STRENGTH OF CONCRETE ON REPLACEMENT OF SAND WITH QUARRY STONE DUST AS FINE AGGREGATE

1. T SAIKRISHNA, 2. Ms.P.Anusha

1. PG Scholar (Structural Engineering), Amrita Sai Institute of Technology, Paritala, NTR Dist, Andhra Pradesh, India. **E-mail id**:saikrishnatuduru1@gmail.com
2. Assistant Professor (Structural Engineering), Amrita Sai Institute of Technology, Paritala, NTR Dist, Andhra Pradesh, India. **E-mail id**: piratlaanusha832@gmail.com

Abstract

Because of the high expense of transporting from natural sources, river sand is a premium product. Depletion of these resources on a wide scale also has negative consequences for the environment. A substitute or replacement product for the concrete industry must be discovered as environmental transportation and other constraints make river sand less desirable. River sand, a common fine aggregate in concrete, is in short supply in many parts of the country. With regards to its supply, cost, and environmental impact, its continued use has begun to pose major concerns.

Quarry rock dust may be a more cost-effective option than river sand in some circumstances. Quarry Rock Dust is a non-volatile waste product left over after rocks have been extracted and processed into tiny particles with a diameter of less than 4.75mm. As a surface finishing material, Quarry Rock Dust is frequently used on highways, as well as in the production of hollow blocks and lightweight concrete prefabricated pieces. Some academics and investigators are concerned about the use of Quarry rock dust as fine aggregate in concrete.

Quarry rock dust has recently received a lot of attention as an alternative to fine aggregate as a filler in concrete. The qualities of concrete made using quarry dust were examined in this study.

Using Quarry Rock Dust as a concrete replacement for natural sand is explored in this thesis. Both conventional and quarry dust concrete mixes have been produced utilising the IS design approach for M25 and M40 slopes. Testing was done on cubes and beams to compare the strength of Quarry Rock Dust Concrete with that of Natural Sand Concrete and the results were compared. Concrete constructed from Quarry Rock Dust has compressive and flexural strengths that are nearly 10% higher than those of normal concrete.

According to the findings, concrete containing quarry stone dust as a fine aggregate had lower compression and flexure strengths when treated with a dosage of 1.3 percent super plasticizer by weight of cement.

1 Introduction

Much attention is being paid to the roadways, sidewalks, and roadside. Paving blocks made of concrete are perfect for walkways because they are easy to place and have a superior appearance and polish. Paving blocks composed of cement concrete are precast solid items. Different sized blocks are available in a variety of different shapes and sizes ranging from rectangular to square to circular, all of which include interlocking designs. Portland cement and aggregates, which are needed in the product's manufacturing process, are readily available across the country. Paving blocks made of cement concrete have a wide range of uses, including sidewalks, gardens, passenger waiting areas, bus stops, and a variety of other public areas. It is often utilised in metropolitan settings for the above-mentioned purposes. As a result, the unit can be located in urban and semi-urban areas, close to the market. Many industrial waste products (such as flyash, silica fume, rice husk and foundry waste) have been successfully utilised in recent years to reduce environmental pollution. A substitute for natural aggregates in concrete has also gotten a lot of interest as an alternate source. Because of this, research have been done to determine whether granite quarry dust may be used in traditional concrete. But many researchers have studied recycled concrete aggregate, fly ash, blast furnace slag as well as several types of manufactured aggregates, Zain et al (1995). As a by-product of the crushing process in quarrying, quarry dust has recently attracted attention for usage as concrete aggregates, particularly fine aggregates. For road construction and the fabrication of building materials, such as lightweight aggregates, bricks, tiles, and autoclave blocks, quarry dust has been used extensively. Quarry dust has been incorporated into concrete in a variety of ways in various countries across the world. According to Galetakis and Raka (2004), concrete's fresh and hardened qualities differed depending on how much sand was replaced with quarry dust (20, 30 and 40%). (Nevillie, 2002). While Celik and Marar studied the properties of fresh and hardened concrete, Saifuddin et al. investigated the effect of replacing sand with quarry dust and cement with mineral admixtures on compressive strength (Safiuddin et al., 2001; Celik and Marar, 1996). Goble (1999) and De Larrard and Belloc (1997) conducted a study on the impact of quarry dust addition on conventional concrete and the pace of compressive strength development for varied quarry dust to coarse aggregate ratios.

