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Experimental Investigation on Quarry Dust Concrete with Chemical Admixture PCE and SNF

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Abstract: **In this technical paper the experiment carried on the compressive strength of various grades of concrete with the replacement of sand by manufactured sand and with the addition of chemical admixture is discussed. Concrete plays a very important role in the construction industry and is being utilized in a large scale. River sand, which is one of the constituent used in the production of conventional concrete, has become expensive and also a scarce material. In view of this there is a need to find an alternative source for the replacement of this river sand, which will be having the same properties of the river sand thus a alternative quarry dust is being selected and is made used in a concrete as an alternative for river sand in addition with the chemical admixtures Polycarboxylic ethers (PCE) and salphonapthalene formaldehyde (SNF). Concrete traditionally comprises of cement, fine aggregate, coarse aggregate and water. An attempt here has been made to replace the fine aggregate with quarry dust with an objective of utilizing the waste material. It is found that quarry dust improves the mechanical properties of concrete when used along with super plasticizers. In fact we need high strength concrete to withstand to the heavy loads in a building. The sand is replaced by manufactured sand by 100% and various chemical admixtures being added to increase the workability of a concrete.**

Keywords: **Quarry dust, chemical admixture, Workability, Compressive strength, Flexural strength.**

1. INTRODUCTION

The concrete is an constitute made essentially of Portland cement, fine aggregates, coarse aggregates and water. The mixture of the materials will undergo in a chemical reaction called hydration and this process will result in a change of mixture from plastic state to a solid occurs over a period of time. By reducing the cost of the constituent's materials in a concrete, the cost of concrete can be reduced. The cost reduction can be achieved by the usage of locally available alternative materials, instead of conventional materials. The consumption of fine aggregate in concrete production is very high throughout the world , and several developing countries have facing difficulties in meeting the supply of natural fine aggregate in order to satisfy the increasing needs of infrastructural development in recent years. To the solution for the stress and demand for river fine aggregate, researches have being conducted and an alternative materials such as fly ash, slag, limestone powder and siliceous stone powder is been made used. The attempts for the replacement of river sand by quarry dust have been made in India. Quarry dust, the waste material that causes disposal problem is made as a valuable resource by the successful utilization of this quarry dust as a fine aggregate and this will also overcome the strain on supply of river sand as fine aggregate and also the cost will be reduced. To evaluate the possibilities of replacement of fine sand aggregate with the quarry dust along with super plasticizers such as PCE and SNF at different dosages is the main objective of the present investigation.

During the present study, 100% replacement of fine sand aggregate by quarry dust was made and for each grade of concrete selected the two super plasticizers PCE and SNF been added at preferred dosages. The compression, flexural and split strengths were found after 7, 28 and 56 days of curing.

2. LITERATURE REVIEW

 Sivakumar and Prakash M. - The investigation on the mechanical properties of concrete with quarry dust is carried out. They reported that the quarry dust may be used as an effective replacement material for natural river sand which increased the strength.

 Ilangovana. R. carried out an investigation on strength and durability properties of concrete containing quarry rock dust as fine aggregate. It was reported that the physical and chemical properties of quarry rock dust as well as the durability of quarry rock dust concrete under sulphate and acid action was better than that of conventional concrete.

 Nima Farzadnia explored the possibility of incorporating mineral admixtures in sustainable high performance concrete. It was found that mineral admixtures, whether industrial by products or agro-waste minerals, used to reduce cost of concrete.

 Shanmugapriya .T and Uma .R. N. made an investigation on optimization of partial replacement of M-sand by natural sand in high performance concrete with silica fume. It was reported that M-sand and silica fume increased the flexural and compressive strength.

 Devi .M and Kannan. K. carried out an investigation on strength and corrosion resistance behaviour of inhibitors in concrete containing quarry dust as fine aggregate. The incorporation of inhibitors as admixture did not show any adverse effects on the strength properties and there was an increase in strength up to certain percentage. The addition of inhibitors as admixture to concrete was found to lower the permeability and water absorption.

3. MATERIALS

Cement:

Ordinary Portland Cement (53 Grade) with specific gravity of 3.16 was used for this experimental investigation.

Fine Aggregate (Natural River Fine Aggregate):

Locally available river sand having density of 1550 kg/m 3 and fineness Modulus (FM) of 2.66 was used. The specific gravity was found to be 2.62. The fine aggregate was found to be confirming to Zone III as per IS 383:1970.

Coarse Aggregate:

Natural granite aggregate having density of 1500 kg/m^3 and fineness modules (FM) of 7.05 was used. The specific gravity was found to be 2.84 and maximum size of aggregate was 20mm.

Quarry Rock Dust:

Quarry dust is fine rock particles. When boulders are broken into small pieces quarry dust is formed. It is grey in colour and it is like fine aggregate. The physical and chemical properties of quarry rock dust and the fine aggregate are listed in Table 1 and Table 2 respectively. Table-1. Physical properties of quarry rock dust and natural fine aggregate.

