EXPERIMENTAL ANALYSIS OF FLY-ASH & SILICA FUME ON THE ENGINEERING PROPERTIES OF CONCRETE

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Abstract: - Now a day the world is witnessing the construction of very inspiring and challenging structures, the world is leaning towards the concrete jungle and the high raised concrete skyscrapers are becoming predominant structures in society. The main ingredient in the conventional concrete is Portland cement the process that are being used in the construction industry for the production of cement releases large traces of carbon dioxide which leads to rise in earth surface temperature. The process of cement production leads to unsustainable development by depleting the natural resources in the form of quarrying of lime stone. For analyzing the effect of different percentage of fly-ash it considered seven different ratios. After analyzing the effect of addition of only fly-ash in concrete, addition of only silica fume in concrete was also analyzed. For analyzing the effect of addition of silica fume in concrete three different ratio proportions was considered during experiment. It also analyzed the effect of addition of fly-ash and silica fume both in concrete.

Keywords: - Silica fume, Fly ash, Compressive strength, split tensile strength, Flexural strength, durability

1. INTRODUCTION

Concrete is the most versatile man-made construction material in the world and being extensively used in all types of construction activities. The strength, durability and other characteristics of concrete be contingent upon the properties of its ingredients, the mix proportions, the technique of compaction and other controls during placing, compaction and curing. The improvements in concrete technology had flagged the way to make the finest use of locally obtainable materials by proper mix proportioning and workmanship so as to harvest a strong, durable and uniform concrete. An important part of research on concrete is the use of raw materials, cement additives, or the addition of minerals or the replacement of ingredients. The usage of industrial wastes with pozollanic character and the development of cement properties is employed to substitute cement and aggregates, some parts strengthen the durability and help protect the environment. Environmental impacts from the extraction of river sand and crushed rock are becoming a source of growing concern in most parts of the country. Therefore, the invention of lightweight concrete with alternative aggregates is highly endorsed by researchers.

Light Weight Concrete

In conventional concrete, high self-weight of concrete is one of the disadvantages. Normally density of concrete is in the order of 2200 to 2600 kg/m3. This heavy self-weight makes an uneconomical structural material. In order to produce concrete of desired density to suit the required application, the self-weight of structural and non-structural members are to be reduced, thereby economy is achieved in the design of supporting structural elements which lead to the development of light weight concrete (Ramamurthy et al 2008). Low thermal conductivity, a property which improves with decreasing density is the most important characteristic feature of light weight concrete (RamazanDemirboga et al 2003). The reduced mass with adequate strength, improved thermal and sound insulation properties and less energy demand during construction makes lightweight concrete as well as high performance material. Though lightweight concrete can't always substitute normal concrete for its strength potential, it has its own advantages like reduced dead load, and thus economic structures and enhanced seismic resistance, high sound absorption, high thermal insulation, and good fire resistance. (Tommy et al 2004).

Review of the Work

Nawaz et.al (2020) The intention of this study was to upsurge the level of fly ash inclusion in hybrid hybrids (cement plus fly ash) using sulfate activation techniques to overcome the problem of low productivity at a young age. The levels of fly ash replacement with cement were retained at 20%, 40% and 60%. Sodium sulfate (Na2SO4) 2% by weight of the binder was used as the activator. Compact strength and flexibility tests of the samples were accomplished at 3, 28, and 90 days of age. Endurance assessments such as realization, coefficient of sadness and chloride penetration were also performed, and experimental consequences disclosed that sulfate activity increased at a young age at all levels of fly ash.

Zahedi et.al (2020) In this study, two different FBC fly ash from North America were employed when replacing 20% Portland cement in a concrete mix with a paving stone. The upshot of fly ash on the fresh, hard and stable properties of concrete and equivalent was appraised. It has been pragmatic that in concrete with fly ash from FBC, the desired solution of air content, air cavity structure and strength development can be achieved. In addition, FBC fly ash has enhanced concrete durability, coefficient formation and chlorite penetration resistance. Compact effect on drying is also adequate. While the high SO3 content of fly ash does not cause harmful expansion per concrete cylinder containing fast flying ash, SO3 is susceptible to sulfate attacks.

Fan et.al (2019) The article presents an experimental study of the mechanical properties of fly ash during heating. Tests were achieved on equipment definitely designed to study the "hot" mechanical properties of concrete. Outcomes comprise compressive strength, peak stress, young modulus, and stress ratio at ambient temperatures up to 900 ° C. Led to a smaller reduction in compressive strength and a more linear stress reply to deformation at higher temperatures due to the further reaction between reactive silica in fly ash and calcium hydride under climatic conditions.

Sahoo et.al (2018) This paper offerings the consequences of experiments to consider the belongings of adding fly ash to concrete as part of the substitution of cement on compressive strength with prolonged exposure to sulfur. In addition, artificial neural networks (ANNs) were developed to predict the compressive strength of concrete at different levels of ash replacement, day hardening, water, and duration of sulfate exposure.

