Review on Use of Stone Dust as a Partial Replacement of Fine Aggregates in concrete as a Rigid Pavement

Harsh Bansal[1], Munish Kumar[2]

[1] Student of Shree Ram Mulkh College of Education, RaipurRani
[2]Assistant Professor in Department of Civil

Abstract - Currently India has taken a major initiative on developing the infrastructures such as express highways, power projects, ports and harbors, to meet the requirements of globalization, in the construction of pavements and other structures concrete plays the key role and a large quantum of concrete is being utilized in every construction practices. River sand, which is one of the constituents used in the production of conventional concrete, has become very expensive and also becoming scarce due to depletion of river bed. In view of this, there is a need to identify suitable alternative material from waste in place of river sand. Today researches all over the world are focusing on ways of utilizing either industrial or agricultural wastes as a source of raw materials for the construction industry. These wastes utilization would not only be economical, but may also help to create a sustainable and pollution free environment. The main problem in the world is now or future existing is the downstream of the natural resources for building and constructing purpose. Basically, Countries like India should concern with these developments to undergone by replacing the materials of the industrial by products and waste products to minimize the use of the natural sources in the building and construction. Concrete is the material mostly used in the construction field for building and pavement construction. Natural sand is a very fine material which can contribute for a concrete to solidify to give the necessary strength for a certain structure. Natural sand fill up the pores or voids inside concrete which is also a contributing factor for the strength of the concrete.

***Key Words*: Stone dust**

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.

1.1 Physical and Chemical Properties

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.

2. LITERATURE SURVEY & DISCUSSIONS

Common river sand is expensive due to excessive cost of transportation from natural sources. Also large-scale depletion of these sources creates environmental problems. As environmental transportation and other constraints make the availability and use of river sand less attractive, a substitute or replacement product for concrete industry needs to be found. River sand is most commonly used fine aggregate in the production of concrete poses the problem of acute shortage in many areas and its continued use has started posing serious problems with respect to its availability, cost and environmental impact.

2.1 Related Work

(1984) R.N. Misra studied the water requirements and compressive strength of cement mortar using manufactured sand as FA, with FM ranging from 0.50 to 2.0 and 75% and 100% flow of mortar. Based on the above extensive experimental investigations, he had concluded that the strength of mortar with manufactured sand is higher than that of the corresponding mix with cement (sand) mortar. He has recommended the use of manufactured sand for mortar and has cautioned the removal of excessive proportions of very fine particles.

(1985) V.M. Malhotra studies the performance of concrete, incorporating limestone dust (obtained from limestone quarries after crushing operations) as a partial replacement for natural sand in concrete. Three series of concrete mixes with w/c ratio 0.70, 0.53 and 0.40 respectively, incorporating lime stone dust from 5-20% were prepared by direct replacement on an equivalent mass of recombined sand basis. The properties of fresh concrete i.e. slump, unit weight and air content (%) were determined. Compressive strength, freezing and thawing, drying and shrinkage, creep was determined for hardened concrete. They have concluded that incorporation of upto 10% limestone dust as a partial replacement for FA in concrete with w/c = 0.70 and 5% limestone dust in concrete with w/c = 0.53 does not significantly affect the properties of fresh and hardened concrete. However, there is considerable loss in slump, irrespective of w/c ratios, if lime stone dust is in excess of 10%.

(1996) T.S. Nagaraj et al. reported that rock dust due to its higher surface area consumes more cement in comparison to sand which increases workability. He studied to effect of rock dust and pebble as aggregate in cement and concrete and found that crushed stone dust could be used to replace the natural sand in concrete. The mix design introduced by Nagaraj T.S reported that there are three possibilities of ensuring the workability namely combination of rock dust and sand, use of super plasticizers and change water content.

(1998) Shukla et al. investigated the behavior of concrete made by partial or full replacement of river sand by crushed stone dust as fine aggregate and reported that 40 percent sand can be replaced by crushed stone dust without effecting the strength of concrete.

(1999) Hudson reported that, ''concrete manufactured with a high percentage of minus 75 micron material will yield a more cohesive mix then concrete made with typical natural sand''.

(1999) Venugopal et al. examined the effect of rock dust as fine aggregate in cement and concrete mixes. They have suggested a method to proportion the concrete using rock dust as fine aggregate.

(2000) M. Shukla et al. studied environmental hazardous stone dust utilization in building construction. It is found that partial replacement will not affect the strength and also solve the problem of disposal of stone dust. The workability of concrete reduces with the increase in stone dust and this can be improved by adding suitable admixtures.

(2004) A.K. Sahu et al. investigated the basic properties of conventional concrete and concrete made using quarry dust have compared. They have studied M20 and M30 concretes. Equivalent mixes are obtained by replacing stone dust partially/fully. Test results indicate effective usage of stone dust with same compressive strength, comparable tensile strength and modulus of rupture. Workability of 40% replacement of stone dust with 2% Superplasticizer is equal to the workability of conventional concrete. Workability is increased by the addition of Superplasticizer.

(2008) R. Ilangovana et al. reported that the compressive strength, split tensile strength and flexural strength of concrete made with 40% or 50% replacement of sand with quarry dust is more than that made with other percentage of replacement Natural river sand, if replaced by hundred percent Quarry Dust from quarries, may sometimes give equal or better than the reference concrete made with Natural Sand, in terms of compressive and flexural strength.

