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"A Study on Concrete by Adding Chemical Admixture and using M-Sand and by Partial Replacement of Cement by Fly Ash"

Srikrishna M. R, V. Ramesh, Raghavendra Y. B

Abstract: - The utilization of Fly ash in concrete as partial replacement of cement is gaining immense importance today, mainly on account of the improvements in the long term durability of concrete combined with ecological benefits. Scarcity of good quality Natural river sand due to depletion of resources and restriction due to environmental consideration has made concrete manufacturers to look for suitable alternative Fine aggregate. One such alternative is "Manufactured Sand". In this paper, an attempt has been made to find out the strength of cement concrete containing Fly ash as a puzzolanic material, Manufactured sand and Chemical admixture. Through standard parameters about 24% of cement is replaced by class F Fly ash, 100% replacement of Natural sand is done by Manufactured sand, SNF based Chemical admixture is added by 0.6% of cementitious materials and PCE by 0.5% of cementitious materials is added to the concrete to reduce the water content during the mix and to increase the strength parameters. Mix designs were made for M35 and M25 standard concrete mixes and their Strength parameters such as Compressive strength test, Flexural test and Test on cylinders were studied at 7, 28 and 56 days and Durability tests such as Acid test and Base test were studied at 56 days. Studies revealed that the cost whole Concrete mix will become economical than normal concrete mix. Comparing SNF and PCE, PCE in Concrete mix gave better results than SNF in almost every parameters.

Keywords: Fly Ash, Compressive strength, Modulus of Rupture, Durability, SNF, PCE

I. INTRODUCTION

In view of Global warming, efforts are on to reduce the emission of CO_2 to the environment. Cement industry is a major contributor in the emission of CO_2 as well as using up high levels of energy resources in the production of cement. By replacing cement with a material of puzzolanic characteristic, such as Fly ash, the cement and concrete industry together can meet the growing demand in the construction industry as well as help in reducing the environmental pollution. India is a resourceful country for Fly ash generation with an annual output of over 110 million tones, but utilization is still below 20% in spite of quantum jump in last three to four years.

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***** Correspondence Author
Srikrishna M. R*, M.Tech (CCT), East Point College of Engineering and Technology, Bangalore, India.
Dr. V. Ramesh, Professor and Head of Civil Engineering Department, East Point College of Engineering and Technology, Bangalore, India.
Raghavendra Y. B, Deputy Manager in Ultra Tech, East Point College of Engineering and Technology, Bangalore, India.

Availability of consistent quality Fly ash across the country and awareness of positive effects of using Fly ash in concrete are pre requisite for change of perception of Fly ash from a 'A Waste Material' to 'A Resource Material'.
With the world wide decline in the availability of construction sand along with the environmental pressures to reduce extraction of Sand from rivers, the use of Manufactured sand as a replacement is increasing. With the ban on sand mining implemented by different states and with the increasing demand for river sand for construction works, many civil engineers have expressed the need to promote use of Manufactured sand in the construction industry. All round the globe effort are being made to make concrete a more exact material and introduction to admixtures has been one of the most notable contributions to concrete technology. Today efforts are made not only to improve concrete's compressive strength but also durability. Durability has gained worldwide concern because experts believe that the expenditure in rehabilitation and resurrection of concrete structure in near future going to be equal to the expenditure of new construction. Admixtures are used to change the rheological properties of concrete or mortar to make them suitable for the work at hand, or for economy, or for such other purpose as saving energy.

II. MATERIALS

The materials used in the experiment are:
a. Cement
b. Fine aggregate
c. Coarse aggregate
d. Water
MINERAL ADMIXTURES
The admixtures used in this experiments are:
Class F Fly Ash
CHEMICAL ADMIXTURES
The chemical admixtures used in this experiment:
a. SNF
b. PCE

III. METHODOLOGY

1. Based on Physical and Chemical Properties, the materials were selected for the project as ingredients of concrete.
2. Different material tests were conducted to check the suitability of materials for the study.
3. Different mix designs is to be prepared and from that the proportions and quantities of materials for concrete mix is calculated.

