International Journal of Engineering Research and Development
e-ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com
Volume 11, Issue 03 (March 2015), PP.46-52

Improved Concrete Properties Using Quarry Dust as Replacement for Natural Sand

Anzar Hamid Mir
Student, Bachelor of Civil Engineering, IUST Awantipora, J&K, INDIA

Abstract:- Concrete plays a major role in the construction industry. Natural sand is a prime material used for the preparation of concrete and also plays an important role in Mix Design. Now a day's river erosion and other environmental issues have led to the scarcity of river sand. The reduction in the sources of natural sand and the requirement for reduction in the cost of concrete production has resulted in the increased need to find new alternative materials to replace river sand so that excess river erosion is prevented and high strength concrete is obtained at lower cost. One such material is Quarry stone dust: a by-product obtained during quarrying process. Attempts have been made to study the suitability of Quarry dust as sand replacing material and it has been found that Quarry dust improves the mechanical properties of concrete as well as elastic modulus. The optimum compressive strength is achieved at the proportion of fine to coarse with 60:40 ratio.

Keywords: Compressive strength, Concrete, Elastic modulus, Natural sand, Mechanical properties, Quarry dust

I. INTRODUCTION

Concrete is that pourable mix of cement, water, sand, and gravel that hardens into a super-strong building material. The most commonly used fine aggregate is sand derived from river banks. River sand has been the most popular choice for the fine aggregate component of concrete in the past, but overuse of the material has led to environmental concerns, the depleting of river sand deposits and an increase in the price of the material. The developing country like India(Authors native land) facing shortage of good quality natural sand and particularly in India, natural sand deposits are being used up and causing serious threat to environment as well as the society. The rapid extraction of sand from the river bed causes problems like deepening of the river beds, loss of vegetation on the bank of rivers, disturbance to the aquatic life as well as agriculture due to lowering the water table in the well etc. Therefore, construction industries of developing countries are in stress to identify alternative materials to replace the demand for river sand.

Quarry dust has been proposed as an alternative to river sand that gives additional benefit to concrete. Quarry dust is known to increase the strength of concrete over concrete made with equal quantities of river sand. The Compressive strength of quarry dust concrete continues to increase with age for all the percentage of quarry dust contents. The utilization of quarry dust as fine aggregate would turn this waste material that causes disposal problem into a valuable resource. The utilisation will also reduce the strain on supply of natural fine aggregate, which in turn will also reduce the cost of concrete.

II. NEED FOR THE REPLACEMENT OF SAND

River sand is expensive due to excessive transportation cost from natural sources. Also the depletion of sources of natural sand creates environmental problems. These constraints make the availability and use of river sand less attractive. Thus there arises a need for a substitute of natural sand in concrete. To overcome the above limitations, Quarry dust has been proposed as an alternative to river sand that gives additional benefit to concrete

III. QUARRY DUST

In concrete production it could be used as a partial or full replacement of natural sand. Besides, the utilization of quarry waste, which itself is a waste material, will reduce the cost of concrete production.

3.1 ORIGIN OF QUARRY DUST:

The quarry dust is the by-product which is formed in the processing of the granite stones which broken downs into the coarse aggregates of different sizes.

3.2 PHYSICAL AND CHEMICAL PROPERTIES:

The physical and chemical properties of quarry dust obtained by testing the sample as per the Indian Standards are listed in the below table

Table 1 showing the Physical properties of quarry dust and natural sand [1]

Property	Quarry Dust	Natural Sand	Test method
Specific gravity	2.54 -2.60	2.60	IS2386(Part III)- 1963
Bulk density (kg/m3)	1720- 1810	1460	IS2386(Part III)- 1963
Absorption (%)	1.20- 1.50	Nil	IS2386(Part III)- 1963
Moisture Content (%)	Nil	1.50	IS2386(Part III)- 1963
Fine particles less than 0.075 mm (%)	12-15	6	IS2386(Part III)- 1963
Sieve analysis	Zone-II	Zone-II	IS 383- 1970

Table 2 showing the typical chemical properties of quarry dust and natural sand [1]

Constituents	Quarry Dust (%)	Natural Sand (%)	Test method
SiO2	62.48	80.78	IS 4032-1968
Al2O3	18.72	10.52	
Fe2O3	6.54	1.75	
CaO	4.83	3.21	
MgO	2.56	0.77	
Na2O	Nil	1.37	
K2O	3.18	1.23	
TiO2	1.21	Nil	
Loss of ignition	0.48	0.37	

IV. MATERIALS USED

1. QUARRY DUST: Quarry dust is fine rock particles. When boulders are broken into small pieces quarry dust is formed. It is grey in color 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.
2. COARSE AGGREGATE: Natural granite aggregate having density of 2700 kg/m2 .The specific gravity was found to be 2.58.
3. CEMENT: Ordinary port land cement (43 grade).
4. WATER: Potable tap water.
5. MIXING OF MATERIALS: The normal grade of the concrete that is used is M20 for normal construction purposes in India [2]. The mix deign is done separately for the quarry dust using the minimum void ratio methods and maximum density method [3].

