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Study the Variation of Properties of Concrete Mix Using Binding Material Portland Cement and Fly Ash Cement

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Abstract: In the current study, a number of experiments were carried out to compare the mechanical properties of concrete mixes made with Portland cement, fly ash cement, and their mixtures (in 1:0.5 and 1:1 proportion). A replacement silica fume of 5%, 10%, 15%, and 20% was added to concrete mixtures. The materials are combined in the ratios of 1: 1.5: 3. After three days, 14 days, and 28 days, the compressive strengths, workability, and porosity characteristics were examined. By making different types of binder mixes denser, silica fume increases their strength.
Keywords: Cement, Concrete, Blending, Silica fume, Strength, workability.

I. INTRODUCTION

Fly ash can be used as prime material in blocks, paving or bricks however, one the most important applications is PCC pavement. PCC pavements use a large amount of concrete and substituting fly ash provides significant economic benefits. Fly ash has also been used for paving roads and as embankment and mine fills, and it's gaining acceptance by the Federal government, specifically the Federal Highway Administration. Silica fume (SF) is a byproduct of manufacturing silicon and ferrosilicon alloys which are finely segregated residue captured from the oxidized vapor on top of the electric arc furnaces. Silica fume consists of fine particles, [15] with particles approximately one hundredth the size of the average cement, because of its intense fineness and high silica content, silica fume is a very effective pozzolanic material particle. Properties which can be improved are its compressive strength, bond strength, and abrasion resistance Addition of silica fume can also reduce the permeability of concrete to external harmful agents, which results in protecting the reinforcing steel of concrete from corrosion, especially in marine environments which are prone to chloride attack. It has been reported that the [17] pozzolanic reaction of silica fume is very significant and the non-evaporable water content decreases with the addition of silica fume.

II. LITERATURE REVIEW

Velosa and Cachim (2009) carried out experimental work on Oxygen and water vapor transport in cement pastes, and concluded that the increase in compressive strength of mortar containing silica fume as a partial replacement for cement, greatly contributed to strengthening the bond between the cement paste and aggregate. It was also demonstrated that super plasticizer in combination with silica fume plays a more effective role in mortar mixes than in paste mixes.This can be attributed to a more efficient utilization of super plasticizer in the mortar mixes due to the better dispersion of the silica fume.

Gonen and Yazicioglu (2009) studied in concrete. These SCM's is partially replaced with filler material like silica fume in various mix proportions of 10%, 20%, 30% in concrete of M20 mix. Considering the above parameters in view, the aim of the analysis is to study the performance of various properties like compressive and flexural strength and Wet-Dry test after 26 and 56 days of concrete.

Barbhuiya et al. (2009) studied the properties of fly ash concrete modified with hydrated lime and silica fume and concluded that addition of lime and silica fume improves the early days compressive strength and long term strength development and durability of concrete.

Thanongsak et al. (2010) carried out research work in the influence of mineral admixtures on the short and long term performance of concrete and concluded that silica fume contributed to both short and long term properties of concrete, where as fly ash shows its beneficial effect in a relatively longer time. As far as the compressive strength is concerned, adding of both silica fume and fly ash slightly increased compressive strength, but contributed more to the improvement of transport properties of concrete.

Duan et al. (2017) carried out experimental work Geopolymer specimens were prepared by alkali activation of fly ash, which was partially replaced by silica fume at levels ranging from 0% to 30% with an interval of 10%, by mass. Microstructure, residual strength and mass loss of fly ash based geopolymer blended with silica fume before and after exposed to 7, 28 and 56 heat-cooling thermal cycles at different target temperatures of 200 °C, 400 °C and 800 °C were assessed and compared. The pores of geopolymer are refined by the addition of silica fume. The incorporation of silica fume optimizes the microstructure and improves the thermal resistance of geopolymer.

