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High Performance Concrete using Quarry dust as Fine aggregate

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ABSTRACT— *This paper describes the experimental study of High-Performance concrete with quarry dust as fine aggregate in addition of steel fibre. To over-come the difficulties due to excessive sand mining, quarry dust was used as fine aggregate. Quarry dust is the fine material, produced from gravel crushers. Super plasticizers were used to improve workability of concrete. Cement was replaced with 10% of silica fume. The M60 grade concrete used was designed by using a modified ACI method suggested by Aïtcin. Volume fraction of the fibres used in this study as 0%, 0.5%, 1%, 1.5%. Specimens were casted and compression, split tensile and flexure test were conducted for 7 and 28days. Durability tests such as rapid chloride penetration test, Acid attack, sulphate attack, alkaline attack was also conducted. From the result it was found that addition of silica fume will increase the compressive strength, steel fibre will increase the tensile strength. Addition of 1% steel fibre is found as optimum from the experimental results.*

Keywords — Quarry dust, High performance concrete, Sand, Steel fibre, Silica fume.

1, INTRODUCTION

Concrete structures will play the major role for developing country like India. Concrete is a mixture of cement, fine aggregate and coarse aggregate with water. River sand is mainly used as fine aggregate. Now-a-days it is very difficult to get river sand due to scare and expensive of river sand. There are so many draw backs due to sand mining in river bed. So here I replace sand with quarry dust. In recent day it is very common material which is produced by aggregate crusher machines. The excessive excavation of river sand is becoming a serious environmental problem. Erosion and failure of river banks, lowering of river beds, damage to the bridge foundations and other structures situated closer to the rivers, saline water intrusion into the land and coastal erosion are the major adverse effects due to intensive river sand mining. As a result, the Government has banned sand mining in some identified areas of major rivers. At present, the construction industry in India is facing a serious shortage of sand due to overexploitation and government banning of river sand mining. In the future, the entire construction industry may come to a halt if there are no alternative sources instead of river sand. Therefore, it is necessary to explore the possibilities for alternative sources to minimize river sand extraction. At present, the identified alternative sources are dune sand, offshore sand, manufactured sand (crushed rock sand) and quarry dust. Quarry dust, a by-product from the crushing process during quarrying activities is one of such materials. Granite fines or rock dust is a by-product obtained during crushing of granite rocks and is also called quarry dust. Concrete containing quarry dust as fine aggregate is promising greater strength, lower permeability and greater density which enable it to provide better resistance to freeze and thaw cycles and durability in adverse environment. The compressive strength of quarry dust concrete can be improved with admixture and also super plasticizers can be used to improve the workability of quarry dust replaced concrete

2, MATERIAL USED AND THEIR PROPERTIES

2.1 Materials used

Ordinary Portland Cement (43 Grade) conforming to IS: 8112-1989 was used for the investigation along with the silica fume supplied by Moon Traders, Madurai. The fine aggregate used was river sand and quarry dust passing through 4.75mm. Double end hooked steel fibres with an aspect ratio of 50 were used throughout the study. A sulphonated naphthalene-based super plasticizer was added to the mixes for getting required workability.

2.2 Material properties

Table No. (1): Material Properties

Properties	Sand	Quarry dust	Coarse aggregate
Specific gravity	2.53	2.58	2.8
Fineness modulus	4.97	5.29	2.46
Silt content	5%	6%	9%

2.3 Mix proportions

HPC mix proportions for M60 grade concrete were obtained based on the ACI 211 guidelines (ACI, 1998), as modified by Aïtcin (Aïtcin, 1998). The details of mix proportions thus obtained are given in Table 1. Part of the cement was replaced by micro-fillers such as silica fume in this study 10% replacement of cement by silica fume was considered. Workability of the mix was kept constant at the compaction factor of 0.9. Same mix proportions were maintained for all the mixes. However, as the steel fibres were added to the HPC, the workability was found to decrease. Hence in order to maintain uniform workability, dosage of super plasticizer was adjusted in the SFRHPC mix.

Table No. (2): Mix Proportion for Conventional Concrete

Water	Silica fume	Cement	Fine aggregate (sand)	Coarse aggregate	Super plasticizer
168.3	58.03	580.34	586.34	1108.40	29.01
0.29	10%	1	1	1.9	5%

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Table No. (3): Mix Proportion for Quarry dust Concrete

Water	Silica fume	Cement	Fine aggregate (quarry dust)	Coarse aggregate	Super plasticizer
168.3	60.0	600.8	566.7	1108.4	30.04
0.29	10%	1	0.9	1.8	5

3, EXPERIMENTAL WORK

3.1 Slump Cone Test

The slump test is most commonly used method of measuring consistency of concrete which can be employed either in laboratory or at site of work. The apparatus for conducting the slump test essentially consists of a metallic mould in the form of frustum of a cone having the internal dimensions are 20cm bottom diameter, 10cm top diameter, 30cm height.

The table shows the results of conventional HPC, HPC with quarry dust and HPC with quarry dust and addition of various percentage of steel fibre. Workability of quarry dust HPC decreases when compared to conventional HPC. With addition of super plasticizer workability of quarry dust concrete will increases. When adding steel fibre it reduces the workability of concrete.