(2010) A. Krishnamoorthi et al. reported that The 3 and 7 days cube compressive strength for concrete with 20% and 40% quarry dust is same as conventional concrete and with above 40% quarry dust the strength decreases subsequently. 28 days strength satisfies the target strength. The split tensile strength and flexural strength of concrete made with 40% of replacement of sand with quarry dust is more than that made with other percentage of replacement. The compressive strength of concrete made with 40% of quarry dust is more than that made with 0%, 20%, 50%, and 60% of quarry dust. Tensile strength of concrete made with 40% of quarry dust is more than that made with 0%, 20%, 50%, and 60% of quarry dust. Tensile strength of concrete made with 60% of quarry dust is more than that made with 0% of quarry dust.

(2010) Manasseh investigated the suitability of Crushed Granite Fine (CGF) to replace river sand in concrete production for use in rigid pavement. Slump, compressive strength and indirect tensile strength tests were performed on fresh and hardened concrete. The 28 day peak compressive and indirect tensile strength values of 40.70 N/mm2 and 2.30 N/mm2 respectively, were obtained with the partial replacement of river sand with 20 per cent CGF, as against values of 35.00 N/mm2 and 1.75 N/mm2 obtained with the use of river sand as fine aggregate. Based on economic analysis and results of tests, river sand replaced with 20 per cent CGF is recommended for use in the production of concrete for use in rigid pavement. Conservation of river sand in addition to better ways of disposing wastes from the quarry sites are some of the merits of using CGF.

(2010) Radhikesh et al. investigated The cost of quarry dust much cheaper than that of the sand as such the proposal is also financially viable. This also reduces the burden of dumping crusher dust on earth and hence environmental pollution.

(2010) Sivakumar et al. studied The 28 days compressive strength of 100% replacement of sand with quarry dust of mortar cube (CM 1:1) is higher than the controlled cement mortar cube. The 56 days maximum Compressive strength, split tensile strength and modulus of elasticity of concrete for 100% replacement of sand with quarry dust of 400 kg/m3 at F/C=0.6, was higher than the reference concrete.

(2010) Thaniya Kaosol studied on the reuse of concrete waste as crushed stone for hollow concrete masonry units. The main objective was to increase the value of the concrete waste, to make a sustainable and profitable disposal alternative for the concrete waste. Attempts were made to utilize the concrete waste as crushed stones in the concrete mix to make hollow concrete blocks. Various percentages of crusted stones have been tried the amount (i.e. 0%, 10%, 20%, 50% and 100%). From the results they found concrete waste can used to produce hallow concrete block masonry units.

(2011) Ganesha Mogaveera et al. studied the effect of Partial Replacement of Sand by Quarry dust in Plain Cement Concrete for different mix proportions. They have concluded that sand can be replaced effectively by means of quarry dust up to 20% to 25%.

(2011) K. Nagabhushana et al. studied the properties of mortar and concrete in which Crushed Rock Powder (CRP) was used as a partial and full replacement for natural sand. For mortar, CRP is replaced at percentages of 20, 40, 60, 80 and 100. The strength properties of concrete were investigated by replacing natural sand by CRP at replacement level of 20, 30, and 40 per cents.

(2011) M. Devi et al. carried out an investigation on strength and corrosion resistance behavior 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.

(2012) Joseph O Ukpata et al. studied the workability of concrete using lateritic sand and quarry dust as fine aggregates was found to have the same trend with normal concrete. The density of hardened concrete using lateritic sand and quarry dust was found to range from 2293-2447 kg/m3.

(2012) Lohani et al. studied the slump value increases with increase in percentage replacement of sand with quarry dust. The increase in dust content up to 30% increases compressive strength of concrete, if the dust content is more than 30% the compressive strength decreases gradually. But the compressive strength of quarry dust concrete continues to increase with age for all the percentage of quarry dust contents.

(2012) T. Shanmugapriya et al. carried out 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.

3. OBJECTIVE OF RESEARCH WORK

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.

3.1 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.

4. CONCLUSION

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 quarry works; and also produces a 'greener' concrete.

REFERENCES

1. Basavararajaiah, B. S. & Krishna Raju, N. 1975. "Experimental Investigations on Permeable Concrete", Journal of the Institution of Engineers India. Part CV: Civil Engineering Division. Vol 55. No. Pt. CI 4. March. pp 137-140.

2. Malhotra, V. M. 1976. "Permeable Concrete – Its Properties and Applications", Journal of the American Concrete Institute. Vol 73. No. 11. pp 628 – 644.

3. Ghafoori et al (1995) produced permeable concrete with a compressive strength in excess of 20 MPa when using an aggregate-cement ratio of 4:1.

4. Australia Standard, As 1012.2 – 1994. "Method 2: Preparation of concrete mixes in the laboratory", Standard Australia Committee. Australia standard, AS 1012.3.1 – 1998. "Method 3.1; 7: Determination of properties related to the consistency of concrete – Slump Test", Standard Australia Committee.

5. Australian Standard. AS 1012.3.1 – 1998. Method 3.1: "Determination of Properties related to the Consistency of Concrete" – Slump Test. Standards Australia Committee.

6. Ayers, R 2004. "Transport Engineering – Study book. University of Southern Queensland".

7. Department of Civil Engineering University of Botswaa.