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Experimental Studies on the Behavior of Cement & Concrete Containing fly Ash

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Abstract:** Fact of this study is to test and examine compressive strength of fly ash cement concrete, which can use in on road construction in provincial zones, Reinforced concrete, precast concrete, large structures, and Decoration. There is an immense area of covered by Industrial waste as fly ash, so utilizing this waste in construction can arrange this waste and furthermore gainful in limit contamination in the environment. Lab tests were performed on fly ash to decide its properties, which might be utilized as a part of road construction, earth dam development, soil adjustment and so on. Fly ash was gathered from Tanda Thermal Power Station (NTPC) located in the Ambedkar Nagar district in the Indian state of Uttar Pradesh. In arrangement think about facts getting ready concrete by substitution of Ordinary Portland Cement (OPC) with fly ash in different extent like- 10%, 20%, 30%, 40% and 50% by mass. The examination reveals that high volume of fly ash in concrete lessens the water use and enhances the workability. Think likewise uncovers that the OPCC and HVFAC show comparative solidified properties. Examinations, for example, compressive strength test, slump test for workability. Consistency test, specific gravity test and so forth are done so as to decide the properties of fly ash, which can consider in the construction field. An examination is made between fly ash and concrete properties which are utilized as sub-grade, base in Highway construction. It would have been a decent circumstance if regular mechanical squanders like fly ash can be considered as an elective alternative to blend in concrete materials for highway construction with sparing arrangement.

I. INTRODUCTION

The shelter, street and Electricity are the fundamental requirement for each human. Fundamentally, every human move one place to somewhere else and Transportation system give them a superior way to move. The real wellspring of energy age in India is on the coal-based Thermal power plant, where 75% of the overall power is getting from these plants. During the time spent power age, a substantial measure of fly ash get delivered and end up accessible as a byproduct of coal based thermal power stations. Fly ash remains are a fine powder coming about because of the combustion of powdered coal - transported by the vent gases of the kettle and gathered in the Electrostatic Precipitators (ESP). Fly ash is characterized in Cement and Concrete Terminology (ACI Committee 116) as the finely separated buildup coming about because of the combustion of ground or powdered coal, which is transported from the firebox through the boiler by pipe gases. Fly ash is a fine powder, the particles of which are spherical in shape and range in approximate from 0.5 to 100 µ. They include primarily of silicon dioxide (SiO_2), which is available in two structures: amorphous, which is round and smooth, and crystalline, which is sharp, pointed and precarious; aluminum oxide (Al_2O_3) and iron oxide (Fe_2O_3). Fly ash is generally extremely heterogeneous, comprising of an invention of smooth particles with different demanding crystalline stages, for example, quartz, mullite, and different iron oxides.

A. Classes of fly ash

As per ASTM C-618 fly ash is comprehensively grouped into two noteworthy classifications: Class F and Class C fly ash. The central distinction between these two classes is the measure of calcium, silica, alumina, and iron substance. The synthetic properties of the fly ash are to a great extent impacted by the concoction substance of the coal burn (i.e., anthracite, bituminous, and lignite).

1) Classes "F" fly ash the combustion of old anthracite and bituminous coal normally creates Class F fly ash, which contains under 10% lime (CaO). Having pozzolanic properties, the polished silica and alumina of Class "F" fly ash requires a cementing agent, for example, Portland cement, quicklime, or hydrated lime, with the immediacy in the presence of water the end goal to respond and create the cementitious agent. Then again the increase of a chemical activator, for example, sodium silicate (water glass) to a Class "F" ash can swift the arrangement of a Geo-polymer.

2) Class 'C' fly ash - Class "C" fly ash created from the combustion of more young lignite or sub bituminous coal the most part of it contains over 20% lime (CaO). This sort of fiery debris does not require an activator and the substance of Alkali and sulfate (SO_4) are the most part is higher as compared with the Class "F" fly ash.