Table No. (4): Slump Value of various Mixes

Material	Slump Value (cm)
HPC	7.5
HPC1	6.5
HPC2	6
HPC3	6
HPC4	5

HPC=> HPC with sand as fine aggregate
HPC1=> HPC with quarry dust as fine aggregate
HPC2=> HPC with quarry dust as fine aggregate addition of 0.5% of steel fibre
HPC3=> HPC with quarry dust as fine aggregate addition of 1% of steel fibre
HPC4=> HPC with quarry dust as fine aggregate addition of 1.5% of steel fibre

3.2 Casting

Cubes of 10cm, Cylinders of 10cm ϕ, 20cm height, and Prism 10×10×50cm specimens were casted. Steel moulds were used for casting the specimens. Cement, fine aggregate, coarse aggregate, silica fume, water and super plasticizers were added and mixed properly. Steel fibre was added with varying percentage as 0.5%, 1%, 1.5%. Then concrete was poured into the mould, table vibrator was used for better compaction. After 24 hours, specimens were demoulded and then placed into curing tank. Testing was conducted after 7days and 28 days of water curing. The results were compared with concrete containing sand as fine aggregate and quarry dust as fine aggregate.

3.3 Compression test

As per IS 9013:1978 compression test was carried out on cube specimen. The compression test is carried out on specimens cubical or cylindrical in shape. The cube specimen is of the size10 x10 x 10cm. Compressive strength at 7 and 28 days was found out.

3.4 Split tensile test

The cylindrical specimens were tested for split tensile strength at an age 7, 28, 60 and 90 days. Three specimens were tested for each percentage at an average of three was taken. Two packing strips plywood 3mm thick were used. The specimen was placed between two plywood strips and aligned properly. The maximum load applied was then recorded. The size of the specimen is 10cm diameter and 20cm height.

3.5 Flexural test

The beam specimen were tested for flexure strength at the end of 28 days. The specimen size was 10 x 10 x 20cm. Three specimens were tested for each percentage at 28 days and average of three was taken. The system of loading used to finding out the flexural strength is two point loading. The axis of specimen carefully aligned with the axis of the loading. The load was applied without shock and increasing continuously. The load was increased until the specimen failed and the maximum load applied to the specimen was recorded. Unusual fractures were recorded.

4, RESULTS AND DISCUSSSION

4.1 Compression test results

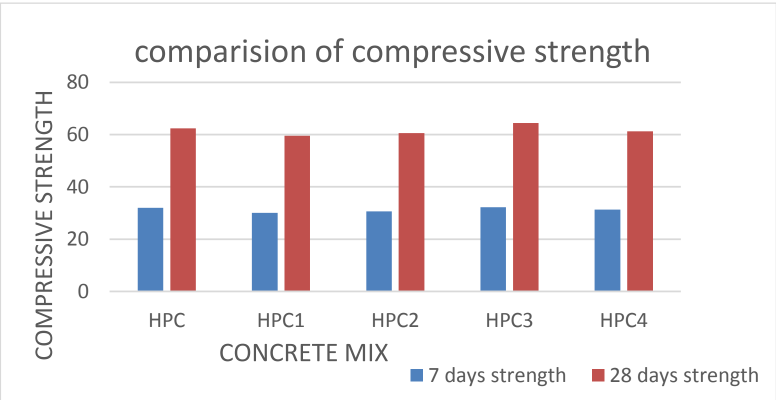

Fig No. (1): Comparison of Compressive Strength

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4.2 Split tensile test results

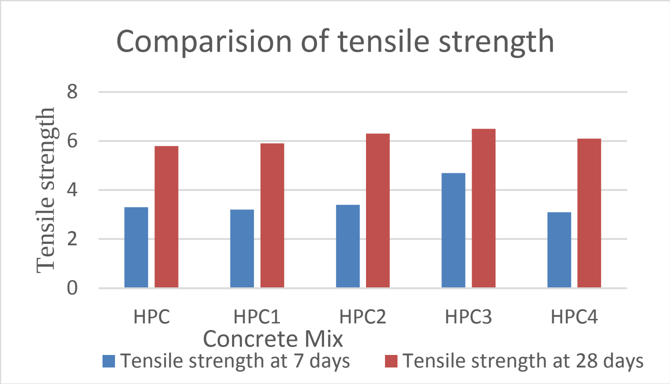

Fig No. (2): Comparison of Tensile Strength

4.3 Flexural test results

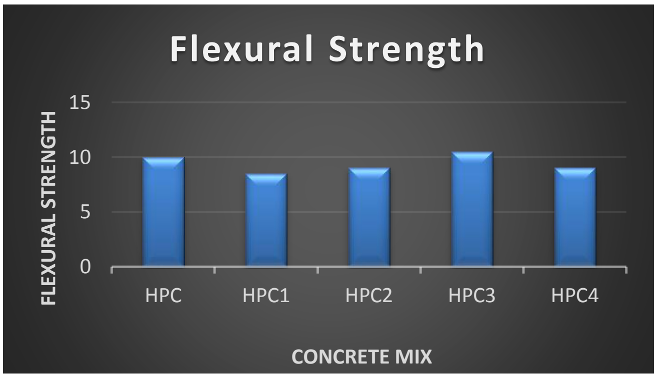

Fig No. (3): Comparison of flexural strength after 28 days

IV CONCLUSION

The experimental investigation was conducted for high performance concrete with quarry dust as fine aggregate with partial replacement of cement with silica fume and also with addition of steel fibre. Workability and strength characteristics of the high performance concrete were compared with conventional concrete.

Quarry dust has lots of finer dust particle than sand. Which reduce the workability of concrete. To compensate this problem super plasticizer was used. Combination of quarry dust and silica fume exhibiting good performance due to efficient micro filling ability and pozzolanic action of silica fume. From this can conclude that 100% of sand with quarry dust shows good strength and durability.

When adding 0.5%, and 1% of fibre content compressive strength and tensile strength of the mix will increase. When 1.5% of steel fibre was added strength will decrease because of accumulation of fibre. When adding more fibre in concrete, bonding between the fibres will increase and accumulate of fibre will occur. It is called balling effect. From the experimental investigation it was found that the optimum fibre content is 1%.

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