International Journal of Civil and Structural Engineering Research ISSN 2348-7607 (Online)
Vol. 3, Issue 1, pp: (128-133), Month: April 2015 - September 2015, Available at: www.researchpublish.com

Experimental Investigation on Strengths and Durable Properties of Concrete on Manufactured Sand and GGBS with Chemical Admixtures

[1]Lokesh Gowda, [2]Dr. V. Ramesh, [3]Srinivas Raju

[1, 3]Research Scholar, [2]Head Of Department, [1,2,3]Department of Civil Engineering, EPCET, India.

***Abstract*: Availability of natural sand has reduced dramatically due to over exploitation. Environmental concerns are being raised against extraction of natural sand. The arguments are mostly in regards to protecting riverbeds against erosion and the importance of having natural sand as a filter for ground water, so there is a need for alternative source for fine aggregates. This paper presents experimental investigation carried out to evaluate use of manufactured sand as a full replacement as fine aggregate. The cost of the cement in market is being increased drastically as the partial replacement of cement with GGBS is being carried out. Its known that the scarcity of water in the high-tech cities and construction is high boom so to enhance water scarcity the chemical admixtures are being added. Results of compressive and tensile strength and durability properties of concrete are been presented in this paper and optimum percentage of replacement has been suggested. Concrete traditionally consists of cement, fine aggregate, coarse aggregate and water. An attempt has been made to replace the fine aggregate with manufactured sand with an objective of utilizing the waste material. It is found that manufactured sand improves the mechanical properties of concrete when used along with super plasticizers.**

Keywords: **admixtures; manufactured sand; GGBS; concrete; compressive strength.**

1. INTRODUCTION

Concrete is an artificial conglomerate stone made essentially of Portland cement, water, fine and coarse aggregates. The mixture of the materials results in a chemical reaction called hydration and a change in the mixture from plastic to a solid state occurs over a period of time. The cost of concrete can be reduced by reducing cost of constituent materials. Cost reduction can also be achieved by using locally available alternative material, instead of conventional materials. The worldwide consumption of fine aggregate in concrete production is very high, and several developing countries have encountered difficulties in meeting the supply of natural fine aggregate in order to satisfy the increasing needs of infrastructural development in recent years. To overcome the stress and demand for river fine aggregate, researchers and practitioners in the construction industries have identified some alternative materials such as fly ash, slag, limestone powder and siliceous stone powder. In India attempts have been made to replace river sand with manufactured sand.

The successful utilization of manufactured sand as fine aggregate would turn this waste material that causes disposal problem into a valuable resource. The utilization will also reduce the strain on supply of natural fine aggregate, which will also reduce the cost of concrete. The main objective of the present investigation is to evaluate the possibilities of using manufactured sand as a replacement to fine aggregate along with super plasticizer at a dosage of 0.5 and 1 % by weight of cementitious material. During the present study, 10%, 20%, 30%, 40%, 50% and 55% of GGBS was replaced with cement. For fine aggregates the manufactured sand is being replaced. For each mix, 0.5 and 1% of super plasticizers by weight of cement was added. Compression, split and flexural strengths and its durability were found after 7, 28 and 56 days of curing.

2. MATERIALS

The materials used in the experiment are:

a. Cement

b. Fine aggregate

c. Coarse aggregate

d. Water

MINERAL ADMIXTURES:

The admixtures used in these experiments are:

a. Ground granulated blast furnace slag

CHEMICAL ADMIXTURES:

The chemical admixtures used in this experiment:

a. Super plasticizer-PCE (For workability)

b. Super plasticizer-SNF (For workability)

3. METHODOLOGY

A) Material collection of GGBS and manufactured sand.