B. Types of Fly Ash

There are three sorts of fly ash created by thermal power plants:-

1) *Fly ash* - This type of fly ash is products from vent gases through Electrostatic precipitator in dry form. These fiery remains are fine material and have great pozzolanic property.
2) *Bottom powder* - This type of fly ash gathers at the base of the heater. It is a relatively coarse material and contains higher un-combustible carbons. It has zero or little pozzolanic property.
3) *Pond ash*- fly powder and base cinder when transported and dispose to the pond, it is named as Pond ash.

C. Use of fly ash in construction

Fly ash is utilized by antiquated time, at first it is utilized in less amount, however, now daily a noteworthy creation of fly ash is made. So its uses and breaks down is important to protect our environment from contamination. It is utilized as take after:-

1) The ROMANS normally utilized happening volcanic ash from Mount Vesuvius to cement the payment stones in their roadways. Numerous miles of this antiquated roadway, although tough by all accounts – still exist as useable highway.
2) Fly ash cement was first utilized as a part of the U.S. in 1929 for the Hoover Dam, where engineers found that it took into account less cement.
3) Major achievement in utilizing fly ash in cement was the construction of Hungry Horse Dam in 1948, using 120,000 metric tons of fly ash.
4) In January of 1974, The Federal Highway Organization demonstrated that "the supplanting of cement with fly ash of the request of 10% to 25% can be improved giving equivalent or better strength quality and durability.
5) In January 1983, the Environmental Protection Agency distributed government rules for concrete and cement containing fly ash, which boost the use of fly ash and build up consistence due dates.
6) The seven story structure of 10780m2 office space in Canada was built with HVFAC having compressive strength 30-50N/mm2.

II. GOAL AND SCOPE OF STUDY

The rewards of utilizing fly ash far outweigh the disadvantages. The most imperative advantage is decreased penetrability to water and forceful chemicals. Appropriately cured cement made with fly ash makes a denser item the fact that the extent of the pores is lessened. This expands quality and decreases penetrability.

A. Objective of this Examination

To test and investigations on fly ash cement arranged by fly ash ideal replacement with cement. 28 days compressive strength of fly ash concrete is to be checked.

B. Scope of work

Following procedure are involved to be improved the condition this work-

1) Experimental analysis is to be done on material to discover physical properties.
2) Materials are to be mixed in genuine extent and shaped into a cube.
3) In this examination, an ordinary grade of cement must be taken and get ready fly ash cement by adding fly ash with the most extreme substitution of cement. Different example, mixing extent of cement and fly ash, arranged, substitution of cement by weight 0%, 10%, 20%, 30%, 40% and 50%.
4) These different specimens of fly ash cement concrete are to be tried and typical 28 days compressive strength is to be checked.
5) Analyzing test results.

III. EXPERIMENTAL STUDY

A. Working Procedure

In this experimental study works are done in following steps as showing in flow chart:-

B. Collection of Material

Intended for fly ash concrete, materials are gathered and their physical properties additionally to characterize by conducting analyses. Materials ought to be qualities and acquired from appropriate place. The following materials are utilized for planning of fly ash cement concrete-

1) *Cement*-Ordinary Portland cement of 43 grade adjusting to Indian standard IS 12269(1987) was utilized for the present investigations.
2) *Fly Ash* -Fly ash got from "thermal Power Station (NTPC Tanda)". Slag gathered from close to the evaporator.
3) *Aggregates*-20 mm to 4.75 mm Aggregates taken as coarse Aggregates and beneath 4.75 mm totals taken as fine Aggregates.

C. Physical property of Material

Physical property as color, specific gravity, initial setting time, moisture content and so on, were controlled by the tests

D. Blending Process

Materials are weighted in legitimate strategy and as necessary for blending. A short time later, it blended in fitting means ostensible blend strategy. For this investigation M-20 grade of concrete was prepared, by ostensible blend strategy. For ebb and flow think about cement was blended in 1:1.5:3 extents and the water cement ratio was taken 0.55. Bond was substituted with fly ash, fly ash added at 10 % to half of the cement weight, which was utilized as a part of blending concrete. The material was blended as expressed in table 1, as follows.