V. METHODOLOGY

5.1 TESTS ON MATERIALS

1. SPECIFIC GRAVITY:

The Specific gravity of the aggregates that are used is tested by following the Indian Standards specification by following IS 2386 (Part III) – 1963. The specific gravity is one of the important factor that everything depends on the design mix also depends on the specific gravity of the materials that we use. As the particle size is less we will use pycnometer for sand. The empty weight of the pycnometer is measured and then it is filled with sand up to a mark and the weight is measured. Then water is filled with water and the weight is measured. Then weight of the pycnometer only with water is measured and the specific gravity of the fine aggregates used is calculated. The same method is used for determining the specific gravity of the raw quarry dust.

Fig.1 Pycnometer with quarry dust and water

2. PARTICLE SIZE ANALYSIS:

The Particle size analysis is done by following the procedure given in IS 2386 (Part I)-1963, the gradation of the aggregate material is important for determining the size and shape of the material The gradation is used to determine the fineness modulus of the plastic material that is used for casting of the cubes. In the first step the IS sieves are arranged in order(i.e. 4.75mm, 2.36mm,1.18mm, 600µ, 300µ,150µ) . take about 2kgs of fine aggregate and place them on the top most sieve and start sieving them for fifteen minutes and then note down the weight retained on each IS sieve and the values of fineness modulus is calculated. A graph is plotted between the particle size and the percentage fineness on a semi log graph sheet. The graph that is plotted is called gradation curve / particle size distribution curve(PSD) this is use full to know whether the sample of the aggregates is well graded or poorly graded. If the coarse aggregates is poorly graded it is not used in the construction (fig.2)

Fig.2

3. BULKING:

The bulking test is done by following the procedure given in IS 2386 (partIII) – 1963, the bulking is the property of change of volume when water is added to the material. Bulking is a major problem while mixing the concrete. A measuring jar is taken and sad is filled up-to a mark in the measuring jar. Then water is added up to the highest mark in the vessel and left it for settling and the settled height is measured and the percentage bulking is calculated. (Fig.3)

Fig.3

4. WORKABILITY:

The workability is one of the physical parameters of concrete which affects the strength and durability and the appearance of the finished surface. The workability of concrete depends on the water cement ratio and the water absorption capacity if the aggregates. If the water added is more which will lead to bleeding or segregation of aggregates. The test for the workability of concrete is given by the Indian Standard IS 1199-1959 which gives the test procedure using various equipments. In our case we have used slump cone test for measuring the workability of concrete. We have measured the height of the fall of the cone of concrete for various water-cement ratios and recorded the values for ordinary concrete. Then the same procedure is done with the concrete having the partial replacement of sand with raw quarry dust at various percentages. (Fig 4)

Fig 4

5. COMPRESSIVE STRENGTH:

Concrete has relatively higher compressive strength, nut very poor in tensile strength. The different mix of concrete gives various strength, **according to the IS 10262:1982** gives the characteristic and design strength values for various grades of concrete. The strength attained by the mix must be tested by its compressive strength of the samples which are made in the standard mould of size 150mm X 150mm X 150mm and then the cubes are kept for curing and the compressive strength test was done according to IS 516: 1959 for 7days, 14days, 21 days and 27days for ordinary mix and for the partial replaced samples.

Fig.5 Compression test on cubes

Fig.6 Load indicators

Fig. 5&6 respectively

VI. RESULTS

The results of the physical properties like specific gravity, Particle Size analysis and bulking are the most needed for determining the mix design of the concrete. The results are as follows

1. SPECIFIC GRAVITY:

The average values of the specific gravity of natural river sand is 2.596, the average values of the specific gravity of quarry dust is 2.58