B) Physical Tests to be conducted on GGBS

C) Preparation of mix design for M20 grade

D) Adding of GGBS of 0, 10, 20, 30, 40,50,55% in cement

E) Making number of samples of concrete cubes

F) Testing of cubes was done for 7, 28 & 56 days

The following testes are to be conducted on specimens

- Compressive strength
- Flexural strength
- Split tensile test
- Durability test

Specific gravity of GGBS

Specific gravity of GGBS = 2.82

4. MIX PROPORTIONS FOR M20 GRADE

Cement = 145 kg/m^3

GGBS = 170 kg/m^3

Water = 157 litre

Fine aggregate = 800 kg/m^3

Coarse aggregate = 1112 kg/m^3

Chemical admixture = 2.1 kg/m^3

Water – Cement ratio = 0.50

5. CASTING AND CURING

The Cubes and beam moulds are assembled on the concrete leveled flooring with a paper between the mould and the floor. The inner side of the mould is lubricated properly. Cover blocks of sufficient thickness are placed below the bottom of the case so that the required effective depth is maintained. The materials are mixed in the electronically operated mixer thoroughly to get the uniformity. The concrete is placed in the moulds in two layers and compacted with tamping rod. The moulds are de molded after 24 hours of casting. After the required period of curing, the specimens are taken out of the curing tank, wiped off the moisture and the surface is made dry.

The physical properties of concrete depend to a large extent on the degree of hydration of the cement and the resultant microstructure of hydrated cement. It is necessary to create conditions of temperature and humidity during a relatively short period immediately after placing and compaction of concrete, favorable to the setting and hardening of concrete. The process of creation of a favorable environment is termed as curing. The cube cylinder and beam specimen was kept in water for 7, 28, 56 days of curing before conducting the tests.

Experimental work:

The specimens required for compressive strength test (both number of specimens and its size) are cast with established Concrete mix proportion, as per the relevant codal requirement, the details of which are as given below. To study the compressive strength behavior of M20 grade concrete in which cement is partially replaced. The cube specimens of size 150mmx150mmx150mm and beam specimen of 500x100x100 and column of 300x 150dia are prepared. The cubes ,beams and columns each tested for 7, 28 & 56 days. Compressive, split tensile and flexural strength of modified concrete is compared with another chemical admixture.

6. TEST PROCEDURE AND RESULTS

Compression test:

After 28 days of curing, the cubes were taken out of the curing tank, dried and tested using a compression machine. These cubes were loaded on their sides during compression testing such that the load was exerted perpendicularly to the direction of casting. The cubes were placed in the compression testing machine and the loads are applied gradually. The average value of the compression strength of three cubes was taken as the compression strength. Three conventional concrete cubes with manufactured sand and GGBS of 53% were also cast and tested. The compressive strength of conventional concrete was found to be 27.88 N/mm^2 . The compressive strength of concrete with manufactured sand and super plasticizer are given in Fig.1

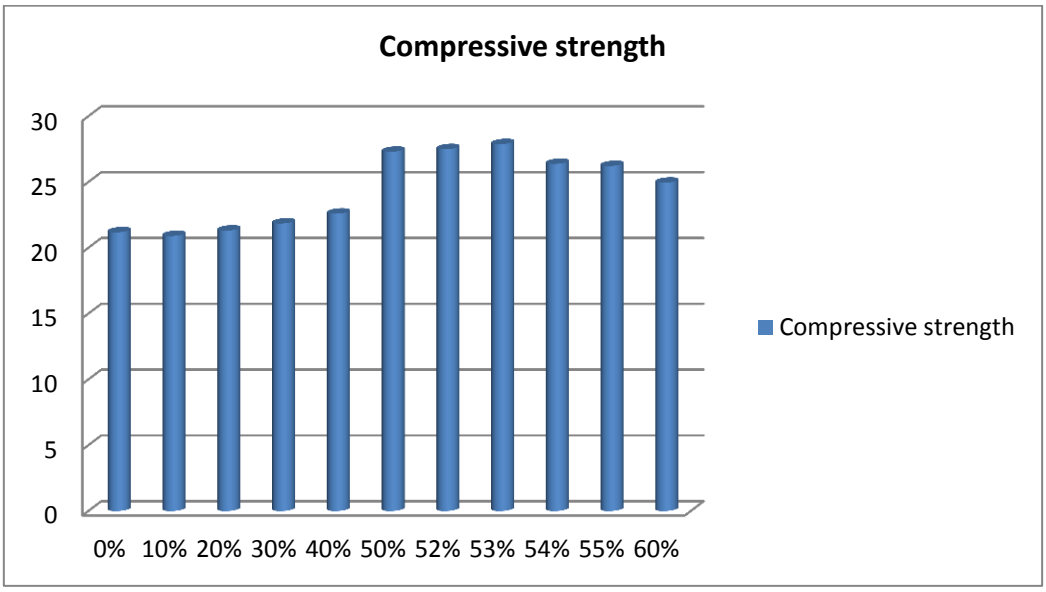


Fig.1 The strength variation is to be shown in graph of various replacements of GGBS

