpa)
Conventional	1	25.80	25.29
	2	24.79	
Type 1 A	1	26.59	26.34
	2	26.09	
Type 1 B	1	27.58	26.39
	2	25.20	
Type 2 A	1	30.12	32.87
	2	35.62	
Type 2 B	1	31.20	33.11
	2	35.02	
Type 3 A	1	41.88	43.28
	2	44.69	
Type 3 B	1	42.36	43.13
	2	43.91	

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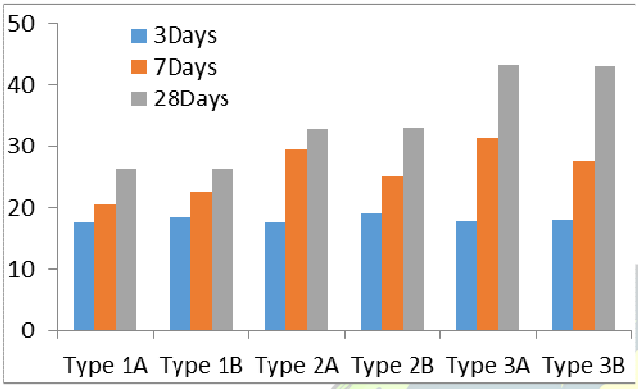
Figure 1: Comparison of Compressive strength results with various proportions for 3, 7 & 28 days



IV. RESULTS AND DISCUSSION

The compressive strength test on conventional concrete, glass added concrete and glass and lime added concrete was performed on digital compression testing machine. Each of the compressive strength test data corresponds to the mean value of the compressive strength of two cubes. At 28 days the glass powder concrete shows strength of 43.28N/mm², meanwhile the strength at 28 days for glass and lime added concrete is strength 43.13N/mm² at 20% cement replacement.

Physical observation of samples –the physical observation of samples showed less cracks in specimens using lime than the specimens with glass powder.

V. CONCLUSION

As per the present experimental study we have arrived at the conclusion that 80:20 cement: glass powder proportion gave an maximum load of 1005.6 kN as per 28 days of curing. A 80:20 proportion of cement: glass powder along with 100g of lime powder recorded a load of 988kN.

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