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Investigations on Various Concrete Properties by Replacement of Fine Aggregate with Stone (Quarry) Dust

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***Abstract*- The global consumption of natural sand is very high, due to the extensive use of concrete. In general, the demand of natural sand is quite high in developing countries to satisfy the rapid infrastructural growth, in this situation developing country like India facing shortage in good quality natural sand. Particularly in India, natural sand deposits are being depleted and causing serious threat to environment as well as the society. Increasing extraction of natural sand from river beds causing many problems, loosing water retaining sand strata, deepening of the river courses and causing bank slides, loss of vegetation on the bank of rivers, exposing the intake well of water supply schemes, disturbs the aquatic life as well as affecting agriculture due to lowering the underground water table etc are few examples. The study employed case study design of generation and utilization of quarry dust at chimakurthy quarry. The quarry dust was tested experimentally for technical viability in the production of quarry dust building blocks; an impact assessment was conducted and finally a cost benefit analysis was carried out to determine the commercial viability as well as social cost benefit of utilizing the quarry dust as a raw material in the manufacture of building blocks. All the experimental data shows that the addition of the industrial wastes improves the physical and mechanical properties. Here we will conclude that the strength should be increased at 25% of stone dust. So by this we will say that from 25% on wards we have to use stone dust. But it should not exceed to 50%.**

***Keywords*- : Cement, Quarry Dust, Fine Aggregate, Coarse Aggregate and Compressive Strength.**

I.INTRODUCTION

In past decade variable cost of natural sand used as fine aggregate in concrete increased the cost of construction. In this situation research began for inexpensive and easily available alternative material to natural sand.

Some alternatives materials have already been used as a part of natural sand e.g. fly ash, slag limestone and siliceous stone powder were used in concrete mixtures as a partial replacement of natural sand.

However, scarcity in required quality is the major limitation in some of the above materials. Now a day's sustainable infrastructural growth demands the alternative material that should satisfy technical requisites of fine aggregate as well as it should be available abundantly.

II. LITERATURE REVIEW

According to Neville (1972) aggregates used in concrete making are divided into two groups, course and fine and are covered by BS 882 (1954) British Standards. The Fine aggregates include crushed gravel, sand and naturally occurring sand (e.g. river sand). Fine aggregates comprise of particles mainly passing a 5mm test sieve while the Coarse Aggregates comprise crushed stone, crushed gravel or uncrushed gravel which consists of particles that are mainly retained on a 5mm test sieve. It is a requirement that aggregates should be durable and chemically inert under the conditions to which they is exposed. Aggregates are selected with regard to; Strength, Size, Particle shape, Surface texture, Grading, Impermeability, Cleanliness, Chemical inertness and Cost (Faber and Mead, 1979) and mixed in different proportions when making concrete.

Concrete is mixture of Portland cement, fine aggregates, course aggregates and water. The quality of the formed concrete depends on the properties of the ingredients and how well they fit or blend together. It is therefore important to select well proportioned mixture that is sufficiently workable, that will make the tasks of transporting, handling, placing and finishing of concrete easy (ACI, 2001).

According to Kong and Evans (1987), Mix design is the process of determining the required characteristics of the concrete mixture. This includes desirable aggregate size, workability; required strength, durability and water-cement (w\c) ratio. The mixture is proportioned to determine the appropriate quantities of all ingredients making the necessary adjustment to achieve the required

specified strength of concrete. The strength is the most important performance requirement and measured at 28 days.

III. MATERIALS USED

1. Cement:
Approximate proportions of lime stone and clay a major role in cement manufacture. After these raw materials has been crushed and sieved, they are fed into a drum rotating at 2 rpm, into which fuel is sprayed counter-current and temperature about 500.

The Types of cements are Ordinary Portland cement and Portland pozzolana cement. Ordinary Portland cement-The Portland cement clinker used in the manufacture of Portland-pozzolana cement shall comply in all respects with the chemical requirements of IS 269 : 1989 and the purchaser shall have the right, if he so desires, to obtain samples of the clinker used in the manufacture for purposes of checking its conformity to IS 269 : 1989.

Ordinary Portland Cement (53 Grade) with 26 percent normal consistency Conforming to IS: 8112-1989 [3] was used in our project. Portland pozzolana cement- An intimately inter ground mixture of Portland clinker and pozzolana with the possible addition of gypsum (natural or chemical) or an intimate and uniform blending of Portland cement and fine pozzolana.

There are different grades of cement is available in market. i.e., 43 grade cement, 53 grade cement etc…. IS 269: 1989 and the purchaser shall have the right, if he so desires, to obtain samples of the clinker used in the manufacture for purposes of checking its conformity to IS 269 : 1989. Here we use 53 grade OPC cement.