According to Bureau of Indian Standards (BIS), the KCP of 53 grade is used in this research project. Sources for the stone dust are found in the Andhra Pradesh city of Madhurawada Visakhapatnam. In line with IS 2386-1968, the specific gravity and bulk density of the stone dust are measured. An accessible crusher in the village of Anakapalli, Visakapatnam district, provides machine-crushed angular metal for use as coarse aggregate. Using the Conplast SP-430, a super plasticizer, as a water treatment method was successful. Workability can be improved by using a reducing agent

1.2 Quarry Stone dust:

Crushed stone screenings are used to make it. Quarry stone crushers produce it as a byproduct. Due to the difficulty in obtaining natural sand, this is now commonly utilised as a fine aggregate. Making fine aggregate from rocks requires the use of specially designed crushers in India. The QSD from current crushers, a byproduct, was utilised in this study.

1.2.1.1

Stone dust can be used in a variety of ways in the construction of a yard. Grounds and walkways might benefit from the compacted layer of stone dust. A sub-base for placing paving blocks and slabs or for jointing natural stone, it's a wonderful choice for both. Banks must be taken into account while installing a stone dust surface because it is incredibly dense and waterproof.

1.2.2.1

The Properties Byproduct of crushing, stone dust has an average particle size of 0 to 3..4mm or 0 to 6..8mm. Stone dust has a strong, load-bearing surface because it comprises very fine mineral aggregates (grain size 0mm).

2.MATERIAL PROPERTIES

2.1 Cement:

The specific gravity of the cement is 3.07

Ordinary Portland Cement (53 Grade) with 32% normal consistency Conforming to IS: 8112-1989 was used. The properties of cement were given below:

Initial setting time : 118 min.

Final setting time : 242min.

Specific gravity 3.13

Fineness(IS sieve) 90 microns

Ultimate compressive strength of standard mortar cubes

a) At the age of 7-days (MPa) 40.0
b) At the age of 28-days (MPa) 56.4

2.1.1 Quarry rock dust

Concrete cubes and beams were cast using Quarry Rock Dust from Sri KanakaDurgaFal-G Brick products, Visakhapatnam. Tables 1 and 2 show the physical and chemical parameters of Quarry Rock Dust as determined by testing samples according to Indian Standards.

Table-3.1. Physical properties of quarry rock dust and natural sand.

Property	Quarry rock dust	Natural sand
Specific gravity	2.54-2.60	2.50
Relative density (kg/m^3)	1720-1810	1813.33
Sieve analysis	Zone II	Zone III

River sand having density of 1813.33kg/m^3 and fineness modulus (FM) of 2.015 was used. The specific gravity was found to be 2.66.The specific gravity of stone dust was 2.63 and fineness modulus was 2.67

2.1.2 Coarse aggregate:

The material whose particles are of size are retained on IS sieve of size4.75mm is termed as coarse aggregate and containing only so much finer material as is permitted for the various types described in IS:383-1970 is considered as coarse aggregate. Aggregates should be of uniform quality with respect to shape and grading. The size of coarse aggregated depends up on the nature of the work. The coarse aggregate used in this experimental investigation is 20mm and 10mm size, crushed and angular in shape. The aggregates are free from dust before used in the concrete. The specific gravity of the coarse aggregate is 2.8

2.1. Super Plasticizer

A ready-to-use additive, Conplast SP 430, is applied to the concrete during the batching process. As soon as you've added 50% to 70% water, you should add it. It should not be applied to the dry materials at all. Superplasticizer Conplast SP430 is unique in that it is based on an aqueous solution of lignosulphonates, a long-chain organic polymer. This considerably enhances the dispersion of cement. While electrostatic dispersion takes place at the beginning of the mixing process, it is stabilised by the existence of lateral chains, which are attached to the polymer backbone, creating a steric barrier. This method produces a concrete that can be easily poured, while requiring significantly less water. The admixture dosages are 1%, 1.3 %, and 1.6 % by weight of cement, respectively.

3. EXPERIMENTAL PROGRAM

3.1 Cubes

Cast iron standard cube moulds with dimensions of 150X150X150mm were utilized to achieve the desired levels of strength and durability.