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4. Casting and Curing of Cubes, Cylinders and Beams are done.
5. Tests were conducted on above specimens at 7, 28 and 56 days.

Experiment results of Material tests:

The average Specific gravity of Cement was found to be **3.08.**

The average Specific gravity of Fly ash was found to be **2.45.** The average Fineness modulus of Fine aggregate (M-Sand) was obtained as **2.75**. This confirms to **Zone II** according to IS: 383 – 1970. The tested Coarse aggregate sample confirms to the requirement of graded aggregate as per IS: 383-1970 (RA in 2007)

IV. MIX PROPORTIONS

Cement = 320 kg/m^3
Fly ash = 100kg/m^3
M-Sand = 783 kg/m^3
Coarse aggregate:
20mm = 646 kg/m^3
12.5mm = 431 kg/m^3
Water = 157litres
Chemical admixture:
PCE = 2.1 kg/m^3
SNF = 2.52 kg/m^3
Water – Cement ratio = 0.40

V. EXPERIMENTS ON CONCRETE

5.1 COMPRESSIVE STRENGTH TEST

Procedure - The specimen was tested after the surface is dried on removal from the curing water in which it has been stored. Any loose material was removed from the sides of the specimen. The bearing surfaces of the testing machine was wiped clean and the specimen was placed in the machine in such a manner that the load was applied to opposite sides of the cube as cast, that is, not to the top and bottom. The axis of the cube was carefully aligned with the centre of thrust of steel plates bearing the testing machine. No packing other than auxiliary steel plates was used between the faces of the specimen and steel plates of the testing machine. The load on the specimen was applied without shock until failure occurred. The maximum load at failure was noted. Test value is tabulated in table 4.9 shows cast of specimen and typical specimen failure. The formula used for calculation is as follows,

$$Compressive\ Strength = \frac{Loads\ in\ KN}{\text{Area in mm2}}$$

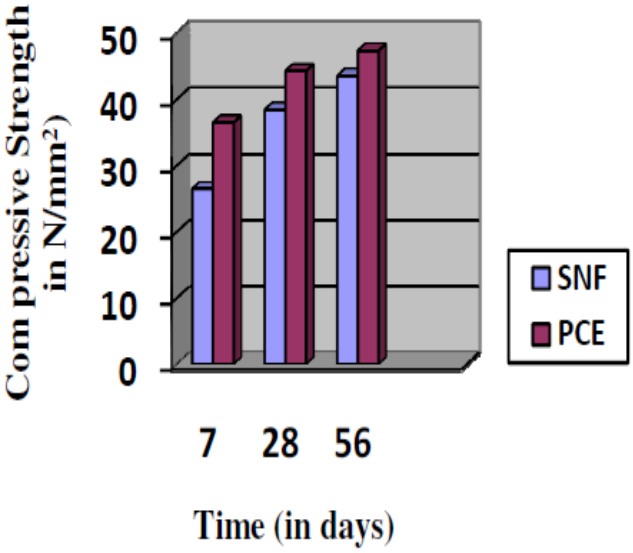

Figure 1: Graphical representation of behavior of SNF & PCE in M35 grade concrete of cube specimen

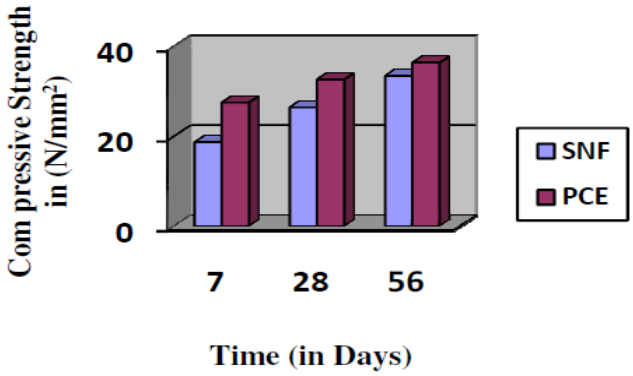

Figure 2: Graphical representation of behavior of SNF & PCE in M25 grade concrete of cube specimen