2. Fine Aggregate:
Generally, when the sand is fine, smaller proportion of it is enough to get a cohesive mix; while coarser the sand, greater has to be its proportion with respect to coarse aggregate. River sand having density of and fineness Modulus (FM) of 2.51 was used. The specific gravity was found to be 2.47. In India there are different zones of sand are available. i.e., zone 1, zone 2, zone 3 etc., here we use zone 3 sand for our project.

3. Coarse Aggregates:
Greater the size of coarse aggregate lesser is the surface area and lesser is the proportion of fine aggregate required and vice Versa. Flaky aggregates have more surface area and require greater proportion of Fine aggregates to get cohesive mix. Similarly, rounded aggregate have lesser surface area and require lesser proportion of fine aggregate to get a cohesive mix. Natural coarse aggregate having density of 2400kg/m3 and fineness modules (FM) of 6.80 was used. The specific gravity was found to be 2.80 and water absorption as 0.15%.

4. Water:
Water is an important ingredient of concrete as it initiates the chemical reaction with cement, and the mix water was completely free from chlorides and sulfates. Ordinary potable water was used throughout the investigation as well as for curing concrete specimens. Here water content is very important. So we have to take care of it. In this total project we have used 24.3 liters of water for mixing of concrete.

5. Stone Dust:
Pulverized stone used in the construction of walk ways or other stable surfaces. The dust is mixed with soil and compacted are used with gravel to fill spaces between irregular stones. Stone dust is a byproduct of crushing operations.

Fig 1. Stone Dust.

III. DISCUSSIONS AND DESCRIPTIONS

By using the above described materials the concrete was prepared by replacing stone dust as fine aggregates. As for Indian standard recommendations there are different grades of concrete are available. They are M5, M7.5, M10, M15, M20, M25, M30, M40 etc. here we use M20 grade of concrete in our project. Here we consider nominal design. Here we conduct different tests on cement, coarse aggregates, fine aggregates and water. The test results are given in tabular columns. The tests include fineness, specific gravity, impact, crushing, workability, sieve analysis and compaction factor.

Table 1. Cement Test Results.

S.No.	Properties	Test Results	Standard Results
01	Fineness of Cement	91.2%	Minimum 90%
02	Normal Consistency	26%	22 – 30%
03	Initial Settling Time	70 Min	>_45min
04	Final Settling Time	190 Min	<_360 Min
05	Fine Modulus	2.53	2.51

Table 2. Tests for Fine Aggregate, Coarse Aggregates and Water Absorption.

S.No.	Properties	Test Results	Standard Value
01	Fine Aggregate	Stone Dust (Replaced)	Sand (Actual)
02	Specific Gravity of Fine Aggregate	2.47	2.5
03	Specific Gravity of Coarse Aggregate	2.86	2.5-3.0
04	Water Absorption	0.15%	Up To 2.0%

Table 3. Impact Value.

S.No.	Details	Trail Number 1	2	Avg
1	Weight of Aggregate Sample in the Cylindrical Measure, W_1g (Excluding Empty Weight of Cylindrical Measure)	0.5	0.5	0.5
2	Weight of Crushed Aggregates After Passing through 2.36mm Sieve W_2 g	0.264	0.259	0.261
3	Aggregate Impact Value :$((W_2/W_1)*100)$	52.8%	51.8%	52.3%

Table 4. Crushing Value.

S. No.	Details	Trail Number 1	2	Avg
1	Weight of aggregate sample in the cylindrical measure, W_1 (excluding empty weight of cylindrical measure)	3000g	3000g	24.167 %
2	Weight of crushed aggregates after passing through 2.36cm sieve, W_2	2250g	2300g	
3	Aggregate crushing value ;$((w_2/w_1)*100)$	25%	23.3%	

Table 5. Sieve analysis.

S.No	Sieve Size (mm)	Weight of Agg Retained (kg)	% retained	Cumulative % retained	% Finer
01	63	-	-	-	100
02	53	0.5	10	10	90
03	45	0.220	4.4	14.4	85.6
04	40	0.6	12	26.4	73.6
05	37.5	0.29	5.8	32.2	67.8
06	25	0.26	5.2	37.4	62.6
07	16	2.47	49.4	86.8	13.2
08	13.2	0.250	5	91.8	8.2
09	12.5	0.048	0.96	92.76	7.2
10	10	0.060	1.2	93.96	6.04
11	Pan	0.300	6	99.96	0.04

Finer modulus = (sum of cumulative % weight retained / 100) = (585.68) / (100) = 5.856