Property	Quarry dust	River sand	Test method
Specific gravity	2.60	2.68	IS 2386 (Part III) 1963
Bulk relative density (kg/m 3)	1700	1550	IS 2386 (Part III) 1963
Absorption (%)	1.30	Nil	IS 2386 (Part III) 1963
Moisture content (%)	Nil	1.50	IS 2386 (Part III) 1963
Fine particles less than 0.075mm (%)	14	06	IS 2386 (Part III) 1963
Sieve analysis	Zone III	Zone III	IS 383 – 1970

Chemical Admixture:

The chemical admixture used for the investigation is super plasticizer PCE and SNF. Super plasticizer produces concrete with high workability and flowability. Use of super plasticizer will also result in the reduction in water content without loss of workability. The electro chemical activity of the super plasticizer is responsible for the high workability. Super plasticizer molecules and cement grains are oppositely charged and hence repel each other. This increases the mobility and hence the flowability of concrete. As per IS 456:2000, the dosage of super plasticizer should not exceed 2% by weight of cement. During the present investigation, dosage of 0.5% and 1% by weight of cement was used.

Experimental Investigation:

The experimental investigation consisted of replacing completely fine sand aggregate with quary dust and with the addition of chemical admixture to improve its workability and determining the mechanical properties of concrete.

The required materials were weighed and mixing of concrete was carried out manually. Cube specimens of size 150 mm x 150 mm x 150 mm, cylinder specimens of diameter 150 mm and length 300 mm and prism specimens of size 500 mm x 100 mm x 100 mm were cast. The specimens were de moulded after 24 hours of casting and the specimens were cured in a water tank at room temperature.

4. METHODOLOGY

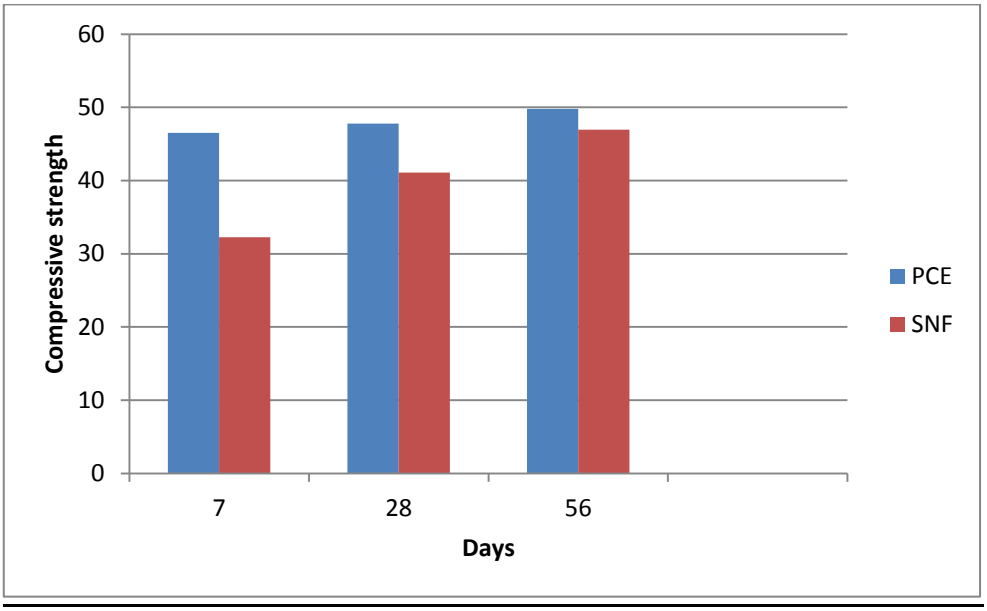
During the present study 100% replacement of fine river sand by quarry dust is done for the grades M40. For each grade of concrete super plasticizer been added once with SNF and for the same grade again with PCE super plasticizer and the comparision in the strength and properties of concrete is shown. The same procedure is being carriedout for the other grade too. In this way the specimens have been casted and later for 7, 28, 56 days of curing the testing is carriedout.