3.2 Creating a Blend

It was discovered that the newly poured concrete had a dark appearance. Mixture water content had an impact on how fresh concrete behaved. Mixtures with a high water content bled and segregation of particles and the paste occurred when the mixing period was extended. Low hardened concrete compressive strength was often the result of this occurrence. It was determined that the concrete should be mixed within five to seven minutes because of the impacts of the water content and the mixing time, and the following processes should be followed:

3.3 **Casting**

The standard moulds have been set up such that there are no gaps between the mould plates. Plaster of pairs was used to fill in any tiny holes. After that, the moulds were greased and stored until they were ready to be used in the casting process. Concrete was mixed in a pan mixer with a capacity of 90 kg, and a super plasticizer was added for workability, as specified and calculated. After dissolving this in water to the correct proportion, it was added to water and the other ingredients before being mixed with water. Molds were kept under curing for the requisite number of days after a casting was completed for 24 hours.

These examples were 150 mm concrete cubes, and concrete beams of the following dimensions: 100 mm, 100 mm x, and 500 mm in length. M25 and M40 grade specimens were cast, and coarse aggregates of 20 mm were employed. Slump values were used to assess the workability of freshly poured concrete. Addition of super plasticizer (1.0 percent, 1.3

percent, and 1.6% of the weight of cement) is necessary to achieve the desired slump value. Concrete was made by thoroughly mixing all of the ingredients until they had a homogeneous consistency. vibrating table crushed the cubes and beams. IS: 516-1959 was used to measure the compressive and flexural strengths.

MIX PROPRTIONS FOR M 20 GRADE OF CONCRETE

Cement = 375kg/m^3

Water = 180kg/m^3

Coarse aggregate = 1204.466kg/m^3

Fine aggregate = 616.503kg/m^3

Chemical admixture = 3.75kg/m^3

Water-cement ratio = 0.48.

MIX PROPORTIONS FOR M40 GRADE OF CONCRETE

Cement = 430kg/m^3

Water = 180kg/m^3

Coarse aggregate = 1181.320kg/m^3

Fine aggregate = 578.685kg/m^3

Chemical admixture = 3.75kg/m^3

Water-cement ratio = 0.43

Concrete specimens are cast using the mix designs listed above. The ratio of water to cement varies depending on the amount of super plasticizer used. The use of super plasticizer lowers the water demand, allowing for the development of new w/c ratios. The w/c ratios achieved at various dosages of super plasticizer for M25 and M40 concrete are shown in the accompanying tables.

TABLE 4.1 W/C RATIOS FOR M25 GRADE

GRADE	SUPERPLASTICIZER DOSAGE (%)	ACTUAL W/C RATIO	W/C RATIO
M25	1	0.48	0.456
	1.3	0.48	0.4557
	1.6	0.48	0.384

TABLE 4.2 W/C RATIOS FOR M40 GRADE

GRADE	SUPERPLASTICIZER DOSAGE (%)	ACTUAL W/C RATIO	W/C RATIO
M40	1	0.43	0.408
	1.3	0.43	0.387
	1.6	0.43	0.366

3.4 MIXING:

Using a scale, the individual mix ingredients are precisely weighed before being placed on the pan. Before the addition of water, the components are well combined. The freshly prepared mix was then immediately tested for its workability with the mix that had just been prepared.

In this experiment, specimens are being cast and tested to determine the compressive and flexural strengths of cubes and beams. The IS 516-1959 standard is used to cast and test these concrete cubes and beams.

The specimens are casted for the following:

1. M25 grade concrete with OPC+NATURAL SAND
2. M25 grade concrete with OPC + QUARRY STONE DUST
3. M40 grade concrete with OPC+NATURAL SAND
4. M40 grade concrete with OPC + QUARRY STONE DUST

3.5 COMPACTION OF CONCRETE:

The method used to release the concrete's trapped air is known as compaction of concrete. It's possible that air will get caught in the concrete during the placement and mixing procedure. Concrete loses a lot of strength if the air isn't completely eliminated. Table vibrator is utilised in this experiment to obtain maximum density and thorough compaction.

4. RESULTS

4.1 Compressive Strength Result

According to the data in the table, both concretes have reached their desired strengths after 28 days. Normal concrete, on the other hand, has slightly higher compressive strengths than Quarry stone dust concrete. Superplasticizer dosage does not affect the strength of the finished product. Compressive strengths are depicted in the following figures.