Adak et al. (2017) The fly ash-based geopolymer concrete typically needs heat activation atvarious temperatures, which has been seen as a major barrier to its widespread use. This restriction can be removed by including the right amount of nano-silica in the mixture. As a result, 6% nano silica can be used in place of fly ash to create a geopolymer concrete that is

based on fly ash. It has been investigated how this geopolymer concrete performs structurally in terms of bond strength, flexural strength, and micro structural behaviour. This fly ash-based geopolymer concrete with nano silica modification exhibits noticeably improved structural behaviour at various ages without any heat activation. Also, the binding strength between the surrounding geopolymer concrete materials (with/without nano silica) and the reinforcing bars (deformed or mild steel) has been compared to conventional cement concrete. In comparison to heat-cured geopolymer concrete (without nano silica) and regular cement concrete samples, the nano silica modified geopolymer concrete displays higher structural performance. Through the use of a Field Emission Scanning Electron Microscope (FESEM), Energy Dispersive X-ray Spectroscopy (EDS), Fourier Transform Infrared Spectroscopy (FTIR) analysis, and X-ray Diffraction (XRD) techniques, the microstructural characteristics of such geopolymer concrete (with/without nano silica) and cement concrete have been examined. The change of the amorphous phase to the crystalline phase in the geopolymer concrete matrix in the presence of nano-silica is the primary cause of the improvement in structural performance.

Wong et al. (2018) There are many million tonnes of solid trash generated worldwide as a result of construction and demolition work, with brick debris ranking among the most common wastes. Many studies have been conducted in recent years on recycling brick scraps to create more environmentally friendly concrete. The performance in terms of the mechanical strengths and some durability-related aspects of the concrete were reviewed in this review, which outlines the use of brick waste as prospective partial cement and aggregate replacement materials. Due to the potential pozzolanic reactivity of the brick dust particles, it was discovered that the most practical application of recycled brick is in the form of brick dust, where up to 20% cement replacement could improve the strength and some durability aspects of the concrete. On the other hand, because of the aggregate's inherent porosity, the addition of recycled brick as aggregate does not significantly improve the characteristics of concrete. Because of this, the use of recycled brick as a partial aggregate replacement should be limited to modest replacement levels and when environmental considerations call for it.

Vardhan et al. (2019)The strength, permeability, and microstructural characteristics of concrete using discarded marble as a partial replacement for fine particles are discussed in this paper. Following the creation of one control mix, six mixes containing 10 to 60% marble powder were created. Up to the age of 365 days, tests were done for permeation characteristics, split tensile strength, and compressive strength. Furthermore, XRD and SEM analyses were performed. According to test results, discarded marble can be added to concrete to increase its strength and permeability characteristics, with the greatest benefit occurring at a 40% replacement level. Due to both physical and chemical changes in the concrete matrix, microstructural examination also revealed densification of the matrix, which is attributable to refinement of pores.Findings show that discarded marble can be used as a substitute fine aggregate to enhance the overall performance of concrete and promote sustainable growth.

III. RESULT FOR COMPRESSIVE STRENGTH

Compressive Strength of different concrete cubes after 3, 14 and 28 days are given in Table 1.

Table - 1, Results of compressive test, Mpa

Type of cement	% of SF replaced	3 days	14 days	28 days
	0	9.55	15.90	19.41
	5	10.81	17.2	20.84

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Ordinary Portland concrete	10	11.64	17.96	21.09
	15	12.35	18.54	22.85
	20	13.05	19.13	23.12
Fly ash cement blend (1:0.5)	0	8.87	14.82	18.57
	5	9.58	15.70	19.51
	10	10.35	16.63	20.46
	15	11.17	17.65	21.50
	20	12.07	18.71	22.57
Fly ash cement blend (1:1)	0	8.20	13.71	17.85
	5	9.20	15.15	19.28
	10	10.31	16.61	20.84
	15	11.55	18.27	22.51
	20	12.91	20.11	24.30

From the above Table 1, it has been found that –

1) Early or 3 days strength and 14 days strength increased rapidly with increase in percentage of replacement by silica fume.
2) Early gain of strength is more in case of fly ash cement with 1:1 blend and gain of strength at later stages is more in case of ordinary Portland cement.
3) The major explanation for early gain of strength in fly ash and cement blend could be rapid reaction among fly ash and silica fume particles due to fine particles.
4) As cement particles are coarser than silica fume particles, reaction rate is relatively sluggish, so, gain of early strength is relatively low in Ordinary Portland cement concrete but at later stages gain of strength is higher.
5) For all mixes it has been observed that up to 20% replacement of cement with silica fume the compressive strength increased with increasing the content of silica Fume as partial replacement of cement.
6) Early strength for all the mixes increased with initial 5% replacement by silica fume. The same is observed in case of 10% replacement.
7) However, amongst three types of mixes, gain in fly ash cement with 1:1 ratio is more. The early days strength increased remarkably by replacing any type of cement by silica fume up to 15%. This increase is more notable in fly ash cement.

