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A Study on Concrete by partial replacement of cement and aggregate by Silica fume, Egg shell powder and E-waste

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ABSTRACT

This research paper represents the collection of data from various experiments done on the compressive strength, flexural strength, tensile strength testing of concrete incorporating Silica fume & Egg shell powder by optimum replacement of cement and E-waste by replacement of aggregate. Portland cement is now a days partially replaced by silica fume, a by-product from silicon alloy factories and Egg shell ,a waste produced in poultries . From various studies Silica fume is a non-metallic and non hazardous material having very large surface area and egg shell have high percentage of lime which will provide binding property whereas E-waste is also used which will provide workability to concrete, which is suitable for concrete mix M25 . This research paper is a good source for understanding the effect on optimum replacement of cement by silica fume and aggregate by E-waste.

***Keywords*: Compressive strength, optimum replacement, flexural strength, tensile strength, Silica fume.**

I.INTRODUCTION

Silica fume is a byproduct resulting from reduction of high purity quartz with coal or coke and wood chips in an electric arc furnace during production of silicon metal or ferrosilicon alloys . Silica fume, also referred to as micro silica or condensed silica fume, is another material that is used as an artificial pozzolanic admixture .Condensed silica fume is essentially silicon dioxide (more than 90%) in nanocrystaline form. When pozzolanic materials are incorporated to concrete, the silica present in these materials react with the calcium hydroxide released during the hydration of cement and forms additional calciumsilicate hydrate (C – S – H), which improve durability and the mechanical properties of concrete.High strength concrete refers to concrete that has a uniaxial compressive strength greater than the normal strength concrete obtained in a particular region. High strength and high performance concrete are being widely used throughout the world and to produce them, it is necessary to reduce the water binder ratio and increase the binder content. High strength concrete means good abrasion, impact and cavitations resistance. Using high strength concrete in structures today would result in economical advantages. Nowadays whole world is facing a major problem of environmental pollution these

materials fly ash, micro silica, steel slag may become a major pollution materials. A huge amount of waste is generated from poultry farm of India. According to a study eggshell waste generated in India about 190000 tons per annum. These egg-shells waste are non-biodegradable and majority of eggshell waste is deposited as landfills.

Egg-shell waste in landfills attracts vermin due to attached membrane in landfills, and causes problems associated with human health and environment. So this egg-shell waste is useless as a landfill material. Further during manufacturing of 1 tons of OPC an equal amount of CO2 are released into the atmosphere. The CO2 emission acts as a silent killer in the environment as various forms. In this backdrop, the search for cheaper substitute to OPC is a needful one. Latest innovations in the field of science and technology have changed the very lifestyle of common man. Much electronic equipment that was beyond reach earlier is now available at affordable prices. On one hand this development has made life easy for all but on the other hand it has encouraged use and throw mentality. Nowadays people prefer to buy a new appliance rather than taking the pains to get the older one repaired. Such a trend not only leads to increase in volume of electrical and electronic waste but also poses serious threat to public health and environment. E-waste is growing exponentially in recent years because the markets for these products are also growing rapidly. Thereby the amount of e-waste is increasing day by day. The fraction including iron, copper, aluminum, gold and other metals in e-waste is over 60%, while plastics account for about 30% and the hazardous pollutants comprise only about 2.70%.

II.MATERIAL USED

Ordinary Portland Cement (OPC) is the most common cement used in general concrete construction when there is no exposure to sulphates in the soil or groundwater.OPC is a gray coloured cement powder. It is capable of bonding mineral fragments into a compact whole when mixed with water. This hydration process results in a progressive stiffening, hardening and strength development.

Silica Fume is the byproduct of silicon metal and ferrosilicon alloy. It consists of non-crystalline silicon dioxide(SiO2) with high specific surface area and high pozzolonic reactivity.

An egg shell is the outer covering of a hard-shelled egg and of some forms of eggs with soft outer coats.Egg shell are used in our experiment to increase the lime percentage in concrete.

E-waste consists of discarded electrical or electronic devices from the old computers, TVs, refrigerators, radios etc.E-waste components contains potentially harmful components such as cadmium and lead. Its disposal is necessary as it can cause various health problems to human being.

III.CHARACTERISTICS OF MATERIALS

Physical and chemical properties of silica fume , Egg shell and E-waste :

The physical properties of silica fume are as follows-

- Diameter of silica fume is 0.1 micron to 0.2 micron
- Surface area is in the range of 20,000-30,000 m2/kg.

- Density varies from 150 to 700 kg/m3

The chemical properties of silica fume are as follows:-

- Silica fume contains more than 90% of silicon dioxide (SiO2).
- Other constituents are carbon, sulphur, and oxides of aluminium, iron calcium, magnesium, sodium and potassium.

The physical properties of Egg shell are as follows-

- The breaking strength and the thickness of eggshell are in the average 4.46 kilograms and 0.311 millimeters.
- The pores of the thick shell are small and numerous, while those of the thin shell are large and few in number.

The chemical properties of silica fume are as follows:-

- Egg shell contains more than 50% of lime(CaO) and less than 1% of silicon dioxide (SiO2).
- Other constituents are carbon, sulphur, and oxides of aluminium, iron calcium, magnesium, sodium and potassium but in less percentage .

The physical properties of Egg shell are as follows-

- Specific gravity of E-waste is 1.01.
- Water absorption is 7.07
- Shape of E-waste are angular.
- Size is less than 4.75 millimeters.

