Quarry Dust as Partial Replacement Material for Sand in Concrete

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Abstract: Concrete is the most widely used material in infrastructure development throughout the world. The widely used raw material in the concrete are cement, fine aggregate, coarse aggregate and water, of this river sand is used as fine aggregate and it is of prime importance in Mix Design. Due to increasing demand of river sand, river erosion and other environmental issues have led to scarcity of river sand. In order to reduce the usage of river sand and to reduce the cost of concrete production it is necessary to find new alternative material to replace river sand so that excess river erosion is prevented and strength of concrete is obtained at lower cost. In this paper one such alternative material used is Quarry dust: a by-product obtained during quarrying process. Mix design has been developed for M25 grade concrete with replacement of 0%, 10%, 20%, 30%, 40%, 50% of quarry dusts organized as M1, M2, M3, M4, M5 respectively have been considered for laboratory test like workability test, compressive test, and flexural strength. It was observed that the results have shown positive changes in the concrete and quarry dust can partially replace river sand in concrete.

Keywords: Partial substitute for river sand in concrete, Compressive Strength, Workability, Flexural Strength.

INTRODUCTION

In India major initiative is taken in developing the infrastructures such as express highways, power projects, industrial projects etc., to meet the requirements of globalization. In the construction of buildings and other structures concrete plays a very vital role. River sand which is one of the main constituents used in the production of concrete has become highly expensive and also scarce. In order to conserve river sand and to reduce the cost in concrete production, quarry dust may be used as an alternative partial replacement for river sand. Quarry dust is a kind of waste material that is generated from stone crushing industry and it is available to the extent of 200 million tons per annum which has landfill disposal problems. In highway department the quarry dust is used as binding material between bitumen and coarse aggregate. In this study, attempt has been made to experimentally find whether quarry dust can partially replace river sand in concrete.

Materials:

Cement

Cement acts as a binder to join the aggregate into a solid mass. It is one of the most important constituent of concrete. Ordinary Portland cement of 53 grade is used in concrete.

River sand

River sand is one of the important constituents in concrete. It gives body to concrete and reduces shrinkage and effects economy.

Coarse aggregates

The maximum size of coarse aggregate should be 20 mm and minimum size should be 10 mm. The coarse aggregate with angular in shape and the rough surface texture is used.

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.

Water

Water is an important ingredient of concrete and it initiates chemical reaction with cement. Ordinary potable water is used.

Physical properties

The physical properties of river sand, quarry dust is listed in the table below

Table 1

Property	River sand	Quarry dust
Specific gravity	2.60	2.62
Bulk density (kg/m3)	1460	1726
Absorption (%)	Nil	1.5
Moisture content (%)	Nil	Nil

METHODOLOGY

Test on materials:

Workability

It is one of the physical parameters of concrete which affects the durability and strength and the appearance of the finished surface. The workability of concrete depends on the water cement ratio and the water absorption capacity of aggregates. If more water is added to the dry mix than it will lead to bleeding and segregation of aggregates. The test of workability of concrete is given by the Indian Standard IS-1199: 1959 which gives the test procedure using various equipment's.

Figure 1

In this case slump cone test was done for measuring the workability of concrete as shown in Figure 1. In this water cement ratio was kept constant at 0.44 and height of fall of the cone of concrete for conventional concrete and for the concrete with partial replacement of sand with Quarry dust at different percentages is done.

Compressive strength

Compression test is the most common test conducted on hardened concrete. Concrete has relatively higher compressive strength but very poor in tensile strength. The different mix of concrete gives various strength, according to the IS-10262: 2009 gives the characteristic and design strength values for various grades of concrete. The strength attained by the mix, must be tested by 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 compressive strength was done for 7 days and 28 days for conventional concrete and for the partial replaced samples in compression machine shown in Figure 2. For 28 days accelerated curing test was done.

In accelerated curing test the 28 days strength of concrete is obtained in 8 hours. In this test the concrete cubes are casted and are kept for curing for 24 hours. After 24 hours the cube along with the mould are immersed in boiling water in an airtight tank for 3.5 hours as shown in Figure 3. The temperature of the tank is maintained between 95 to 100 ºC. After 3.5 hours the moulds are removed from the tank, cubes are demoulded and kept for curing under normal water for 4 hours. When curing time is completed, the cubes are tested for compressive test. Formula for accelerated curing test is

$$\frac{\text{Load X 1.64}}{\text{Area}} + 8.09$$

Figure 2

Figure 3

Flexural Strength

Concrete is weak in tension. Number of investigation are carried out for measurement of tensile strength, out of which beam tests are found to be dependable to measure the flexural strength property of concrete. There are two methods for determining the flexural test for a beam, central point loading and two point loading. In this, two point loading method is used to determine the flexural strength of the beams. The different mix of concrete gives various strength, according to the IS-10262: 2009 gives the characteristic and design strength values for various grades of concrete. The strength attained by the mix, must be tested by flexural strength of the samples which are made in the standard mould of size 100mm X 100mm X 500mm and then, the beams are kept for curing and flexural strength was done for 7 days and 28 days for conventional concrete and for the partial replaced samples in universal testing machine shown in Figure 4