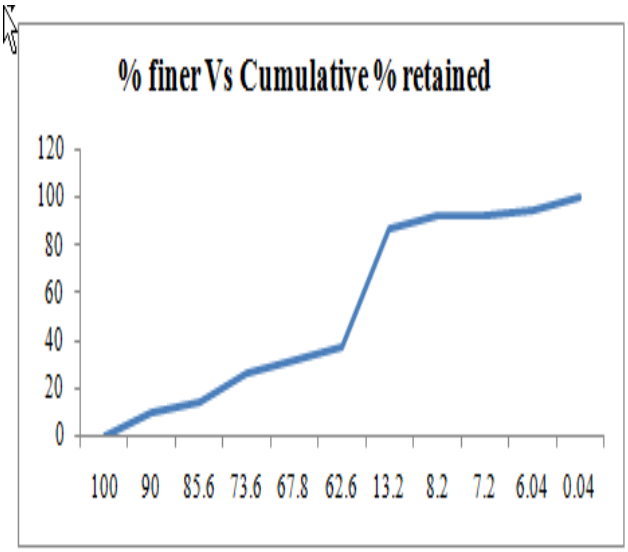

Fig 2. Grain Size Distribution.

Table 6. Slump cone test.

S.No	Type	Slump Cone Collapse Value	Water Cement Ratio
01	0% Stone Dust	3cm	0.8
02	25%Stone Dust	5cm	0.7
03	50%Stone Dust	2cm	0.9
04	75% Stone Dust	2cm	0.9
05	100% Stone Dust	1cm	1.0

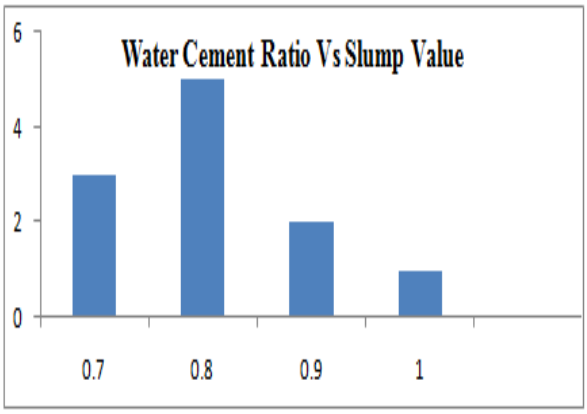

Fig 3. Slump Test.

Table 7. Compaction Factor Test.

S.No.	Type of Concrete	Compaction Factor Test	Water Cement Ratio
01	0% stone dust	0.87	0.5
02	25% stone dust	0.931	
03	50% stone dust	0.92	
04	75% stone dust	0.909	
05	100% stone dust	0.826	

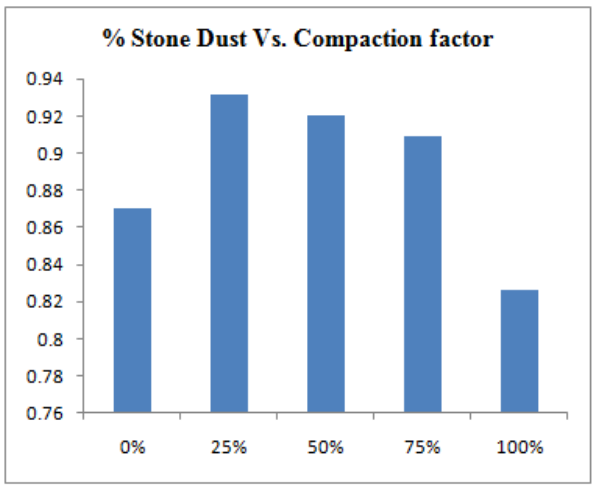

Fig.4. Compaction Results

Table 8. Compressive Strength of Concrete.

S.No.	% of Stone Dust	Compressive Strength	
		7 Days N/mm^2	28 Days N/mm^2
01	0% stone dust	13.165	17.5
02	25% stone dust	14.5	20
03	50% stone dust	12.3	15
04	75% stone dust	11.1	13.7
05	100% stone dust	10.9	12

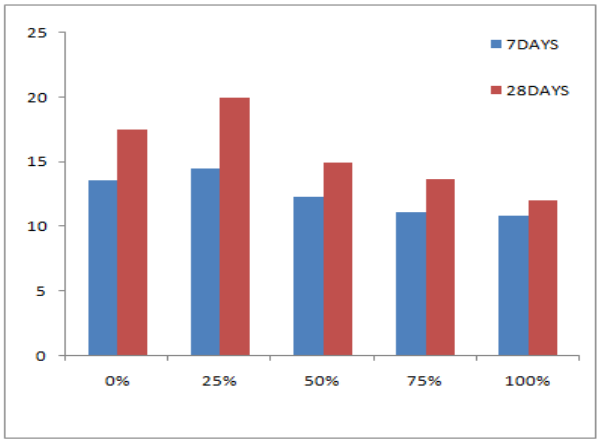

Fig 5. Compressive Strength Results.

