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Experimental Study on Partial Replacement of Fine Aggregate with Stone Dust in Concrete

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Abstract- Stone dust is a waste material obtained from crusher plants. It has potential to be used as partial replacement of natural river sand in concrete. Use of stone dust in concrete not only improve the quality of concrete but also conserve the natural river sand for future generations. In the present investigation, an experimental program was carried out to study the workability and compressive strength of concrete made using stone dust as partial replacement of fine aggregate in the range of 0% - 30%. M20 grade of concrete was designed using Ordinary Portland cement (OPC) 43grade for referral concrete. Workability and Compressive strength were determined at different replacement level of fine aggregate viz a viz referral concrete and optimum replacement level was determined based on compressive strength. Results showed that by replacing 30% of fine aggregate with stone dust concrete of maximum compressive strength can be made as compared to all other replacement levels.

Keywords:- concrete, compressive strength, optimum, replacement, stone dust, workability

1. INTRODUCTION

Stone dust is obtained at crusher plants where the artificial crushing of the rock or gravels is done to obtain coarse aggregate. So the chemical composition of stone dust will be same as that of the coarse aggregate obtained from therein. Stone dust used for concrete should possess comparable fineness modulus as that of fine aggregate which is used in making concrete so that it will not absorb too much water from concrete or workability of concrete can be maintained. Stone dust is a waste material obtained from crusher plants during the process of making of coarse aggregate of different sizes, about 175 million tons stone dust is produced every year, which is kept in great quantity. This used quantity of stone dust requires a suitable disposal site for its easy and safe discarding a large land area is required to accomplish the requirement which would again be a great problem in a country of strongly populated like India.

2. OBJECTIVE

1) To check the behavior of concrete incorporated with stone dust as a replacement of fine aggregate.
2) To find the optimum quantity of used stone dust aggregate in concrete mixtures for engineering applications.
3) To find an effective & inexpensive way of recycling the stone dust.
4) To reduce the recycling of such material. This in turn helps in reducing environmental pollution up to a certain level. Developing such construction materials could have both environmental and economical advantages

3. Literature review

Physical properties like specific gravity, fineness modulus of stone dust and fine aggregate should be comparable in order to use stone dust as a replacement of fine aggregate. Studies shows that optimum replacement of fine aggregate with stone dust gives maximum compressive strength, durability, flexure strength and other mechanical properties.

Manchiryal R.K., Dewangan A. and Gupta D.P. investigated that the physical and chemical properties of stone dust satisfied IS-2386 which could be used as replacement material of fine aggregate. Authors concentrated on cube compressive strength and beam flexure strength in order to give significance to their work. Ordinary Portland cement of 43 grade, Natural River sand with fineness modulus of 2.51 and granite aggregate as a course aggregate were used in the experiments. Quarry dust was obtained from local resource. In the experiments, river sand was100% replaced by quarry dust and variation in strength was compared. It was concluded that compressive strength from concrete with quarry dust was comparatively 10% -12% more than the conventional concrete. They also concluded that durability under the influence of sulphate and acid attack of quarry dust concrete was higher than conventional concrete.

Permeability of concrete decreased due to better relative density of quarry dust than that of conventional concrete5.

Reddy, M.V. (2010) carried out some experiments using waste product like stone dust and ceramic scrap as partial and full prepared six samples of concrete in which first sample was prepared by replacing 100% fine aggregate by stone dust. Other samples were prepared by replacing 10% 20%, 30%, 40%, 50% and 100% replacement of coarse aggregate by ceramic scrap. Mix proportion of M25 and water cement ratio of 0.48 was chosen for the investigation. He casted cubes of 150mm size, cylinders of 150*300mm size and prisms of 100*100*500mm. These samples were subjected strength, split tensile the result of can be effectively used as replacement of fine aggregate but ceramic scrap should not be replaced more than 20% of coarse aggregate in order to achieve significant structural strength6.

Patel, A.N. and Pitroda J.K. investigated the strength properties and economic feasibility of concrete, when it was prepared using stone dust as a partially replacement of cement. Portland Pozzolana cement of grade 53 was used for mix design. They prepared mix of M25 using 0.40 water cement ratio. Six controlling the mix design, 10%, 20%, 30%, 40% and 50% of cement is replaced by stone dust. Cube specimens of concrete of size 150*150*150mm was cast and 7days, 14 days and 28 days compressive strength was analyzed. It was found that compressive strength of cubes decreased as the percentage of replacement of cement was increased. On the other hand, the research showed economically feasible as the cost in preparation of cube is reduced by replacing cement by stone dust7.

Abbas S.Y., Srivastava V. and Agarwal V.C. conducted their research on the mix design of M25 concrete. They carried out their work using PPC cement of grade 43. Stone dust was obtained from local stone crusher mill of Mirzapur, India. Cube sample of size 150mm size was prepared and compressive strength at 7 days and 28 days were obtained. From their research, they have concluded that optimum percent of replacement of fine aggregate by stone dust is 60%.Replacement of 60% of fine aggregate by stone dust gave better strength at 7 days as well as at 28 days. They also specified that increase in strength might be due to change in the composition of matrix of concrete8.

Syam Prakash V., Krishnan D. and Jeenu G. investigated the effect of stone dust on M30 grade of high strength concrete.