Discussions on Results

The properties of Concrete by using 53 Grade Ordinary Portland Cement, Fly ash, Manufactured Sand, Coarse Aggregate and Chemical Admixtures were investigated and compared with Normal Cement Concrete as per Indian code provisions. Here after studies, we observed that the Compressive Strength of the cubes were more than 35N/mm² and 25N/mm² for both SNF and PCE on both M35 and M25 at 28 days respectively and the Compressive Strength at 7 and 56 days were also greater than nominal values of Normal Concrete. Further if we compare in between SNF and PCE, the Compressive strength of Concrete for which PCE is added gave more values than SNF at 7, 28 and 56 days both in M35 and M25.

5.2 FLEXURAL STRENGTH TEST

Place the specimen on its side, centered in the machine in such a manner that a minimum of 25mm of the beam extends outside the support rollers. Apply a load of between 3 and 6% of the expected ultimate load. If full contact is obtained between the specimen and the load-applying blocks and the supports so that there is no gap longer than 25mm, test the specimen without further preparation.

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The load may be applied rapidly until approximately 50% of the breaking load has been reached. Beyond that point, reduce the rate of loading and record the total load required to break the beam.

Modulus of rupture, $R = PL/(bd^2)$

Where,

R= Modulus of rupture in MPa

P= Maximum applied load N

L= Span length mm

b= Avg. Width of specimen=150mm

d= Avg. Depth of specimen =150mm

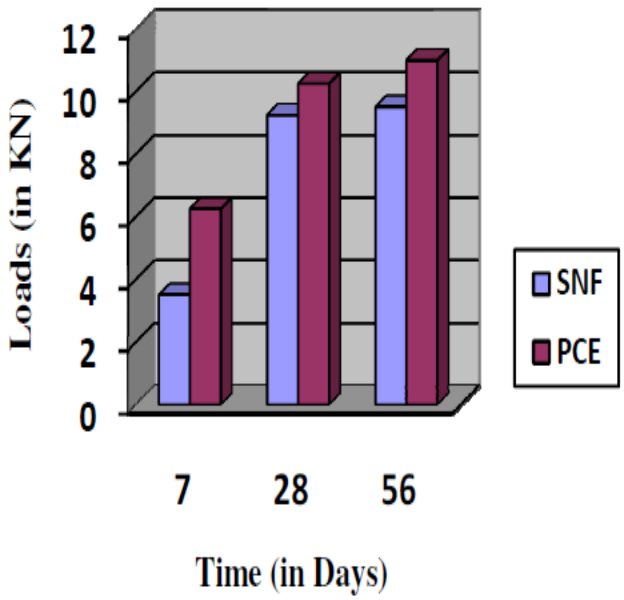

Figure 3: Graphical representation of behavior of SNF & PCE in M35 grade Concrete