Table5.1- Strength comparison for M25 Grade cubes

S.No.	Sp %	OPC + SAND		OPC + QUARRY STONE DUST	
		7 DAYS	28 DAYS	7 DAYS	28 DAYS
1	1.00	14.54	28.33	17.22	28.67
2	1.30	17.74	28.67	18.89	29.89
3	1.60	18.13	29.67	18.77	28.55

M 25 GRADE - COMPRESSIVE STRENGTHS OF CUBES (N/mm^2)

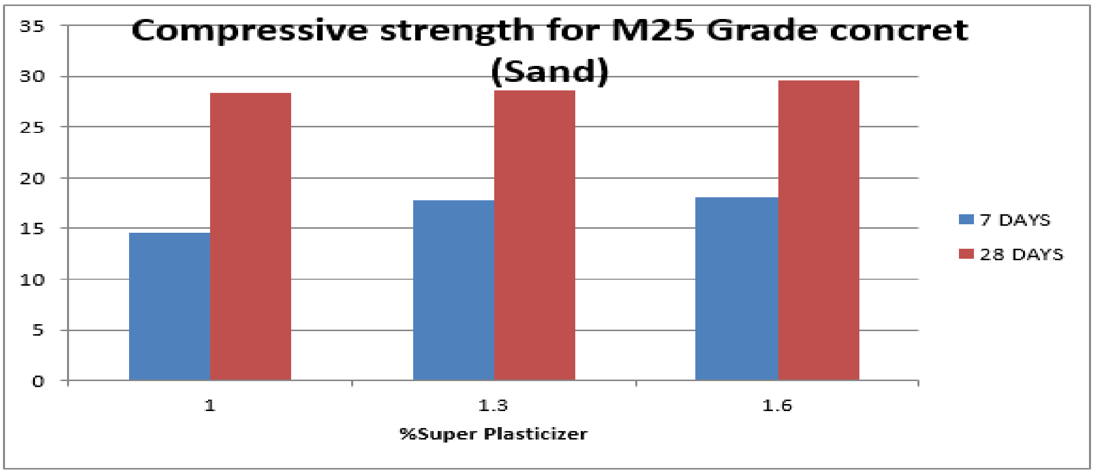

Fig. 5.1(a) Compressive strength of M25 grade concrete

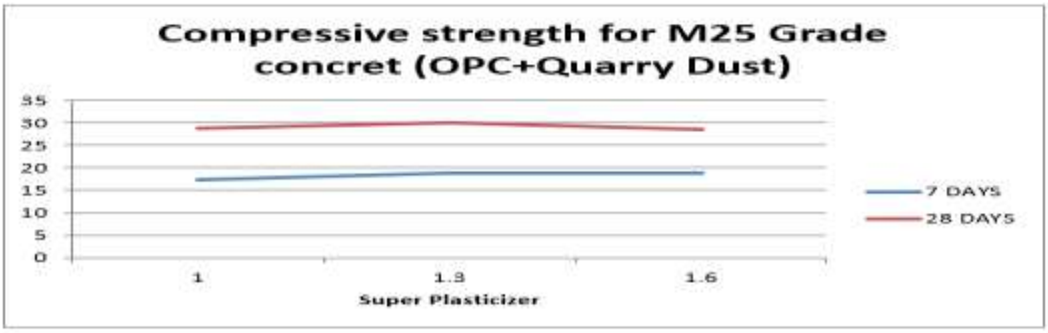

Fig. 5.1(b) Compressive strength of M25 grade concrete (OPC+ Quarry Stone Dust)

4.2 Flexural Strength

Table 5.6- Strength comparison for M25 grade beams.

S.No.	Sp %	OPC + SAND		OPC+QUARRY DUST	
		7 DAYS	28 DAYS	7 DAYS	28 DAYS
1	1.00	2.065	3.495	2.26	3.5
2	1.30	2.74	3.67	2.85	3.7
3	1.60	2.84	3.96	2.62	3.615

M 25 GRADE - FLEXURAL STRENGTHS OF BEAMS (N/mm^2)