Sanjukta et.al (2015)In the this research feasibility of using carbonated fly ash as a part substitute of cement in concrete has been investigated. Experiments were done to determine compressive strength, flexural strength, split tensile strength of carbonated fly ash concrete over a wide range of water curing age. Durability aspects considering strength loss and weight loss subject to chemical exposure have also been investigated. Strength of carbonated fly ash concrete is observed to be more than that of control concrete when water curing period exceeds 180 days. To obtain information on pore structure, Mercury intrusion porosimetry has been conducted. The results reveal higher distribution of pores in narrow diameter range. The TGA indicates higher weight loss in carbonated fly ash concrete.

Arezoumandi, M et.al (2013), studied the effect of total cementitious content on mechanical properties and shear strength of HVFA concrete with 70% replacement of cement with Class C fly ash. The authors concluded that HVFA concrete with low cementitious content showed higher compressive strength, tensile strength and flexural strength than HVFA concrete with high cementitious content. The difference in cementitious content did not have significant effect on shear strength but shear strength found was greater than predicted by codal provision.

Younsi et al. (2013) observed that hydration slowed down on inclusion of fly ash or blast furnace slag as replacement of ordinary Portland cement in concrete. Addition of fly ash or blast furnace slag also resulted in lower portlandite content in concrete. Water cured concrete mixtures incorporating mineral additives displayed same or finer pore structure and lower resistance to accelerated carbonation than that of reference concrete.

Effect of addition of fly-ash in concrete

For analyzing the effect of addition of fly-ash in concrete different percentage of fly-ash was added in to the mortar of concrete. Seven different compositions of fly-ash and cement was considered during the experiment that is 10, 15, 20, 25, 30, 35 and 40 weight percentage of cement. The curing time of the concrete with different composition of fly-ash is fixed and it remain to 48 hr. so for the compression test cubic samples having 15*15*15 cm3 volume was prepared and for flexural strength sample having 150*150*700 mm3 size was prepared. The sample dimension was selected according to the IS code for compressive and flexural strength of the concrete. For getting the repeatability and accuracy of the result in each case of analysis three different samples were tested and getting the result. The reported data is the average of the three results.

Effect of addition of silica fume in concrete

Silica fumes are the industrial waste and utilizing this to different application act as a waste to wealth. Silica fumes act as a fiber like structure, their aspect ratio is large. When it is added in to the concrete it acts as reinforcement inside the concrete. Through previous work it is already known that, when fine fiber is added in to the concrete it increases the strength of the concrete. So in order to test the addition of silica fume in concrete, here in this work three different percentage of silica fumes were added in to the concrete and make the compressive and flexural samples for testing. In each case of silica fume constituents three-three samples were prepared and tested in order to maintain the accuracy of the testing. The compressive samples prepared from silica fume- concrete

Compressive Strength

In order to check and to analyzed the effect of addition of silica fume four different proportion of silica fume that is 10, 15, 20 and 25 weight percent of cement is used during the making of concrete. the value of compressive strength for different composition of silica fume is shown in the below table.

Table. Value of compressive strength of the silica fume-concrete

S.No.	Silica fume Percentage	Compressive strength (MPa)
1	10	20
2	15	32
3	20	25
4	25	18

From above table it is found that as the silica added in to the concrete the compressive strength of the concrete gets enhanced. It is found that, as the percentage of silica increase from 10 to 15% the strength of the concrete block increases up to 32 MPa. Whereas after increasing the percentage of silica fume the compressive strength of the concrete block start decreasing, which is mainly due to agglomeration of silica fumes inside the concrete.

Flexural Strength

Flexural test of silica fume-concrete was also tested and analyzed the data. For different composition of silica fume addition in concrete the flexural strength is mention in the below table.

Table. Value of flexural strength of the silica fume-concrete

S.No.	Silica fume Percentage	flexural strength (MPa)
1	10	5.3
2	15	6.1
3	20	5.8
4	25	5.5

Effect of silica fume and fly ash mixture in concrete

For analyzing the effect of addition of both silica fume and fly-ash, seven different compositions were considered during the experimental work. In these seven different compositions, the percentage of silica fume is fixed that is 10%. Whereas the percentage of fly ash gets varied. In this work we have considered seven different proportion of fly ash that is 10, 15, 20, 25, 30, 35 and 40% and in each case the percentage of silica fume is fixed that is 10%.

Fig. compressive samples of fly ash-silica fume concrete

Fig. shows the compressive and flexural samples prepared from fly ash and silica fume mixture concrete

CONCLUSION

- Workability of concrete increases with increase in percentage of silica fume and fly ash in concrete.
- The flexural strength of composite beam is more than the conventional beam comparatively.
- With increase in percentage of silica fumes the strength of the concrete increases, but after certain percentage the agglomeration of silica fumes decreases the strength of concrete.
- The compressive strength of composite concrete (Fly ash + silica fume) attains its optimum value at 15% when compared with the acid attack concrete (NACl and H2SO4) for 28 days.

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