The Compressive Strength is more for the modified concrete with a super plasticizer dosage of PCE compared to SNF. The percentage increase in strength is 27.29 % more for the PCE than SNF having a super plasticizer dosage of 0.45%.

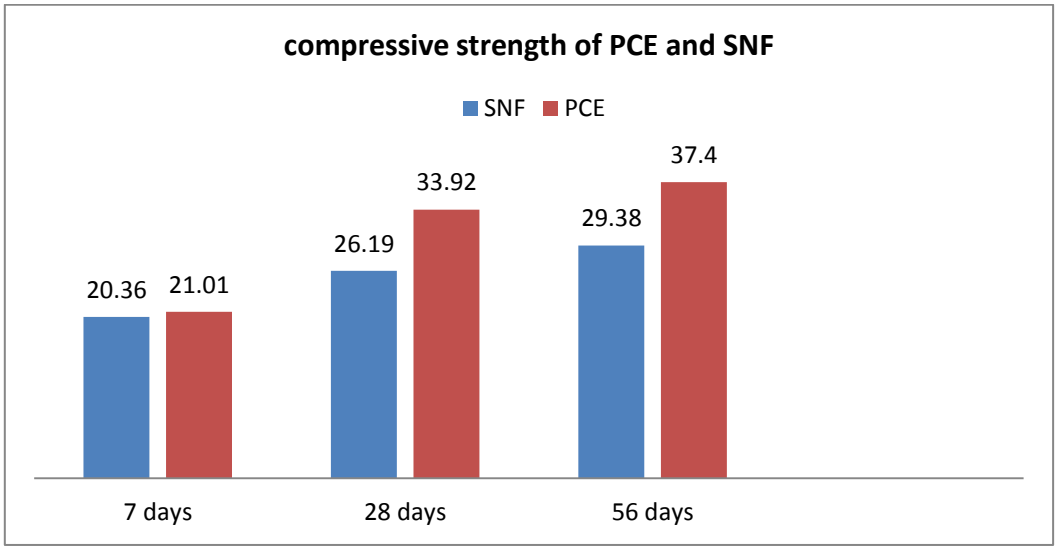


Fig.2 The strength variation is to be shown in graph of PCE and SNF chemical admixture

SPLIT TENSILE STRENGTH TEST:

The cylindrical specimens of diameter 150mm and height 300mm were used to determine the split tensile strength. The specimens were tested in computerized universal testing machine of capacity 1000 kN. Three cylindrical specimens were tested for each percentage of replacement. The cylinders were placed in the machine horizontally. Load was applied gradually at a uniform rate until the specimens failed. Split tensile strength was taken as the average strength of three specimens. Three conventional concrete cylinders with super plasticizer and manufactured sand and with GGBS of 53% replacement were also cast and tested. The split tensile strength of conventional concrete was found to be 8.67 N/mm2 for PCE and 2.07 N/mm2 . The split tensile strength of concrete with super plasticizer and manufactured sand and with GGBS of 53% replacement are given in fig.3