Figure 4

RESULT

WORKABILTY (SLUMP VALUE)

The measured values of conventional concrete and quarry dust replaced concrete with water cement ratio 0.44 such as Mix 1(0% replacement), Mix 2(10% replacement), Mix 3 (20% replacement), Mix 4(30% replacement), Mix 5(40% replacement), Mix 6(50% replacement) respectively. The variations of the slump value with quarry dust percentage are shown in Table 2. The workability of concrete decreases with increase in percentage of quarry dust.

Table 2

Mix	Quarry dust content (%)	Slump (mm)
1	0	80
2	10	75
3	20	70
4	30	65
5	40	60
6	50	60

COMPRESSIVE STRENGTH

The compressive strength results for 7 days and 28 days are in Mpa and are shown in table 3.The strength of concrete increases for 7 and 28 days when river sand is replaced by quarry dust up to 50 % as shown in figure 5.

Table 3

Mix (M)	Quarry dust content (%)	River sand (%)	7 days	28 days
1	0	100	21.56	30.15
2	10	90	21.98	30.46
3	20	80	22.38	30.79
4	30	70	22.86	30.85
5	40	60	23.25	31.02
6	50	50	23.97	31.31

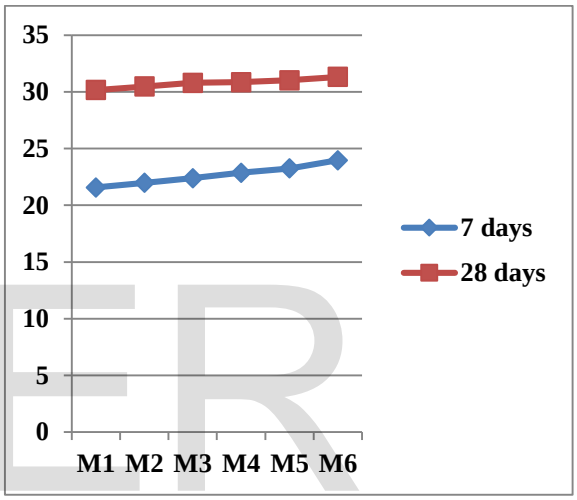

Figure 5

FLEXURAL STRENGTH

The flexural strength results for 7 days and 28 days are in Mpa and are shown in table 4.The strength of concrete increases for 7 and 28 days when river sand is replaced by quarry dust up to 50 % as shown in figure 6.

Table 4

Mix (M)	Quarry dust content (%)	River sand (%)	7 days	28 days
1	0	100	2.5	3.1
2	10	90	2.65	3.3
3	20	80	2.7	3.7
4	30	70	2.86	4
5	40	60	2.90	4.3
6	50	50	2.79	4.15

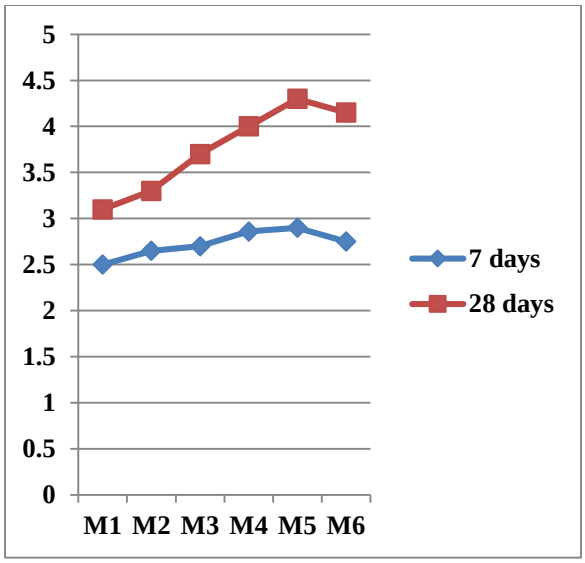

Figure 6

CONCLUSION

From the above results it can be concluded that the addition of quarry dust improves the properties of concrete. Non availability of sand at reasonable cost as fine aggregate in concrete, it was necessary to find alternative material for river sand and quarry dust is quite suitable partial substitute for river sand at low cost. The measured values of quarry dust concrete with constant water cement ratio at 0.44 are found to be 80, 75, 70, 65, 60, 60 mm for different mixes such as Mix 1(0% quarry dust), Mix 2(10% quarry dust), Mix 3(20% quarry dust), Mix4(30% quarry dust), Mix 5(40% quarry dust), Mix 6(50% quarry dust) respectively. It was observed that slump value increases with increase in percentage replacement of sand with quarry dust. The above slump value corresponds to low degree of workability in concrete.

