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

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Abstract: - 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. Many of the previous work had reported the use of fly-ash in concrete and try to use it at different ration. But using fly-ash more that 20% of cement decreases the performance of concrete. So in order to use fly-ash more than 20% without compromising the strength of the concrete, here in this work 10% silica fume was used with fly-ash in concrete. This work includes the effect of addition of fly-ash in concrete on their mechanical property. 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 proportion was considered during experiment. It also analyzed the effect of addition of fly-ash and silica fume both in concrete. With keeping silica fume percentage constant that is 10%, fly-ash percentage gets varied and analyzes the mechanical properties of concrete. It measures the compressive and flexural properties of concrete in each case of composition.

General

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 pozzolanic 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 (Ramazan Demirboga 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.

1. 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.
2. 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.
3. 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.

4. 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.

5. 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.

6. 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.

- Methodology
- Study of concrete and their types.
- Study of different methods used to make concrete.
- Literature survey.
- Identifying the different process parameters and limitation on which the performance of the concrete depends.
- Making of concrete block with different process parameters and checking the mechanical properties.
- Analyzing the compressive and flexural strength of concrete.
- Addition of fly-ash in concrete at different proportion.
- Four different percentage addition of fly-ash was considered during the experiment that is 10, 15, 20, 25, 30, 35 and 40 by weight of cement.
- Performing the compressive and flexural test of fly-ash concrete.
- Addition of silica fumes in concrete at different percentage.
- For addition of silica fumes three different percentage was considered that is 10, 15, 20 and 25 percent
- Performing the compressive and flexural test of silica fume-concrete.
- Analysing the result obtained through mechanical testing.
- After analysing the effect of addition of fly ash and silica fumes separately, effect of combine addition of fly-ash and silica fume was analysed.
- Different ratio proportion of fly-ash and silica fume was considered during the experiment.
- For combine analysis it considered four different ratio proportion in which the percentage if silica is fixed that is 10%, whereas the percentage of fly-ash get varied.
- Comparison of different types of concrete composition at different ratio proportion.
- Report preparation.

Results

As the development goes on, the requirement of new construction and construction materials get increases. As cement is main binding source in concrete, demand of cement gets also increased. Production of cement emit the carbon-di-oxide gas which ultimately increases the global warming. So in order to reduce the consumption of cement different cementitious materials are used with the cement. Fly-ash and silica fumes are the industrial waste material. Storing and handling of fly ash in power plant is a very big issue, so lot of research is going on to utilize the fly-ash in different application. So in the same manner fly-ash is used in concrete with cement at different proportion. But with the increase in percentage of fly-ash more than 10% in concrete, the strength of the concrete start decreasing. So to compensate the strength of concrete different reinforcement was also used with the fly-ash. Due to the use of reinforcement fly-ash can be used more than 10% without compensating the strength of the concrete. Here in this work effect of addition of fly-ash in concrete at different percentage was analysed. It also analyzed the effect of addition of silica fumes separately in concrete. The main objective of this work to increase the percentage of addition of fly-ash in concrete without compensating the strength of the concrete.

So in order to achieve the objective of the work, silica fumes were used with fly-ash in concrete. The experimental work that are carried out during the analysis is mention in the below section.

Compressive Strength

After preparing the samples compressive strength of the mixture concrete a sample were tested and for each case of composition three-three samples was tested. The value of compressive strength for silica fume-fly ash mixture concrete at different composition is mention in the below table.

Table. Shows the value of compressive strength of the silica fume-fly ash mixture concrete

S.No.	Silica fume Percentage	Fly-ash percentage	Compressive Strength (MPa)
1	10	10	18
2	10	15	21
3	10	20	23
4	10	25	28
5	10	30	32
6	10	35	35
7	10	40	33

Above table shows the value of compressive strength of silica fume and fly ash mixture concrete. from table it is found that as the percentage of fly ash increases with 10% of silica fume the strength of the concrete gets increases up to 35% of addition. Whereas beyond that the strength of the concrete get decreases.

Flexural Strength

Three-point bend test was also performed to measure the flexural strength of the silica-fly ash concrete flock. The samples were prepared and tested for each set of proportion. The value of flexural strength for different composition of the concrete is mention in the below table.