The chemical properties of silica fume are as follows:-

- E-waste contains glass fibre more than 70%.
- Copper amount is approximately 12%
- E-waste is consisting of Aluminium, Silicon, Gold, Tin ,Zinc ,Lithium , Nickel etc.

Fig. 1 Initial and Final setting time test

IV.METHODOLOGY

In early stage , we tested the cement (i.e. OPC cement 43Gr.) Then we had decided a definite proportion for mixing of cement ,fine & coarse aggregate , admixtures and water, we had decided M25 mix . Firstly we had done the testing of concrete without replacing the cement and coarse aggregate .Next we had replaced cement 5%,10% &15% by weight using silica fume and Eggshell powder and casted 9cubes for 7 days and 9cubes for 14 days. Now we decided to replace coarse aggregate 10%,15% & 20% by weight using electronic waste and casted 9 cubes for 7 days.The concrete was tested properly and then it is to be allowed for the construction purpose i.e. construction of porous hollow concrete panel and hollow concrete panel.

Fig. 2 Compressive Testing Machine

This panel will be further used for the drainage lining and construction of houses for making them sound proof and also used in the construction of ceiling to protect from the heat problem.

Fig. 3 Compression Test

V.RESULTS

Table No 1. *Compressive Strength test value after 7 days*

Compressive Strength test value after 7 days					
S.No.	Mix	% replace	Sample	Compressive Strength(N/mm^2)	Avg.Compressive Strength(N/mm^2)

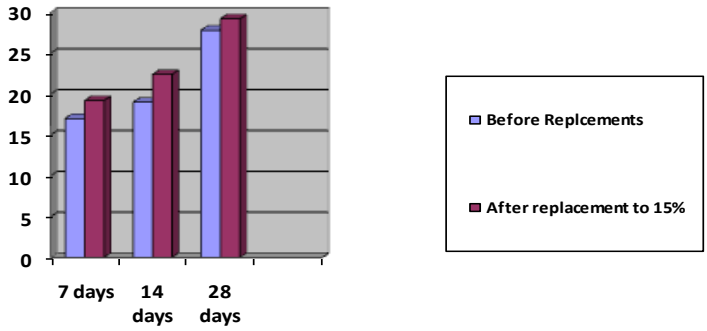
1	M1	5	1	16.90	16.89
			2	17.20	
			3	16.50	
2	M2	10	1	17.50	17.50
			2	18.00	
			3	17.00	
3	M3	15	1	18.80	19.50
			2	20.20	
			3	19.50	
4	M4	20	1	17.85	17.67
			2	18.20	
			3	16.98	

Table No 2. *Compressive Strength test value after 14 days*

Compressive Strength test value after 14 days					
S.No.	Mix	% replace	Sample	Compressive Strength(N/mm^2)	Avg.Compressive Strength(N/mm^2)
1	M1	5	1	20.90	20.53
			2	20.20	
			3	20.50	
2	M2	10	1	21.50	21.30
			2	20.00	
			3	21.15	
3	M3	15	1	21.80	22.40
			2	22.20	
			3	22.50	
4	M4	20	1	20.58	21.05
			2	21.38	
			3	21.20	

Table No 3. *Compressive Strength test value after 28 days*

Compressive Strength test value after 28 days					
S.No.	Mix	% replace	Sample	Compressive Strength(N/mm^2)	Avg. Compressive Strength(N/mm^2)
1	M1	5	1	27.90	26.50
			2	26.20	
			3	25.50	
2	M2	10	1	25.50	27.30
			2	27.00	
			3	27.15	
3	M3	15	1	28.80	29.20
			2	29.20	
			3	29.50	
4	M4	20	1	25.20	25.67
			2	26.38	
			3	25.45	

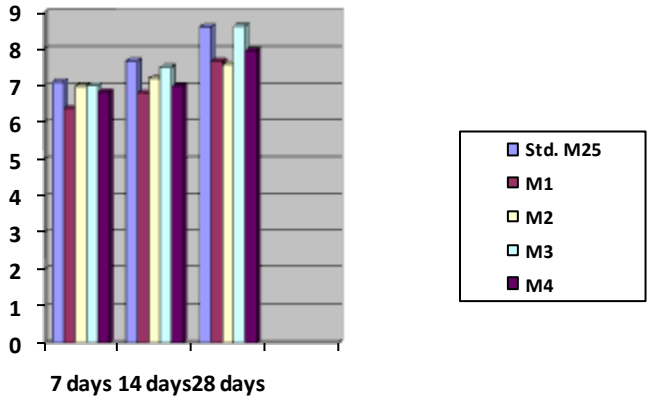


Graph Showing Increments in Compressive Strength

Table No 4 . *Flexural Strength test values*

Flexural Strength test values			
Mix	7 days	14 days	28 days
Std. M25	7.10	7.67	8.60
M1	6.38	6.80	7.67

M2	6.98	7.20	7.58
M3	7.00	7.50	8.62
M4	6.82	6.98	7.95



Graph Showing Increments in Flexural Strength

VI.CONCLUSION

Extensive experimentation has been carried out to determine utilization of the egg shell powder and silica fume as cement replacement material and e-waste as an aggregate replacement material by making the cement mortar and concrete. Based on the results obtained from the experimental work the following conclusions can be drawn:

- The concrete compressive strength with egg shell powder and silica fume as cement replacement material increases up to 15 percent. Addition of silica fume also enhances the strength of concrete.
- To reduce thermal cracking caused by the heat of hydration of cement.
- To increase the workability of concrete by addition of 15% e-waste in concrete.
- To minimize the cost of construction of houses and drainage lines.

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