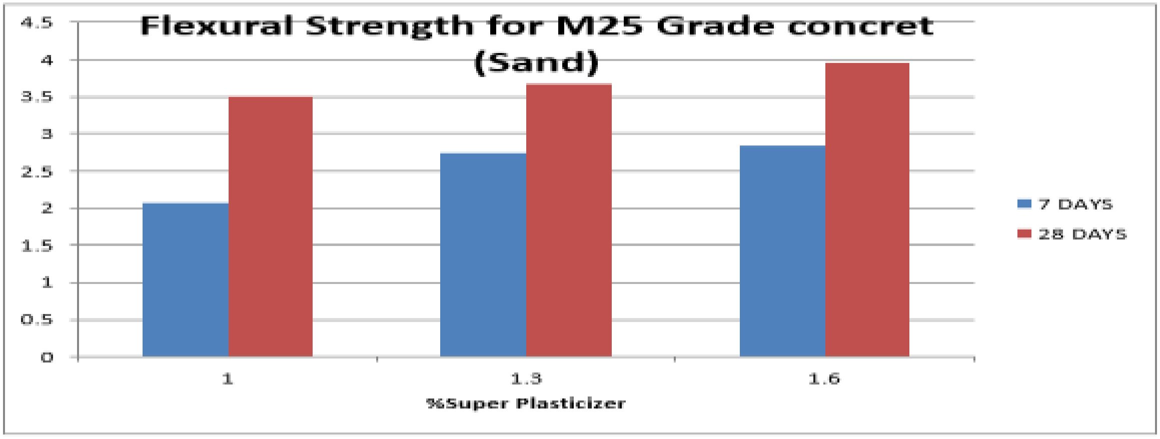

Fig.5.5(a) Flexural strength of M25 grade concrete (OPC+sand)

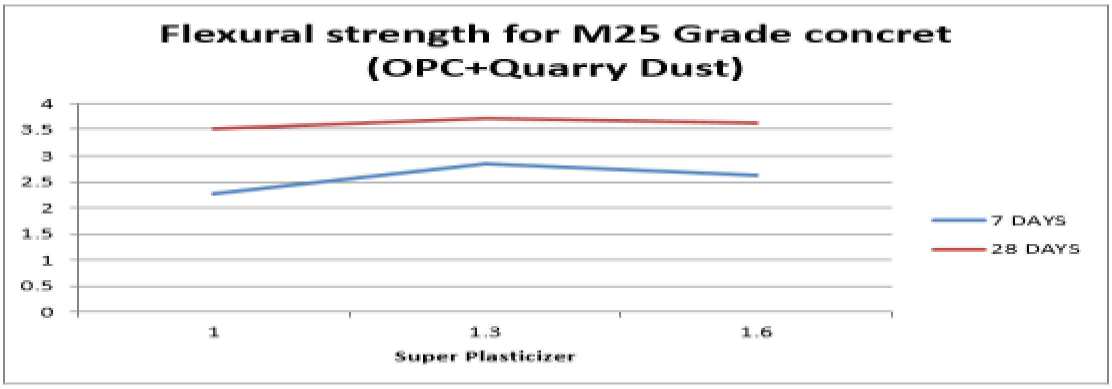

Fig. 5.5(b) Flexural strength of M25 grade concrete (OPC+ Quarry Stone Dust)

S.No.	Sp %	OPC + SAND		OPC + QUARRY DUST	
		7 DAYS	28 DAYS	7 DAYS	28 DAYS
I	1.00	4.32	5.44	4.42	5.5
	1.30	4.44	5.56	4.9	5.85
	1.60	4.82	5.72	4.6	5.65

M 40 GRADE - FLEXURAL STRENGTHS OF BEAMS (N/MM^2)

From the table it is observed that both the concretes are achieving the target strengths at the age of 28 days. But the strengths of Quarry stone dust concrete are slightly higher when compared with normal concrete.

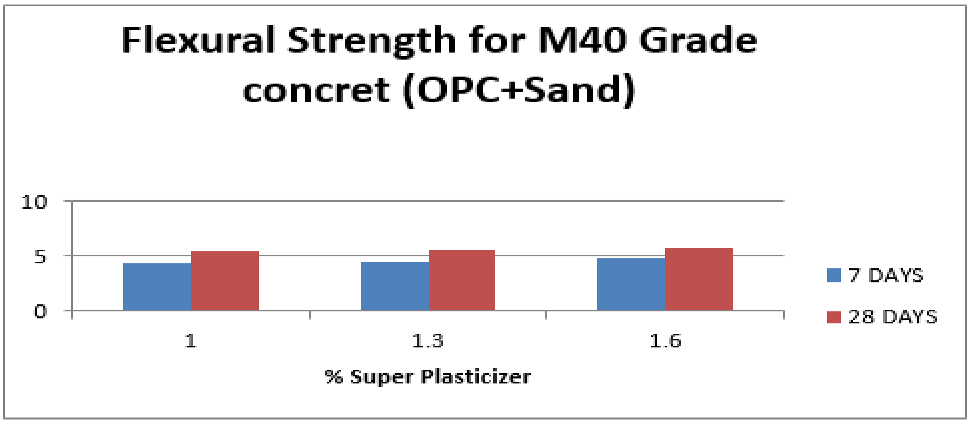

Fig. 5.7(a) Flexural strength of M40 grade concrete (OPC+sand) at 7 days

5.Conclusion

1. The following conclusions can be drawn from the data presented in the previous chapter:
2. 1. The desired characteristic strengths for cubes are reached in conventional concrete and Quarry Stone dust concrete for the proposed mix proportions of M25 and M40 concrete grades.
3. Concrete built with sand as fine aggregate had a higher strength than Quarry stone dust concrete, which had a lower strength rating. However, the super plasticizer dosage of 1.3 percent by cement weight increased strengths

in both cases. M40 grade cubes exhibited a similar pattern of behaviour.