2. PARTICLE SIZE ANALYSIS: Quarry dust is poorly graded as compared to sand.

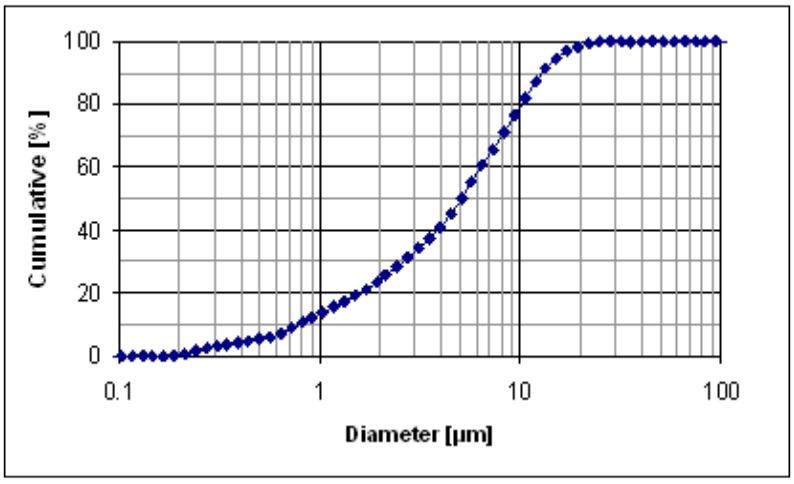

Fig.7 Particle Size distribution for sand

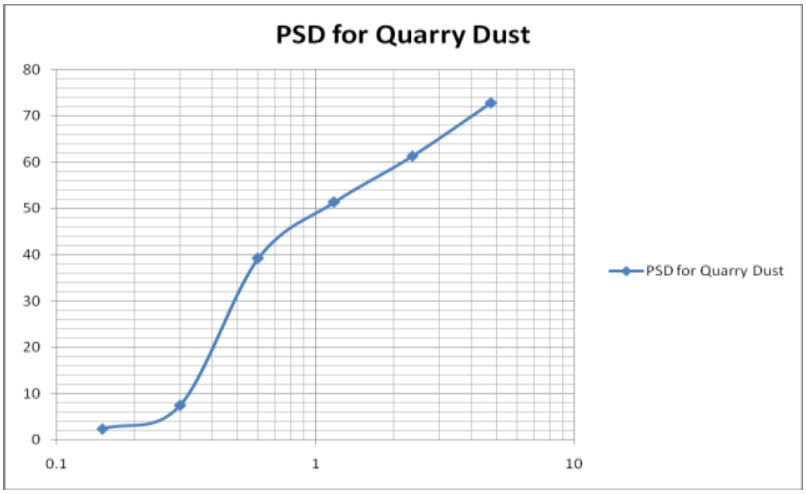

Fig.8: Particle size Distribution for Quarry dust

3. BULKING OF AGGREGATES:

The bulking properties of quarry dust are examined as specified as specified in IS 1180.

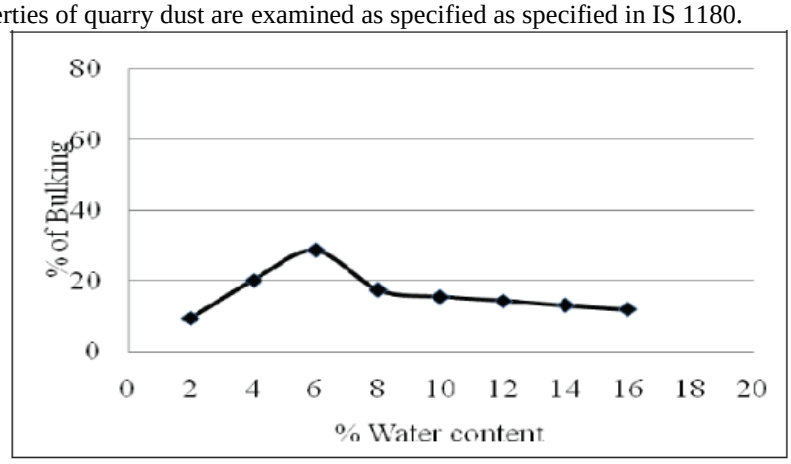

Fig.9 Shows the results of bulking of quarry dust

4. WORKABILITY: The slump value had been measured during the casting of specimen. The slump value decreases as the percentage of crusher dust increases. This reflects as percentage of crusher dust increases the water requirement increases and thus slump value decreases which may due texture of crusher dust. Generally crusher dust has rough texture than sand. The aggregate having rough texture requires more water for surface Weighting. Thus some water is consumed for surface weighting of crusher dust and the net water available get decreases for workability.

5. COMPRESSIVE STRENGTH RESULTS: The results of the compression test are tabulated below.

Table 3

Compressive strength in N/ mm^2			
Days	Ordinary mix	10%	20%
7 days	23.12	22.86	22.65
14 days	24.45	23.87	23.50
21 days	30.52	31.45	31.69
27 days	33.00	34.46	35.21

The results show that there is an increase in the compressive strength of the concrete [3,4] which the increment is about 55% to 75% depending on the replacement if the sand with the quarry dust, for the 100% replacement of the sand the compressive strength is depending on the quarry dust location from where the quarry dust was taken. The workability of the concrete is decreasing when the replacement percentage of the quarry dust is increasing gradually; so as to increase the workability small quantity of the fly-ash is replaced in place of cement to increase the workability [2].