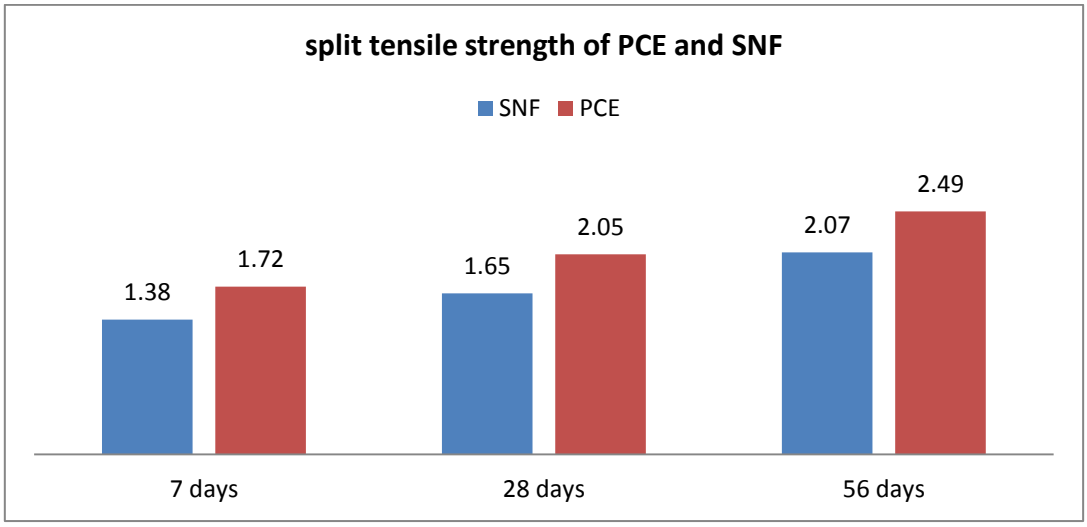


Fig.3 The split tensile strength variation is shown in graph for PCE and SNF admixture

From the figure, it can be seen that as the Curing period increases, the Split Tensile Strength also increases. The Split Tensile Strength is more for the concrete with a super plasticizer of PCE than SNF modified concrete. The percentage increase in strength is 20.29%.

FLEXURAL STRENGTH TEST:

The prism specimens of size 500 x 100 x 100 mm were used for the determination of the flexural strength. The bearing surface of the supporting and loading rollers were wiped clean and any other loose fine aggregate or other materials removed from the surface of the specimen where they are to make contact with the rollers. The specimen was then placed in the machine and two point load was applied. Load was increased until the specimen failed and the load at failure was

recorded and the flexural strength was determined. Flexural strength was taken as the average strength of three specimens. Three conventional concrete prisms with manufactured sand and GGBS of 53% and super plasticizers were also cast and tested. The flexural strength of modified concrete for SNF was found to be 6.16 N/mm2 and PCE to be 13.66 N/mm2. The flexural strength of concrete with manufactured sand and GGBS of 53% and super plasticizers are given in fig.4