They used Ordinary Portland Cement of 53 grade, fine aggregate of zone II and coarse aggregate of less than 20mm size. Super plasticizer was used to mitigate water cement ratio as it was needed for high strength concrete. Standard specimens of cube, cylinder and prism were cast to study different parameters. They studied compressive

strength, split tensile strength, flexural strength, acid resistance property, water absorption characteristic, porosity and sorptivity through their experiments. Different samples of conventional concrete and stone dust concrete were prepared and tested. It was concluded that strengthen properties like compressive strength and tensile strength increased when stone dust was replaced by more than 60%9.

Bhiksham V., Kishore R. and Raju N.H.M. worked on concrete of M40 grade. They prepared standard of size 150*230*1500mm for their experiments. The essential parameters for their study area were compressive strength, ultimate load carrying capacity, moment (Reinforced Concrete OPC of 53 grade, stone dust and super plasticizer to reduce w/c ratio. Cubes and under reinforced beams were casted by replacing fine aggregate 25%, 50%, 75% and 100% by stone dust and test have conducted for their relevant parameters. They concluded from the experiments that replacement of sand by stone dust improved the strength of concrete by 20%. It also decreased total deflection of beam. From the economical point of view, concrete preparation became cheaper by eight percent3.

4. Materials

4.1:-Cement and aggregate: The cement used is Ordinary Portland cement of 43 grade confining to IS-12269 was used for work.

Specific gravity of cement is 2.62, Fineness modulus of cement is 2.9. Coarse aggregates available locally were used. Specific gravity of aggregates is 2.72, Water absorption by the aggregates is 1.30%.

The sieve analysis of 20mm and 10 mm aggregates and fine aggregates locally available from banks of river was used.

Specific Gravity of sand is 2.55 Sieve analysis of sand was done and the sand was found to be of zone II as per IS383-1970

4.2:-Stone dust: Stone dust is obtained at crusher plants where the artificial crushing of the rock or gravels is done to obtain coarse aggregate. So the chemical composition of stone dust will be same as that of the coarse aggregate obtained from therein. The physical and chemical properties of quarry dust obtained by testing the sample as per the Indian Standards.

It is an industrial by product. It is a by product of Stone crushing which broken downs into fine aggregates. It is grey in colour and is like fine aggregate. The stone dust was obtained from nearby crushers from Spore.

It causes environmental problems like damping problems.Converting stones into useful by-product stone dust has many benefits like maintenance of ecological balance. Also it is used for different Activities in construction industry such as road construction and manufacture of building weight aggregates bricks and tiles. It is sieved through 1.18mmIS sieve4

4.3:-Water: Water is one of the most important as it initiates the chemical reaction with cement. It is necessary to check quality of water which is being used. Potable water is used this is to ensures that the water is reasonable free from impurities as suspended solids and used for mixing and curing through the experiment.

5. Methodology

In order to achieve the objective of the present study, an experimental program was planned to investigate the effect of partial replacement of coarse aggregates by waste rubber on the strength characteristics of concrete .The main parameters investigated in this study are compressive strength, flexural strength and split tensile strength. The experimental program included the following:

- Test properties of constituent materials.
- Development of concrete mix of desired strength by making trials.
- Workability of concrete mix.
- Casting and curing of specimens.
- Compressive strength test on waste rubber concrete mix.
- Flexural strength test on waste rubber concrete mix.
- Split tensile strength test on waste rubber concrete mix

6. Result

GRADE:M20(MIX.PROPORTION)

MIX	CEMENT	FINE AGGREGATE	COARSE AGGREGATE	STONE DUST REPLACEMENT
M0	1	1.5	3	0%
M1	1	1.5	3	10%
M2	1	1.5	3	20%
M3	1	1.5	3	30%

COMPRESSIVE STRENGTH OF CONCRETE AT 7 DAY

S.N.	INGREDIENT	NUMBER OF SPECIMEN	ULTIMATE LOAD[KN]	COMPRESSIVE STRENGHT [N/mm^2]
1	Cement+(0%) SD+FA+CA	4	293	13.02
2	Cement+(10%) SD+FA+CA	4	302	13.42
3	Cement+(20%) SD+FA+CA	4	315	14
4	Cement+(30%) SD+FA+CA	4	330	14.6

COMPRESSIVE STRENGTH OF CONCRETE AT 28 DAY

S.N.	INGREDIENT	NUMBER OF SPECIMEN	ULTIMATE LOAD[KN]	COMPRESSIVE STRENGHT [N/mm^2]
1	Cement+(0%) SD+FA+CA	4	415	18.44
2	Cement+(10%) SD+FA+CA	4	426	18.93
3	Cement+(20%)SD+FA+CA	4	436	19.37
4	Cement +(30%) SD+FA+CA	4	465	20.66

CONCLUSIONS

1. Use of admixtures to add to workability of concrete made with stone dust can be studied.
2. Durability aspects of concrete made with stone dust as fine aggregate can be investigated.
3. People approach to the stone waste in concrete will be more and more as it will strengthen the building at economical cost.
4. Environmental effects of wastes and disposal problems of waste can be reduced through this research and make the environment green.
5. It will reduce the wastage and solve dumping problem of the industry
6. Effective utilization of quarry dust in concrete can save the waste of quarrworks; and also produces a 'greener' concrete.

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