Compressive strength of ordinary Portland cement concrete after 3, 14 and 28 days at different content of Silica fume

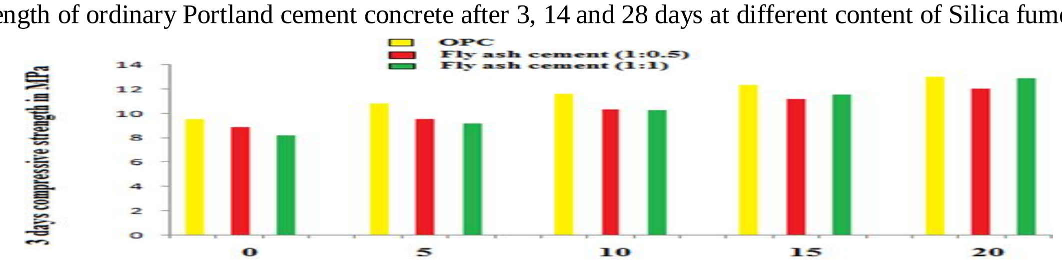

Figure 1 - Compressive strength after 3 days

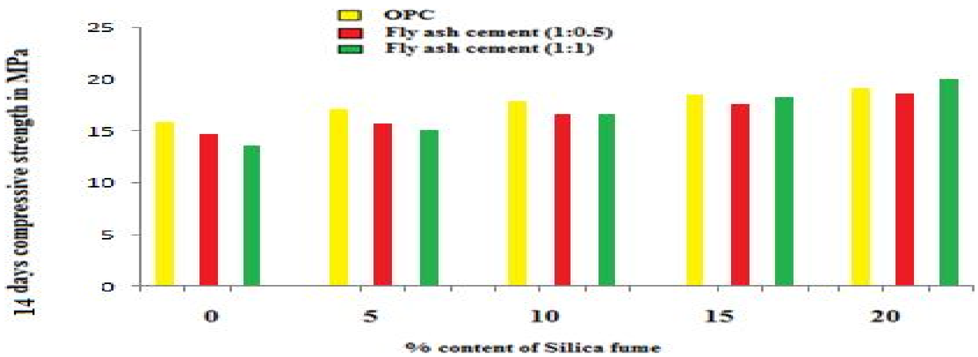

Figure 2 - Compressive strength after 14 days

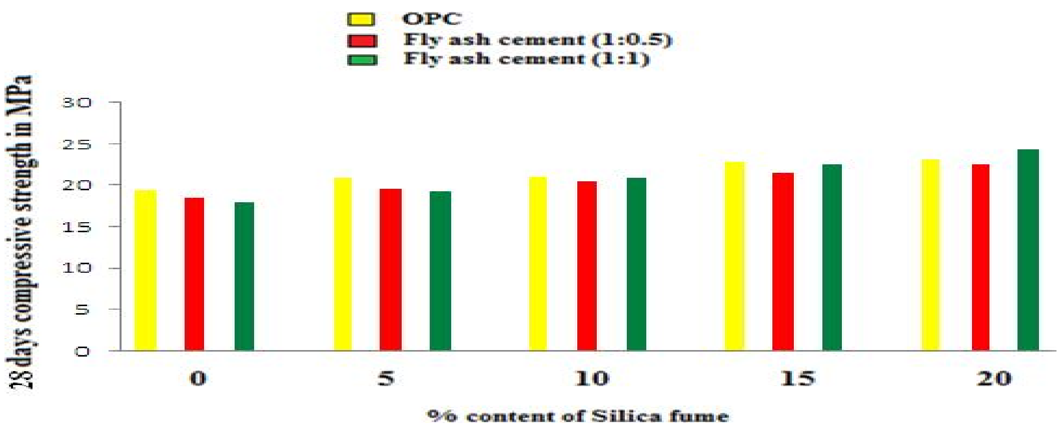

Figure 3 - Compressive strength after 28 days

Based on the above study following conclusions can be made

a) Inclusion of silica fume increases the water requirement of binder mixes to make paste of normal consistency.
b) Water requirement increases with increasing dose of silica fume.
c) Early gain of strength is more in case of fly ash cement with 1:1 blend and gain of strength at later stages is more in case of ordinary Portland cement.

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