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Effects of Fly Ash and Silica Fumes with Recycled Aggregates on Strength of Concrete

Vaibhav Amlathe[1], Vijay Kumar Shrivastava[2]
[1]*M.Tech. Scholar, Dept. of Civil Engineering, Gyan Ganga Inst. of Technology and Sciences, Jabalpur, India*
[2]*Assistant Professor, Dept. of Civil Engineering, Gyan Ganga Inst. of Technology and Sciences, Jabalpur, India*

***Abstract*: This is an experiment conducted with an objective to study the effects of Fly Ash and Silica Fumes with Recycled aggregates on Strength of Concrete. Primarily this is done with an aim to study the changes in compressive strength. The Quantity of material Recycled aggregate is varied 10%, 20 % and 30 % while Fly ash is Varied 0%, 20%, 25%, 30%,35% and Silica fume 5 % & 10%. To achieve it we utilized OPC grade 43. The moulds of size 15 x 15 x 15 cm are utilized. The replacement levels for OPC 43 with Fly ash were 0%, 20% and 25%, 30%, 35% and Adding Silica Fume were 5% and 10% by weight of cement. The concrete is cured for 7 and 28 days. The design mix is M25 type. The maximum compressive strength increased after curing period of 7 days was 20.36 N/mm2 and. The results found at the end of the experiment showed that the maximum compressive strength increased to 31.33 N/mm2 after curing period of 28 days. The cost analysis done is depended on market cost of binding material i.e. fly ash, Silica Fume and ordinary Portland cement. From the cost analysis it can be concluded that the cost of binding material reduced to 75.8 Rs. Per Cubic Metre at the end of this study it was found that optimum percentage of replacement for a curing period of 28 days. Any further partial replacement tends to decrease the compressive strength drastically.**

***Keywords*: Fly Ash, Silica Fumes, Recycled Aggregates, Strength of Concrete**

1. Introduction

To construct a structure, we need a binding material which is chosen as per the standards accepted globally and simultaneously to support the "Goal of Save Environment Todays Need" is to use such ingredients which minimize the mining activity and for that we can use the different waste products which obtain from the different industry like fly ash from thermal power plant, silica fume and ground granulated blast furnace slag from steel industry , rice husk from agriculture field and recycled aggregate from construction sites or dismantled old site As Maximum As Possible. These are the waste product which we used in concrete matrix by replacing the small to medium in quantity with the original one, like few percentage of fly ash can replace the equal amount of cement, similarly silica fume and GGBFS replace the cement and fresh aggregate can replace with recycle aggregate. The cost of the structure depends on several factors- type of structure, purpose of structure and materials used. In this study I have used the Building material like cement, fly ash, silica fume, sand, fresh aggregate and Recycled aggregate in different percentage s and different combination to know the effect on compressive strength and other properties. Cement is known for its binding properties. In this study we have tried to partially replace the cement with Silica Fume (SF) and Fly ash (FA) because they also contain binding properties and Improves Strength. They are waste material which are produced in million tons all over the world. They are less costly then cement. We have chosen All of them to study their combined effect of FA & SF with Recycled Aggregate on Strength and Durability Aspects of Concrete.

2. Material utilized

A. Cement

A bonding material used in manufacturing of concrete is cement. Earlier limestone was used as cement but the cement used in modern construction is Portland cement. This name is derived from the Portland stone, Island of Portland, United Kingdom. Portland cement is of two types of Ordinary Portland Cement (OPC) and Pozzolana Portland Cement (PPC). The difference between OPC and PPC is that OPC contain just the basic silicates and aluminates while the PPC contains fly ash or other additives with silicates and aluminates. The strength giving properties is because of the porous structure of gel. Argillaceous and calcareous material is used in the production of cement. Calcareous material like limestone and argillaceous material like fly ash. The good quality of cement must contain good strength.

B. Fly Ash (FA)

Fly ash is a fine gray powder consisting mostly of spherical, glassy particles that are produced as a byproduct in coal-fired power stations. Fly ash has pozzolanic properties, meaning that it reacts with lime to form cementitious compounds. It is commonly known as a supplementary cementitious material. Fly ash can be used as prime material in many cement-based products, such as poured concrete, concrete block, and brick. One of the most common uses of fly ash is in Portland cement concrete pavement or PCC pavement. Road construction projects using PCC can use a great deal of concrete, and substituting fly ash provides significant economic benefits. Fly ash has also been used as embankment and mine fill, and it has

Table 1
Group Name – M-0 (Plain Concrete)