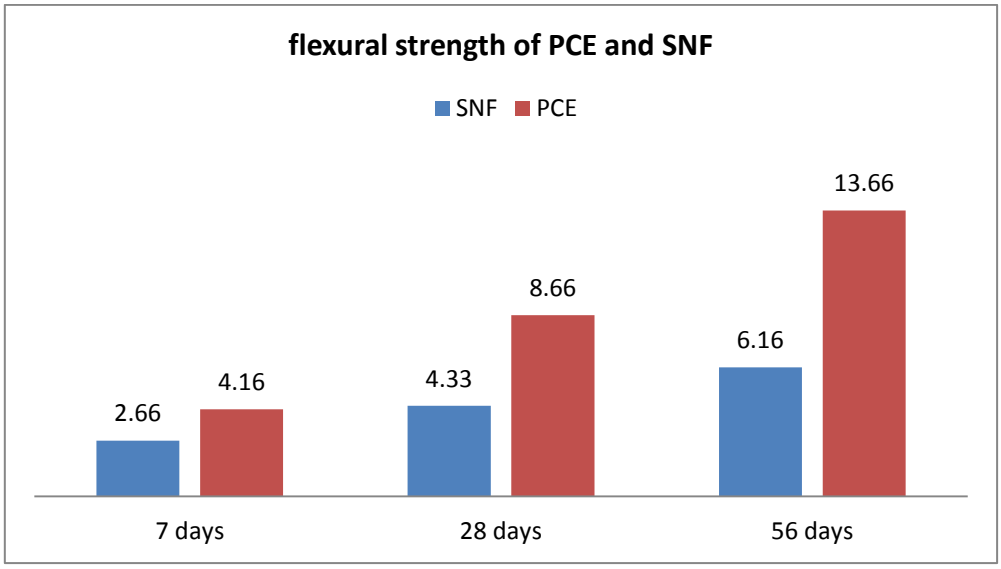
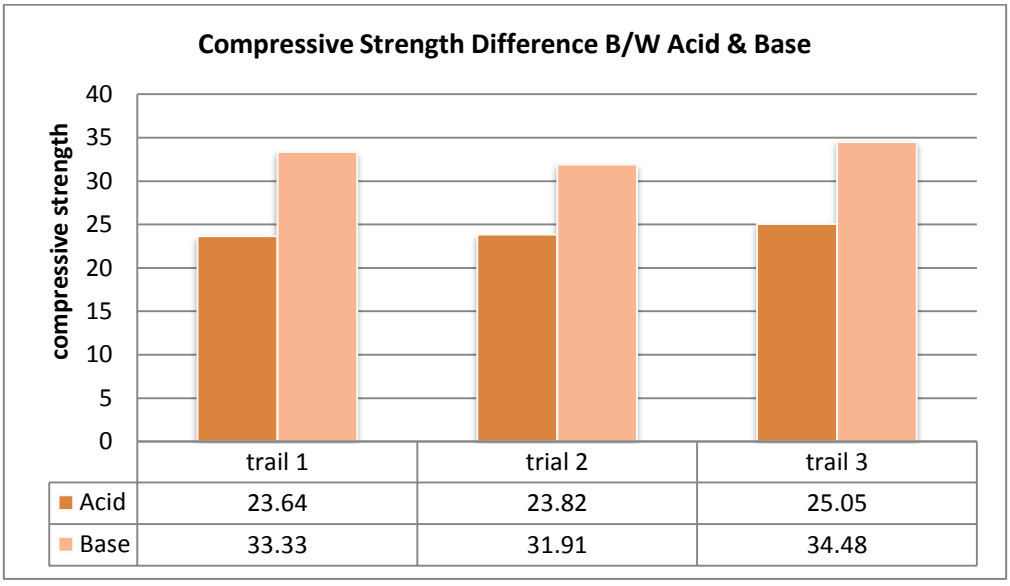


Fig.4 the Flexural strength variation is shown in graph for PCE and SNF admixture

From the figure, it can be seen that as the Curing period increases, the Flexural Strength also increases. The Flexural Strength is more for the concrete with a super plasticizer of PCE than SNF modified concrete. The percentage increase in strength is 220%

Durability Test:

The cube specimens of 150x150x150 were cured for 28 days in the water. Then weighed and kept in the acid (HCL) and base (N_2 SO_4) solutions of the quantity of solution added for immersing of cubes is of 20%. Then the specimens are kept for 28 days for reactions to happen. Then the specimens took from the acid and base solutions for testing in compression machine. Three conventional concrete cubes with manufactured sand and GGBS of 53% were tested.



From the figure, it can be seen that the PCE admixture is obtained high strength compare to SNF chemical admixture for no. of trials .Thus by adding PCE admixture we could attain and achieve the durability and its strength. The decrease in strength for 56 days curing to the ACID attack is 12.72 N/mm^2 and for BASE by 2.92 N/mm^2

7. CONCLUSIONS

The untreated GGBS was used as partial cement replacement in concrete after sieving in 450microns. This GGBs, by its chemical composition, this would fulfill the standard requirements on concrete admixtures thus the prepared concrete had acceptable properties. The 28-days compressive strength of material with 53 % cement replacement was comparable with the reference concrete and its optimization was found to be 53% of replacement with the cement. The cost analysis of the GGBS compared to cement is low by 80% the prepared concrete contained relatively high content of GGBS and based on this experimental investigation, it is found that quarry dust can be used as an alternative material to the natural river sand. The physical and chemical properties of quarry dust satisfy the requirements of fine aggregate. It is found that quarry dust improves its mechanical property of concrete if used along with super plasticizer. Usage of quarry dust it will also reduce the cost of concrete Thus the addition of 0.45% of chemical admixture enhances the scarcity of water and increases the workability of concrete. ; This approach represents a compromise between the ecological request on a practical utilization of GGBS and M.sand and properties of the acquired product. Thus by the results we can practice PCE chemical admixture as water reducers and increase workability for the modified concrete.

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