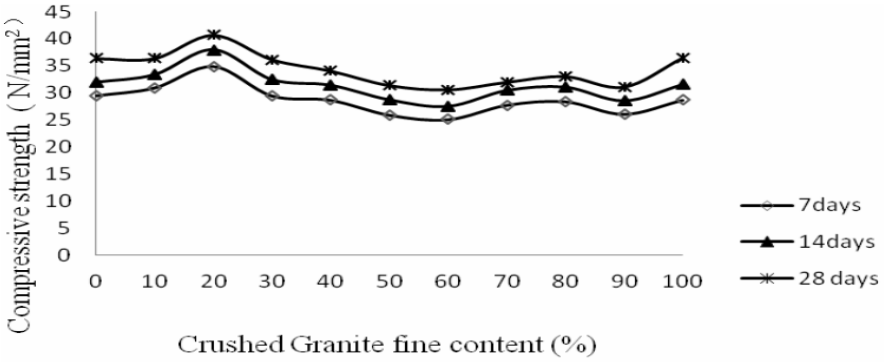

Fig 10 : Above graph showing the Compressive Strength with the replacement of the quarry dust [5]

VII. APPLICATIONS

1) The quarry dust is widely used in construction industry.
2) Quarry dust is used as a fine aggregate in Concrete for paving blocks of good permeability capacity and high grade concrete productions.
3) Quarry dust gives better workability and strength when it is mixed with the ingredients like fly ash, in concrete.

VIII. CONCLUSION

One of the ways to improving sustainability is to reduce the human consumption of natural resources. In order to protect the natural resources such as river sand, this study has identified quarry dust, which is a waste product from stone crushing industry and available almost free-of-cost, as partial replacement for river sand.

Based on this experimental investigation, it is found that quarry dust can be used as an alternative material to the natural river sand and can be introduced as a functional construction material. The physical and chemical properties of quarry dust satisfy the requirements of fine aggregate.

The study suggests that stone dust is quite appropriate to be selected as the substitution of fine aggregate. Quarry dust has a potential to provide alternative to fine aggregate thus minimizing waste products and disposal problems associated with it. The only major limitation is the decrease in workability which can be overcome by the use of fly ash or chemical admixtures such as superplasticizers which give high workability at the same water contents.

REFRENCES

[1]. Strength and durability properties of concrete containing quarry dust as fine aggregate, R.Ilangovana, N.Mahendrana and K.Nagamanib, Pg.No. 20 to 26, ARPN Journal of Engineering and Applied Science, Vol.3,No.5, October 2008.

[2]. Study of Properties of SCC using ‘Quarry Dust’ and ‘Fly Ash’, M.V. Rama Raju, K.V.Vivek, Dr.T.Siva Shankar Reddy and P. Srinivas Reddy, Pg.No. 323 to 332, International Journal if Engineering Science Research, Vol 02, Issue 04, August-September 2011.

[3]. Comparative long term study of concrete mix design procedure for fine aggregate replacement with fly ash by minimum void method and maximum density method, A.D.Pofale and S.V.Deo, Pg.No. 759 to 764, KSCE journal of civil Engineering (2010) 14(5).

[4]. Characteristic studies on the mechanical properties of quarry dust addition in conventional concrete, A.Sivakumar and Prakash M, Journal of civil engineering and construction technology, vol. 2(10), Pg.No. 218 to 235, October 2011.

[5]. Use of crusehed granite fine as replacement ti river sand in concrete production, Manasseh JOEL, Pg.No. 85 to 96, Leonardo electronics journal of practice and technologies, Issue 17, July- December 2010.

[6]. Partial Replacement of Sand with Quarry Dust in Concrete Chandana Sukesh, Katakam Bala Krishna, P.Sri Lakshmi Sai Teja, S.Kanakambara Rao

[7]. EXPERIMENTAL STUDY ON REPLACEMENTOF FINE AGGREGATE BY QUARRY DUST IN CONCRETE Vijay P Gowda1, Dinesh1, Kiran muchandi1, Avinash1 and Kumar S1 Stone crusher dust as a fine aggregate in Concrete for paving blocks Radhikesh P. Nanda 1 , Amiya K. Das 2 , Moharana.N.C 3

[8]. EXPERIMENTAL INVESTIGATION ON QUARRYDUST CONCRETE WITH CHEMICAL ADMIXTURE

[9]. Anitha selva sofia S.D.1, Gayathri R.2, SwathiG.3, Prince arulraj G.4

[10]. Influence of Stone Dust as Partially Replacing Material of Cement and Sand on some Mechanical Properties of Mortar

[11]. TASNIA HOQUE, MUHAMMAD HARUNUR RASHID, MD. ROKON HASAN, EBNA FORHAD MONDOL