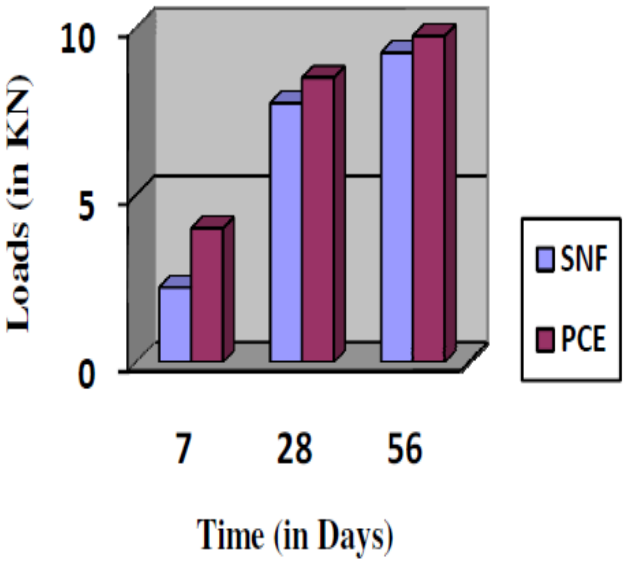

Figure 4: Graphical representation of behavior of SNF & PCE in M25 grade Concrete

Discussions on Results

Here after studies we observed that the Modulus of Rupture of beams were more than the nominal values of a Normal concrete for both SNF and PCE on both M35 and M25 at 7, 28 and 56 days respectively. Further when comparing SNF and PCE, the Modulus of Rupture of beams where PCE is added gave more values than SNF on both M35 and M25.

5.3 TESTS ON CYLINDERS

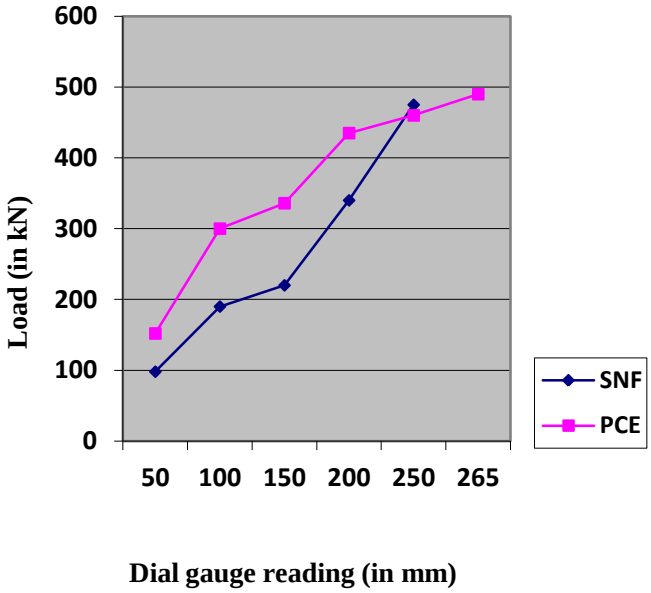

Figure 5: Behavior of PCE & SNF in M35 at 28 Days

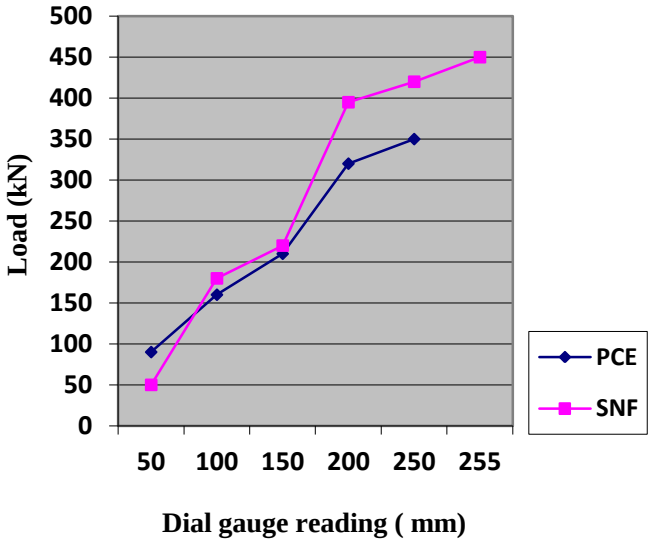

Figure 6: Behavior of PCE & SNF in M25 at 28 Days

Discussions on Results

Here in this Test on Cylinders, mainly we observed the behavior of the specimen when adding PCE and when adding SNF at 28 days on both M35 and M25. After studies on Dial gauge vs. Load readings and graphs, we observed that the behavior of PCE is good and better than SNF at 28 days on both M35 and M25. Similar tests were conducted on 7 and 56 days also and we found the same behavior on SNF and PCE.