Table -1: Material mixing proportions

Fly Ash Content	Fly Ash (kg)	Cement (kg)	Sand (kg)	Aggregates (kg)
0%	0.000	7.500	11.250	22.500
10%	0.750	6.750	11.250	22.500
20%	1.500	6.000	11.250	22.500
30%	2.250	5.250	11.250	22.500
40%	3.000	4.500	11.250	22.500
50%	3.750	3.750	11.250	22.500

E. Molding Process

The concrete mixer formed in cube sized 150 x 150 x 150 mm^3. Completely, six cubes were molded, in which 3 cubes tested after 7 days and rest three cubes tested after 28 days. Concrete is mixed by hand carefully and the concrete placed in cubes with the least delay. It was in good health compacted by tamping rod, temping as well as vibrating to eliminate all air voids subsequently placing.

F. Removing of Mold

Later 24 hours molds were separate. After de molding, each cube was marked with a readable proof of identity on the upper or bottom face using a waterproof marker.

G. Curing Process

Concrete cubes were cured, usually in fresh water for 7 to 28 days at room temperature. Curing plays an important role in attainment of strength of concrete. If the concrete cube not correctly cured, then, it will not achieve satisfactory strength and on the other hand, if concrete cubes cured in extra time then correspondingly its strength reduction. Curing procedure in concrete growths strength and reduce permeability.

H. Testing Process

After taking out from the mold, concrete cubes are verified in the laboratory. Various tests were finished.

For finding physical property of material, specific gravity of cement, initial setting time, moisture content and standard consistency was determined, to check the workability of the concrete slump test was accompanied, and for strength of concrete compressive strength was conducted by compressive strength testing machine.

IV. ANALYSIS AND TEST RESULT

Following tests were accompanied on materials and concrete

A. Physical property of Materials

Physical properties determined by leading proper experiments. Afterward standard consistency and initial setting time of cement and fly ash mix was determined,

Table- 2: Property of Materials

1	Physical Property of cement 1. Specific gravity 2. Moisture content 3. Initial setting time 4. Fineness modulus	3.15 33P 40-45 minutes 8%
2	Properties of Fly ash 1. Specific gravity 2. Moisture content	 2.27 19.48%
3	Property of Fine-aggregates 1. Standard consistency 2. Moisture Content	 2.70 8.86

B. Standard Consistency Test Results

The determination of the consistency test of the OPC 43 grade cement with fly ash is to control the percentage by weight of water to be added to cement, to make a paste of the standard Consistency. It is essential to decide the consistency of cement because other test such as initial setting time, final setting time, strength parameter is reliant on this normal consistency.

Table -3: Standard consistency of Fly ash and cement mix

Content Mix	Weight of cement (grams)	Weight of Fly ash (grams)	Consistency % (P)
0%	400	0	33.0
10%	360	40	32.0
20%	320	80	32.0
30%	280	120	31.0
40%	240	160	30.0
50%	200	200	30.0

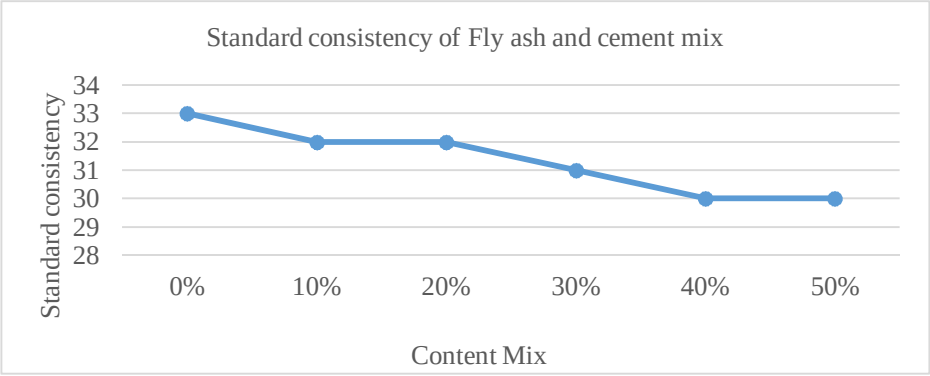


Figure- 1: Standard consistency of cement and fly ash mix Thus by results, we can see as amount of fly ash increased consistency decreased. As amount of fly ash increased in mix, it required less water as compared to cement.