The concrete acquires maximum increase in compressive strength at 50% replacement of river sand by quarry dust. When compared, with the concrete with only river sand, the compressive strength of conventional concrete is 30.15 Mpa while the compressive strength of concrete with 50% replacement of river sand by quarry dust is 31.31 Mpa.

The maximum flexural strength is also at 40% replacement of river sand by quarry dust. . When compared with the concrete beam with only river sand, the flexural strength of conventional concrete is 3.1 Mpa while the flexural strength of concrete beam with 40% replacement of river sand by quarry dust is 4.3 Mpa. As the percentage of quarry dust in the concrete increases the shrinkage in concrete increases. This resulted in decrease in flexural strength of concrete

The above result gives a clear picture that quarry dust can be utilized in concrete mixture as a quality partial substitute instead of river sand.

REFERENCES

[1] IS: 10262-2009, Recommended Guidelines for concrete Mix. Bureau of Indian Standards, New Delhi.

[2] IS: 456-2000, Plain and reinforced concrete. Bureau of Indian Standards, New Delhi.

[3] Anzar Hamid Mir "Replacement for Natural Sand with Efficient Alternatives: Recent Advances in Concrete Technology", Page Number: 51 to 58, International Journal of Engineering Research and applications, ISSN: 2248-9622, Volume 5, Issue 3, March 2015.

[4] J. Karthik, T. Rama, N. Mani Bharathi "An Experimental Study on usage of Quarry Rock Dust as Partial Replacement for Sand in concrete", Page Number:41 to 45, International Journal of Advanced Research in Education Technology, ISSN: 2394-2975(Online), ISSN: 2394-6814(Print), Volume 1, Issue -1, July –Sep 2014.

[5] Sukesh Chandana, Bala Krishna Katakam, P.Sri Lakshmi Sai Teja, Kanakambara Rao S. "Partial Replacement of Sand with Quarry Dust in Concrete", Page Number:254 to 258, International journal Of Innovative Technology And Exploring Engineering, ISSN:2278-3075, VOLUME - 2, ISSUE 6, MAY 2013.

[6] Dr. P. B. Sathivel, C. Ramya, M. Raja "An Innovative Method of Replacing River Sand by Quarry Dust Waste in Concrete for Sustainability", Page Number: 246 to 249, International journal Of Scientific And Engineering Research, ISSN: 2229-5518, Volume -4, Issue 5, May 2013.

[7] Manguriu, Karugu G. N. , Oyawa C. K. , Abuodhaso W. O. , Mulu P. U. "Partial Replacement Of Natural River Sand With Crushed Rock Sand In Concrete Production", Global Engineers And Technologies Review, Volume -3, Issue 4, July 2013.

[8] Kapgate Sudhir S. and Satone S. R. "Effect of Quarry Dust As Partial Replacement Of Sand In Concrete", Page Number: 1 to 8, Indian Stream Research Journal, ISSN: 2230-7850, Volume -3, Issue 5, June 2013.

[9] Balamurugan G., Dr. Perumal P. "Use of Quarry Dust to Replace Sand in Concrete – An Experimental Study", Page Number: 1 to 4, Engineering Science And Technology: An International Journal, ISSN: 2250-3498, Volume -3, Issue 6, December2013.

[10] Balamurugan G., Dr. Perumal P. "Behaviour of Concrete On The Use of Quarry Dust To Replace Sand – An Experimental Study", Page Number: 776 to 7781, International Journal Of Scientific And Research Publications, ISSN: 2250-3153, Volume -3, Issue 12, December2013.

[11] Lohani T. K, Padhi M, Dashk K. P, Jena. S. "Optimum utilization of Quarry dust as partial replacement of sand in concrete", Page Number: 391 to 404, International Journal of Applied Sciences and Engineering Research, ISSN: 2247-9442, Volume -1, Issue 2, December2012.

[12] Langovana R. I, N. Mahendra and K. Nagamanib "Strength And Durablilty Properties Of Concrete Containing Quarry Dust As fine Aggregate", Page Number: 20 to 26, APRN Journal Of Engineering And Applied Sciences, ISSN:1819-6608, Volume -3, Issue 5, October 2008.

[13] SHETTY M. S. "Concrete Technology THEORY AND PRACTICE", revised edition, S. CHAND TECHNICAL, Page numbers: 234, 237, 324, 456, 463.