5.4 DURABILITY TESTS

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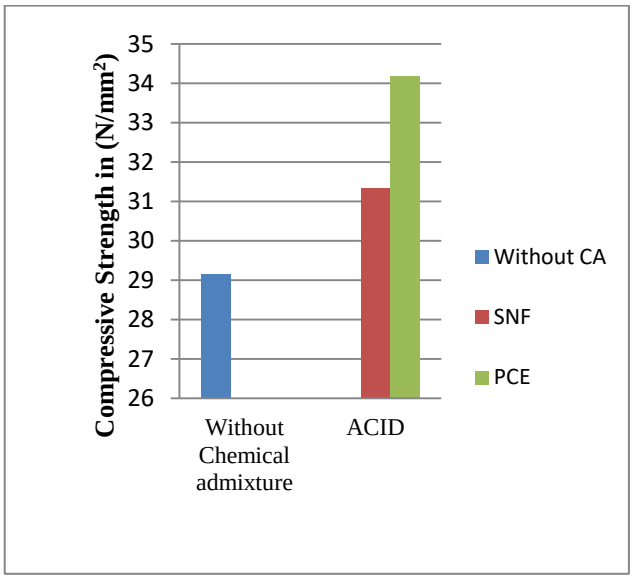

Figure 7: Comparison of Compressive strength of cubes in Acid solution (HCl) without Chemical admixture and when SNF, when PCE is added for M25 grade

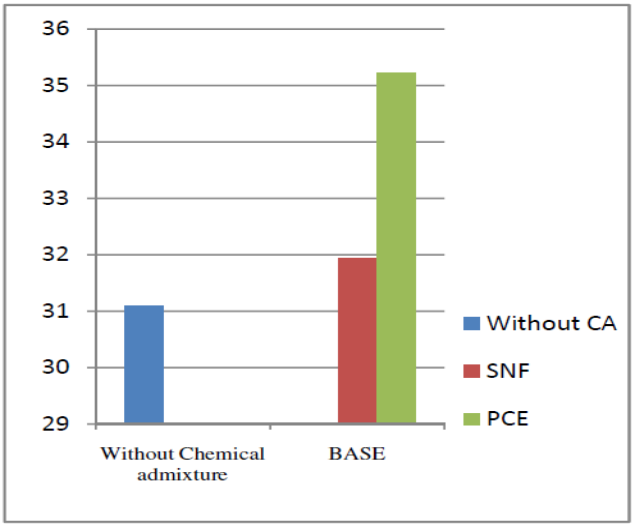

Figure 8: Comparison of Compressive strength of cubes in Base solution (Na_2SO_4) without Chemical admixture and when SNF, when PCE is added for M25 grade

Discussions on Results

Here after evaluation of results it is observed that some acid base attack has been happened for all the cubes. But the Compressive Strength of Concrete which had SNF and which had PCE was more than that of the Compressive Strength of Concrete which didn't had any Chemical admixtures. This says that the Concrete which had SNF or PCE admixture affected less Acid and Base attack. Further when we compare with SNF and PCE, it says that the Compressive Strength of the Concrete which had PCE admixture had more values than SNF admixture. Durability tests were also conducted for M35 grade of concrete mix and we have got the similar results as in case of M25.

VI. CONCLUSION

Finally by this study we can conclude that, if we use the materials for Concrete such as partial replacement of Cement by Fly ash, Manufactured Sand, Coarse Aggregate, Water, SNF or PCE, the cost of whole Concrete mix will become economical than Normal concrete mix and further if we compare SNF and PCE, PCE in Concrete mix gave better results than SNF in every parameters which we have tested. We can also conclude that if we use PCE, it gives results of almost next two grades of Concrete mixes.

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