C. The initial setting time test Results

The initial setting time is clear as the time occupied by paste to harden to an extent such that the Vicat's needle is not allowed to move down over the paste within 5±0.5 mm measured from the lowermost of the Vicat's mould. This is measured from the instant of water is added to the cement. Test results of initial setting time are shown in table 4 and graph is plotted as given in figure-2

Table -4: Initial setting time of Fly ash and cement mix

Content	Weight of cement (grams)	Weight of Fly ash (grams)	Initial setting time (minute)
0%	400	0	45
10%	360	40	50
20%	320	80	56
30%	280	120	65
40%	240	160	75
50%	200	200	90

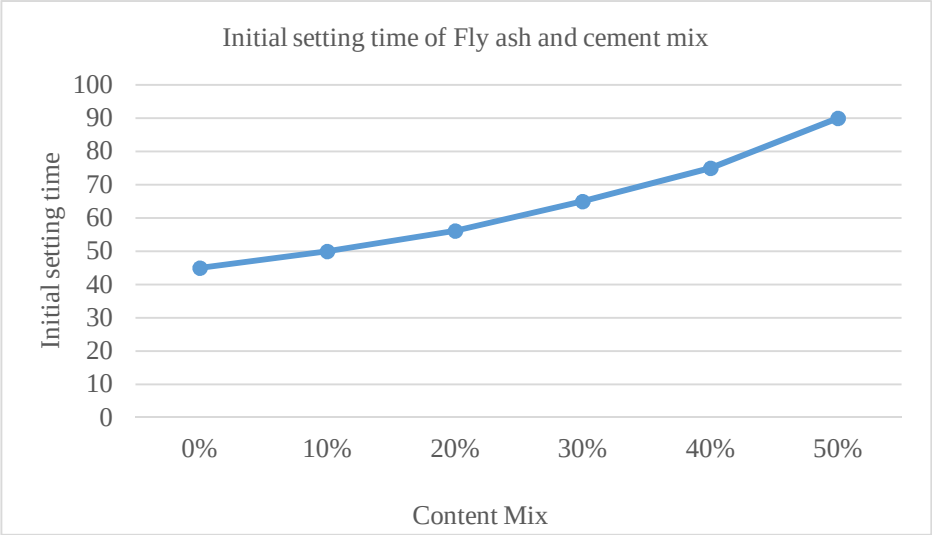


Figure- 2: Initial setting time of Fly ash and cement mix

Thus, by result, it can see that as amount of fly ash increased in cement, initial setting time also increased and it takes more time to settle.

D. The Final Setting Time Test Results

Final setting time is defined as the period elapsing between the time when is added to the cement and the time at which the needle makes an impression on the test block while the attachment fails to make it. The final setting time, therefore, indicates the complete loss of plasticity. Test results of Final setting time are shown in table 5 and graph is plotted as given in figure-3

Table -5: Final setting time of Fly ash and cement mix

Content	Weight of cement (grams)	Weight of Fly ash (grams)	Final setting time (minute)
0%	400	0	315
10%	360	40	342
20%	320	80	370
30%	280	120	395
40%	240	160	405
50%	200	200	372