4. The compressive strength of M40 grade cubes was found to be improved by 1.3 percent super plasticizer dosage.
5. When subjected to two-point loading, the flexural strength of M25 prisms was about the same at all dosages of super plasticizer at 7 days and 28 days for conventional concrete, however in QSD concrete at 1.3 percent dosage of super plasticizer the strength was greater at 28 days.
6. Quantitative strength testing shows that QSD concrete containing 1.3% super plasticizer by weight has the highest strength after 28 days when compared to other dosages.
7. Strength increases with super plasticizer from 1% to 1.3% in M40 grade concrete, but strength drops with quarry stone dust from 1.6% to 1.3% in super plasticizer.

6. Reference

1. Appukutty.P. andMurugesan.R. "Substitution of quarry dust to sand for mortar in brick masonryworks"International Journal on Design and Manufacturing Technologies, Vol.3, No.1, January 2009.

2. Ilangovana.R, Mahendrana.NandNagamani.k. "Strength and durability properties of concrete containing quarry rock dust as fine aggregate". ARPN Journal of Engineering and Applied Sciences. Vol.3, no.5, October 2008.

3. IS: 12269-1987. Specification for 43 Grade ordinary Portland Cement. Bureau of Indian Standards, New Delhi.

4. IS: 383-1970. Specification for coarse and Fine Aggregates from natural sources for concrete. Bureau of Indian standards, New Delhi.

5. IS: 2386-1963 Part 1 to VIII. Indian Standard Methods of Test for Aggregate for concrete. Bureau of Indian Standards, New Delhi.

6. IS: 1199-1959. Indian Standard Methods of Sampling and analysis of concrete. Bureau of Indian Standards, New Delhi.

7. IS: 516-1959. Indian Standard Methods of Test for Strength of concrete. Bureau of Indian Standards, New Delhi.

8. IS: 10262-1982 and SP 23:1982. Recommended Guidelines for concrete Mix. Bureau of Indian Standards, New Delhi.

9. Lohani T.K., Padhi M., Dash K.P., Jena.S "Optimum utilization of Quarry dust as partial replacement of sand in concrete" Int. Journal of Applied Sciences and Engineering Research, Vol. 1, No. 2, 2012.

10. Mahendra.R.C and Prakash.S.P. "Strength Appraisal of Artificial Sand as Fine Aggregate in SFRC"ARPN Journal of Engineering and Applied SciencesVol 5, No. 10, October 2010.

11. Mehta, P.K. and Monteiro, P.J.M. (1997). "Concrete: Microstructure, Properties and Materials" Indian edition, Indian Concrete Institute, Chennai, 1997

12. Priyanka.A.JadhavaandDilipk.Kulkarni "An experimental investigation on the properties of concrete containing manufactured sand" International Journal of Advanced Engineering TechnologyVol.III/ Issue II/April-June, 2012/101-104.

13. SanthoshKumar.P.T and Sajeevan.K.K"Compressive Strength of Concrete Containing Crushed Stone Sand As Well as River Sand as Fine Aggregate"

14. SachinBalkrishnakandekar, AmolJagannathMehetreandVijayshree.A.A."Strength of concrete containing different types of fine aggregate" International Journal of Scientific & Engineering Research Volume 3, Issue 9, September-2012.

15. Shahulhameed.Mand a. Sekar.S.S. "Properties of Green Concrete Containing Quarry Rock Dust and Marble Sludge Powder As Fine Aggregate" ARPN Journal of Engineering and Applied Sciences Vol. 4, No. 4, June 2009.

16. VeeraReddy.M."Investigations on stone dust and ceramic scrap as aggregate replacement in concrete" International Journal of Civil and Structural Engineering Volume 1, No 3, 2010.

17. VenuMalagavelli and RAO.P.N."High Performance Concrete With GGBS and RoboSand"International journal of civil and structural engineering Volume 1, no 3, 2010.