Table.4.11 Value of flexural strength of silica fume-fly-ash mixture beam at different composition

S.No.	Silica fume Percentage	Fly-ash percentage	Flexural Strength (MPa)
1	10	10	4.8
2	10	15	5.4
3	10	20	7.8
4	10	25	8.3
5	10	30	8.7
6	10	35	9.1
7	10	40	8.5

Above table shows the value of flexural strength at different composition of mixture beam. From table it is found that as the percentage of fly-ash increases with 10% of silica fume in concrete the flexural strength of the concrete gets increases. At 35 % addition of fly ash with 10% silica fumes, concrete shows the highest property as compared to other composition which means that addition of 35% fly ash with 10% silica can full fill the requirement of using large percentage of fly-ash without compensating the strength of the concrete. figure showing the comparative value of flexural and compressive strength of fly ash-silica fume mixture concrete is shown in the below figure.

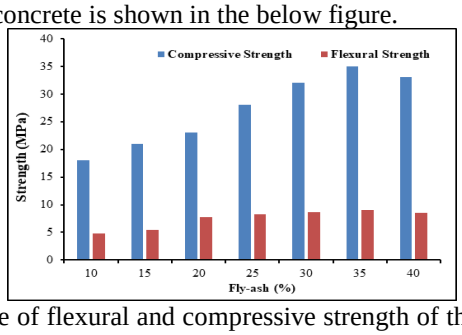

Fig. value of flexural and compressive strength of the fly-ash silica mixture concrete

From above figure it is found that with increase in percentage of fly-ash with 10% silica the compressive and flexural strength of the concrete get increases, whereas beyond 35% the properties start decreasing.

Comparison of Different composition of concrete

After evaluating the properties of different composition of concrete that is fly-ash concrete, silica fume-concrete and fly ash–silica concrete at different composition proportion comparison was done. the mechanical properties of the different composition were done on the basis of compression and flexural strength of the concrete. The comparative table of compressive and flexural properties of different composition is mention in the below section.

Table. Value of compressive strength of concrete at different composition

S.No.	Silica Fume (%)	Fly-ash Percentage	Fly-ash concrete Compressive strength (MPa)	Fly-ash-silica concrete Compressive strength (MPa)
1	10	10	12	18
2	10	15	18	21
3	10	20	22	23
4	10	25	19	28
5	10	30	10	32
6	10	35	7	35
7	10	40	5	33

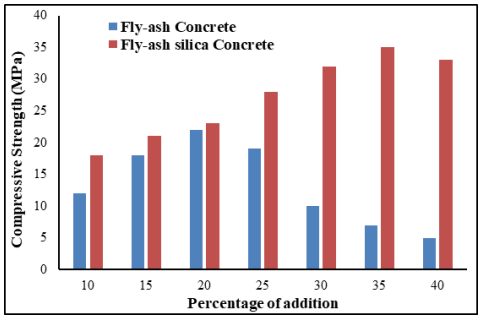

Fig. Shows the comparative graph of concrete with different proportion

Above figure shows the comparative graph of concrete at different composition. From graph it is found that with fly-ash the strength of the concrete increases up to 20 % addition of fly-ash. Whereas in case of fly-ash and silica fume concrete the strength increases up to 35 % addition of fly-ash with 10% of silica fumes. With addition of silica the strength of the fly-ash concrete gets enhanced significantly, both compressive and flexural strength of the concrete get increases significantly. Through experiment it have found that fly-ash can be used up to 35% of cement with 10% silica fume, without compromising the strength of the concrete

CONCLUSION

- Workability of concrete increases with increase in percentage of silica fume and fly ash in concrete Due to this, there is a limitation of using fly-ash up to certain percentage of cement that is not more than 20%.
- Silica fumes act as a fiber reinforcement and

increases the strength of the concrete.

- 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.
- Due to non-uniform distribution of silica fume and agglomeration, it becomes more prone to the crack formation during loading which ultimately decreases the strength of the concrete.
- The flexural strength of composite beam is more than the conventional beam comparatively.

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