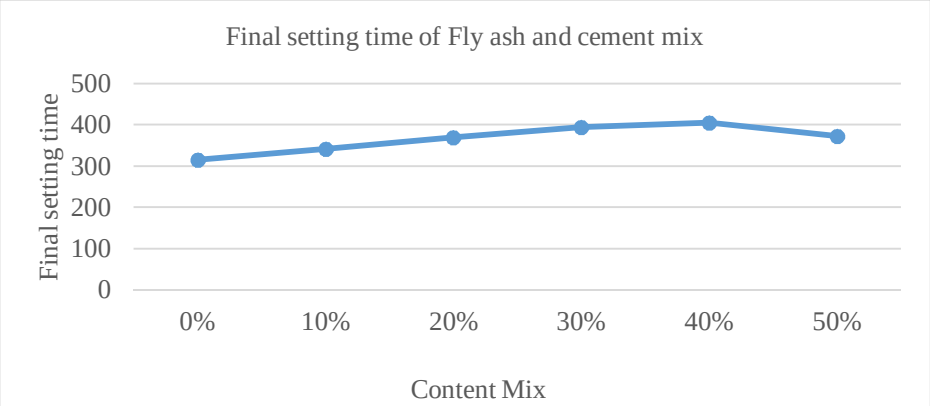


Figure- 3: Final setting time of Fly ash and cement mix

Thus, by result, it can see that as amount of fly ash increased in cement up to 40%, Final setting time also increased and after 40% addition of fly ash, final setting time starts decrees.

E. Slump Test Results

The property like workability of freshly mixed fly ash concrete evaluated and reported in terms of slump value. Table-6 shows the results of Slump Test of fly ash concrete. The given graph shown in Figure-4, is plotted from the Slump test results obtained during testing of fly ash concrete.

Table -6: Slump value of concrete

Fly ash content	Slump value (mm)
0%	25
10%	28
20%	33
30%	40
40%	45
50%	50

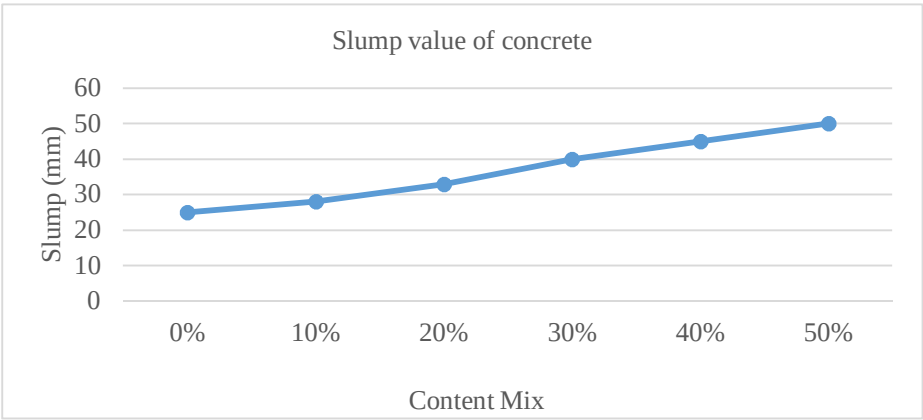


Figure- 4: Slump height of concrete mix

As the amount of fly ash increased slump values increased. Fly ash also has not more binding property so slump values increased. Water/cement ratio also plays an important role in preparing concrete, the amount of water for concrete mix is can be determined according standard consistency of cement. If water is added more it will wet concrete, which have less workability and strength. If water is added less it becomes stiff which is not useful.

F. Compressive Strength test Results

Table 7 shows the results of compressive strength of fly ash concrete at the age of 7 days and 28 days. The given graph shown in Figure-5 is plotted from the compression strength test results obtained during testing of fly ash concrete at the age of 7 days and 28 days.