With the increase in % of stone dust at water cement ratio 0.5. the compressive strength value is increases from 25 % of stone dust and decreases from 50% of stone dust. So we will conclude that 25% to 50% stone dust is used. It gives good strength when compared to remaining percentage.

Here we will conclude that the strength should be increased at 25% of stone dust. So by this we will say that from 25% on wards we have to use stone dust. But it should not exceed to 50%.

Quarry dust has been used for different activities in the construction industry such as for road construction and manufacture of building materials such as light weight aggregates, bricks, tiles and auto clave blocks. From the various laboratory investigations made for characteristics study of quarry dust concrete and based on the studies conducted as explained.

- Non availability of sand at reasonable cost as finer aggregate in cement concrete for various reasons, search for alternative material stone crusher dust qualifies itself as a suitable substitute for sand at very low cost.
- Aggregates with higher surface area are requiring more water in the mixture to wet the particle surfaces adequately and to maintain a specific workability In specific gravity of fine aggregate we get 2.476. This value indicates it is preferable to use in works.
- The specific gravity of coarse aggregate concludes that the value come from our test result is good. It could not exceed standard value. So it is preferable for works.
- The impact value gives that the value comes from our test is quite high from the standard value. So that it is weak for road constructions and surfaces.
- The crushing value gives that the value comes from our test is good. It could not exceed standard value. So we have to use this.
- The measured slump values of quarry dust concrete with constant water cement ratio 0.5 are found to be 3, 5, 2, 2 and 1 cm for different mixes such as 0% quarry dust, 25% quarry dust, 50% quarry dust, 75% quarry dust and

100% quarry dust respectively. It was observed that the slump value increases with increase in percentage replacement of sand with quarry dust. Due to flaky particles shape and higher percentage of fines, concrete does not give adequate workability and the concrete tends to segregate. The above slump value correspond to low degree of workability, suitable for construction of tiles, bricks, canal lining and autoclave blocks as per IS 456-2000.

- The measured compaction factor value for quarry dust concrete with constant w/c ratio (0.5) are found to be 0.87, 0.93, 0.92, 0.909 and 0.826 for different mixes such as 0% quarry dust, 25% quarry dust, 50% quarry dust, 75% quarry dust and 100% quarry dust respectively. The above values shows concrete do not give adequate workability with the increase of quarry dust as fine aggregate.
- The compressive strength of cubes at 28 days curing for control mix are found to be 17.5N/mm2, 20 N/mm2, 15N/mm2, 13.7N/mm2 and 12N/mm2 respectively for different mixes such as 0% Quarry Dust, 25% Quarry Dust, 50% Quarry Dust, 75% Quarry Dust and 100% Quarry Dust respectively. The above values shows concrete do not give adequate strength with the increase of quarry dust as fine aggregate. The above compressive strength corresponds to decrease of strength.
- It was observed that the aggregate crushing value of quarry dust were in the range of 25%.The average crushing value was found to be 25%.The higher the aggregate crushing value of quarry dust, might be caused by particle shape of dust, which is flaky and angular.

IV. CONCLUSION

These results are of great importance because this kind of innovative concrete requires large amount of fine particles, Due to its high fines of quarry dust it provided, to be very effective in assuring very good cohesiveness of concrete. From the above study it is concluded that the quarry dust may be used as a replacement material for fine aggregate.

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REFERENCES

[1] A.D. and Roesler J.R, Villalovos, S & Lange "evaluation, testing and comparison between crushed manufactured sand and natural sand Technical Note, University of Illinois".

[2] Ahmed AAM, Yusuf MA, "Using of stone powder as an alternative of sand" B. Sc. Eng. Thesis, Civil and Environmental Engineering Department, Shah jalal University of Science and Technology, Sylhet, Bangladesh.

[3] Aziz MA, EngineeringMaterials.Z and Z Computer and Printers, Dhaka, Bangladesh.

[4] Chamberlain B, Concrete,A material for the new Stone Age, a mast module, Material Science Technology.

[5] The star, a weekly publication of the daily star, 18th September, 2009.

[6] Mahzuz HMA, Ahmed AAM, Yusuf MA, " Use of stone powder in concrete and mortar as an alternative of sand" African Journal of Environmental Science and Technology Vol. 5(5).

[7] Ferguson PM, Breen JE, Jiras JO, Reinforced Concrete Fundamentals, 5th Ed., John Wiley & Sons

[8] Haque M, Masum MA, "Use of stone powder with sand" B.Sc.Eng.Thesis,Civil and Environmental Engineering Department, Shahjalal University of Science andTechnology, Sylhet, Bangladesh.

[9] Mahzuz HMA, Tajmunnahar HBM, "Assessment of present environmental situation and strategy formulation for future extraction of natural resources of Jaflong" Proceedings of the conference on Engineering Research, Innovation and Education CERIE, 11-13 January, Sylhet, Bangladesh