TEST PROCEDURE:

Compressive Strength Test:

For 7, 28 and 56 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 at a rate of 14 N/mm^2 /min. The average value of the compression strength of three cubes was taken as the compression strength. Three conventional concrete cubes with SNF as a super plasticizer and other three cubes with PCE as a chemical admixture were casted and tested. The compressive strength of concrete with quarry dust and super plasticizer is shown in the below graph

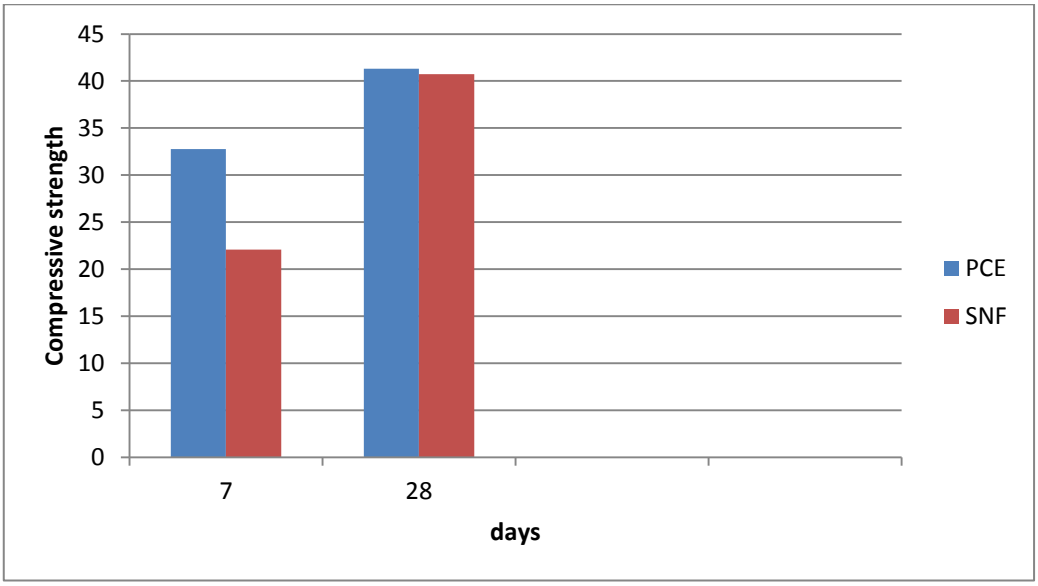
Test results of concrete cube specimens for M40 grade:



Split Tensile Strength Test:

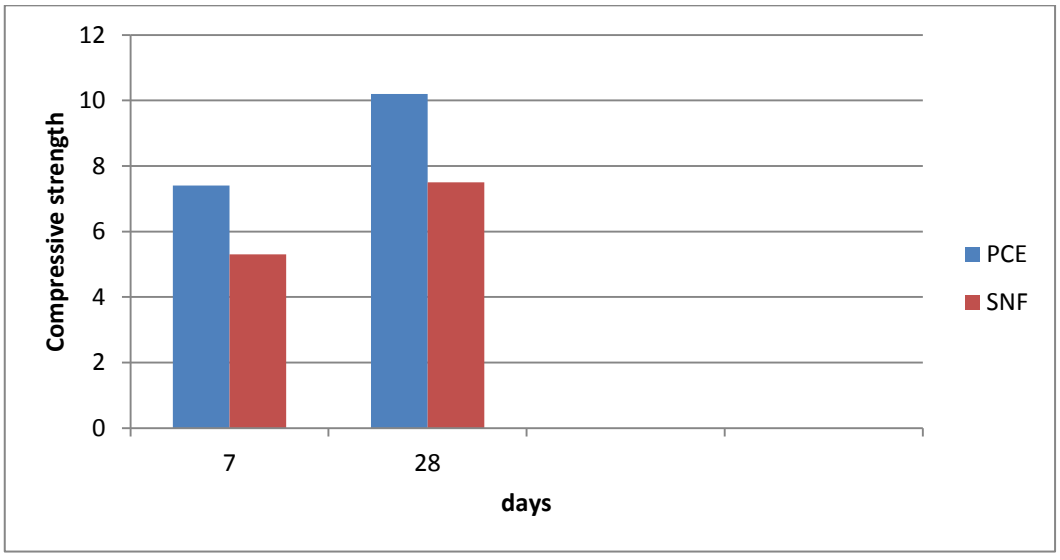
The cylinder specimens of diameter 150mm and height 300mm were used to determine the split tensile strength. The specimens were tested in computerized universal testing machine of capacity 1000 kN. Three cylindrical specimens were tested for each percentage of replacement. The cylinders were placed in 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 SNF super plasticizer and other three with PCE as admixture for both the grades were casted and tested. The split tensile strength of concrete with quarry dust and super plasticizer is shown in the below graph.



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 loads 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 cylinders with SNF super plasticizer and other three with PCE as admixture for both the grades were casted and tested. The strength and the comparison of both PCE and SNF is shown in the below graph.



5. CONCLUSIONS

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 because it is a waste material from quarries. Use of quarry dust in concrete will also reduce the disposal problem. When the conventional fine aggregate is completely replaced with quarry dust along with 1 % dosage of super plasticizer increase in the compressive strength is around 85%. The comparison of the two super plasticizer were carried out PCE and SNF, by that we found that PCE will give more mechanical strength and more workability and also it helps in gaining the strength at 7 days when compared to normal and SNF used.

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