Table -7: compressive strength of concrete

Concrete grade	Sample content	Compressive strength (7days) N/mm2	Compressive strength (28days) N/mm2
M 20	0%(only concrete)	27.00	35.92
	10% Fly ash	22.77	35.68
	20% Fly ash	19.23	31.17
	30% Fly ash	18.10	26.03
	40% Fly ash	16.96	25.82
	50% Fly ash	8.726	18.24

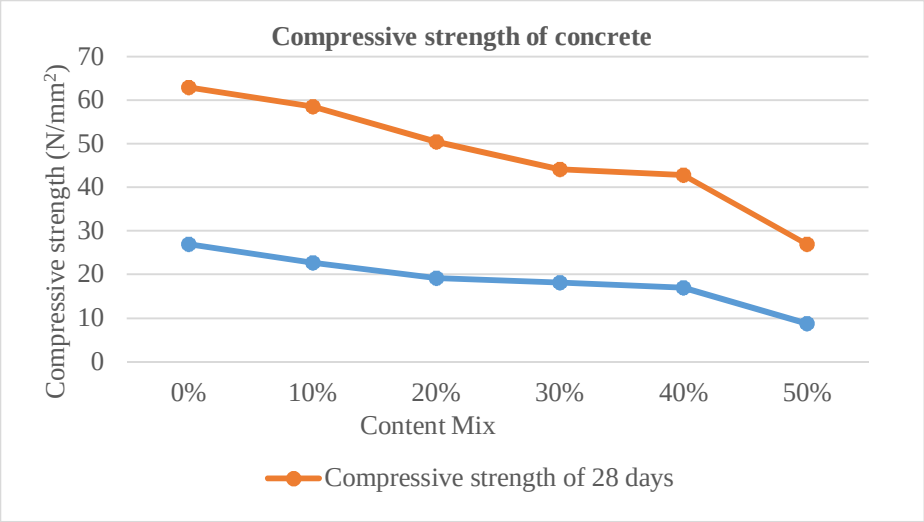


Figure -5: Compressive strength of concrete

Thus, it can see that as amount of fly ash increased compressive strength decreased, up to 30-40% are safe to use in the concrete mix and 50% fly ash cement concrete has not enough compressive strength to use for construction.