MIX COMBINATION				RECYCLED AGGREGATE - 0 % SILICA FUME - 0 % FLY ASH - 0 %		
	Specimen name	Wet weight of cube after 7 days	Failure load after 7 days	Wet weight of cube after 28 day	Failure load after 28 days	
		In kg	Unit- N/mm^2	In kg	Unit- N/mm^2	Average
For 7 days	Mix 1	8.690	20.2	-	-	20.46
	Mix 2	8.770	20.8	-	-	
	Mix 3	8.720	20.4	-	-	
For 28 Days	Mix 4	-	-	8.710	30.3	31.5
	Mix 5	-	-	8.820	33.0	
	Mix 6	-	-	8.760	31.5	

Table 2
Different Proportion of SF, FA and RA in Mix Combination, Group Name – M14

MIX COMBINATION				• RECYCLED AGGREGATE - 20 % • SILICA FUME - 10 % • FLY ASH - 20 %		
	Specimen name	Wet weight of cube after 7 days	Failure load after 7 days	Wet weight of cube after 28 day	Failure load after 28 days	
		In kg	Unit- N/mm^2	In kg	Unit- N/mm^2	Average
For 7 days	Mix 1	8.670	19.9	-	-	20.36
	Mix 2	8.750	20.7	-	-	
	Mix 3	8.720	20.5	-	-	
For 28 Days	Mix 4	-	-	8.700	30.3	31.33
	Mix 5	-	-	8.730	31.1	
	Mix 6	-	-	8.780	32.6	

increasingly gained acceptance by the Federal Highway Administration.

C. Silica fume

Silica fume is a byproduct of producing silicon metal or ferrosilicon alloys. One of the most beneficial uses for silica fume is in concrete. Because of its chemical and physical properties, it is a very reactive pozzolana. Concrete containing silica fume can have very high strength and can be very durable. Silica fume is available from suppliers of concrete admixtures and, when specified, is simply added during concrete production. Placing, finishing, and curing silica-fume concrete require special attention on the part of the concrete contractor.

D. Recycled aggregate

Recycled Coarse Aggregates (RCAs) are obtained by crushing of concretes from demolition of concrete structural components in many structures such as: old buildings, concrete pavements, bridges & structures, at the end of their service life & utility, structures deteriorated beyond the possibility of repairs, structures that are turned into debris resulting from natural disasters (such as floods, earthquake, tsunami, manmade disaster/war, etc.), structures not serving the needs in present scenario, old structures to be brought down to pave way for new construction for better economic growth. RCAs actually results from crushing of waste concrete and this material as a replacement for natural aggregates can be employed in many applications such as: construction of low rise buildings, manufacture of paving blocks & tiles, laying of flooring and approach lanes, in sewerage structures and sub-base course of pavement, besides drainage layer in highways.

3. Test for compressive strength

All cubes taken a specimen are marked before testing for recording the data and results obtained. After then data for each mould is recorded before and after the curing. After then each mould is selected according to date of curing and fixed in the compression testing machine. After then the load on each mould is increased incrementally up to the crushing load failure recorded at each varying load.

4. Conclusion and discussion

After the partial replacement of OPC with FA Silica fume and natural aggregates with recycled aggregates which varied in different proportion, it was found as follows.

1. Total 30 Groups had been Formed for Different Mix Combinations Which Gives Satisfactory Results After 7 & 28 Days
2. The highest compressive strength after 7 days and 28 days was 20.36 N/mm^2 and 31.33 N/mm^2 Respectively. The Above Said Compressive Strength Belongs to Group Name M-14 Having Mix Combination Recycled Aggregate 20 % Fly Ash 20 % And Addition of Silica Fume 10%.
3. The Strength of Plain Concrete Belongs to Group Name M-0 having Strength 20.46 N/mm^2 for 7 Days and 31.5 N/mm^2 for 28 Days.
4. The Comparison of Group Name M-0 And M-14 Shows the Almost Equal Compressive Strength. And the Other Groups Shows Slight Decrement in Compressive Strength.
5. The Results Show that the Optimum Replacement of Recycled Aggregate with natural aggregate is 20% above

that (i.e. 30 %) the Compressive Strength Decreases.

6. By Replacing Cement and Coarse Aggregate with Fly Ash and Recycled Aggregate and adding Silica Fume. the Cost is Reduced Up to 75.8 Rs. Per Cubic Metre.

A. Test results of the experiment

The similar preparation of FA taken for the partial replacement of ordinary Portland cement are shown in the table with the results obtained after the test including the graph for 7 days and 28 days respectively. They show the variation occurred in their compressive strength for M25 mix design of concrete. The maximum compressive strength observed for curing period of 7 days was 20.36 N/mm^2 and the maximum compressive strength observed for curing period of 28 days was 31.33 N/mm^2. It was also observed that the cost of binding material i.e. the OPC, recycled aggregate, FA reduced.

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