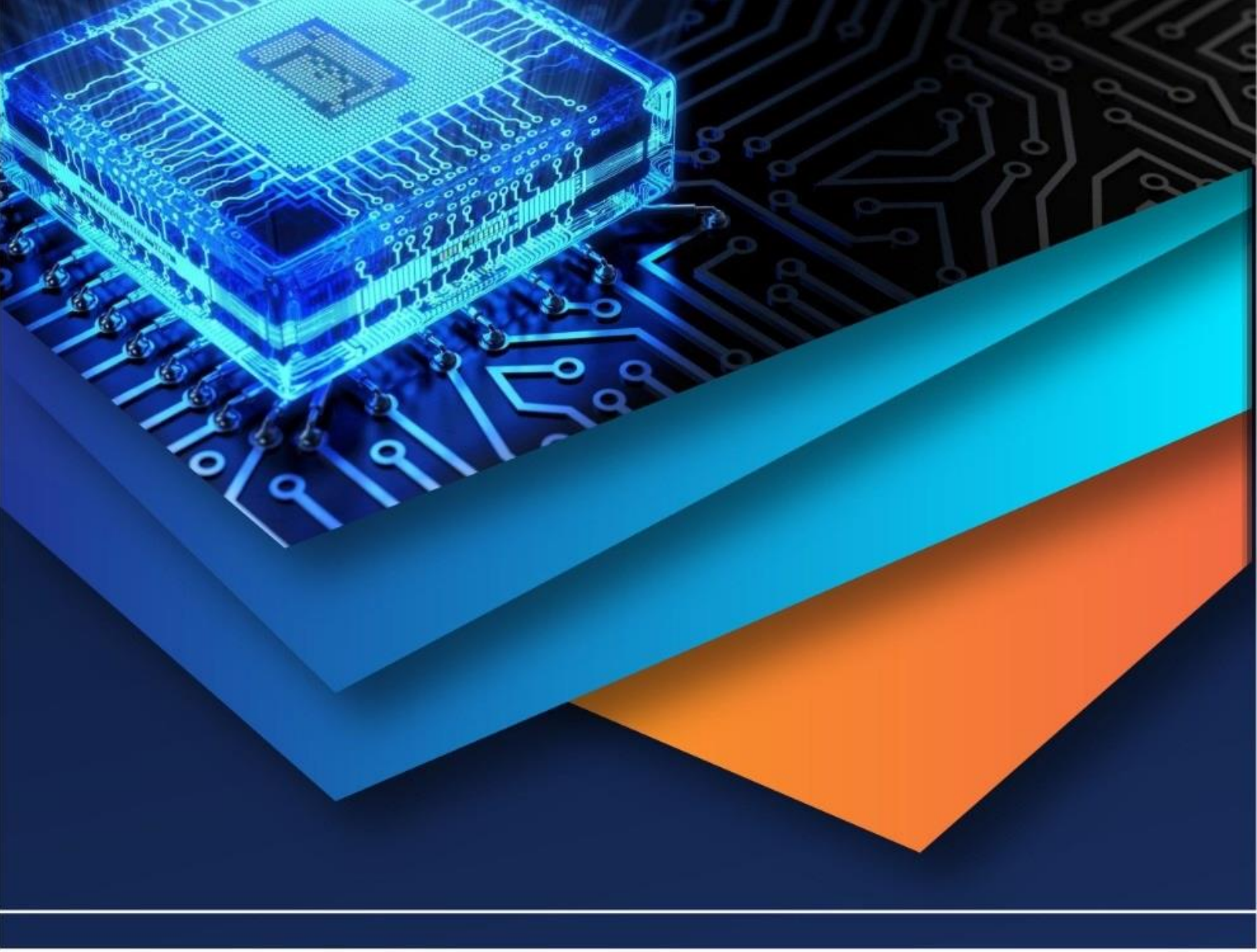
V. CONCLUSIONS

In present study physical properties of cement, fly ash, and fine aggregates determined, and then slump test conducted to check concrete workability, and compressive strength test to check its quality and compressive strength. Results are following-

A. Specific gravity of cement was 3.148 and fly ash 2.27, so the specific gravity of fly ash is less than to cement.
B. Standard consistency increased as amount of fly ash increased in the cement, fly ash mix that means less water quantity need to make cement fly ash mix paste.
C. Fly ash takes longer time to settle down as compared to ordinary Portland cement. Cement paste settles down in 45 to 50 minutes. On the other hand, as amount of fly ash increased its settling time also increased.
D. In slump test, fly ash cement concrete has more workability as compared to normal cement concrete.
E. Fly ash-cement concrete cube absorbs more water.
F. The compressive strength is approximately same as normal cement concrete. As the amount of fly ash increased, as compressive strength decreased. Replacement of fly ash to cement in concrete up to 30% is safe to use in road construction to sustain its better quality.

REFERENCES

[1] Tara Sen and Umesh Mishra, "Usage of Industrial Waste Products in Village Road Construction" International Journal of Environmental Science and Development, Vol. 1, No. 2, June 2010, ISSN:20100264.
[2] Mini Soman, Sobha.K, "Strength and Behavior of High Volume Fly Ash Concrete" International Journal of Innovative Research in Science, Engineering and Technology (An ISO 3297: 2007 Certified Organization) Vol. 3, Issue 5, May 2014.
[3] Tomas U. GanironJr, Analysis of Fly ash Cement Concrete for Road Construction, International Journal of Advanced Science and TechnologyVol.60, (2013), pp.33-44.
[4] Anil Banchhor, S. Krishnan, "Advantages of using Fly Ash in Concrete PPC or site mixing of OPC and Fly ash site"
[5] Indian practical civil engineer's handbook by P. N. Khanna.
[6] V.K. Mathur DGM (AUD), NTPC/CC Fly ash a resource material for construction industries. http://siteresources.worldbank.org/INTSARREGTOPTRANSPORT/3562298117827263241 5/21322969/FLY_Ash_prsntn.pdf.



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