Development of High Strength Concrete Using Quarry Dust As Fine Aggregate

Anuj Kumar Sonkar[1], Ramendra Kumar Singh[2]
[1] Dept of Civil Engineering
[2]Assistant Professor,Dept of Civil Engineering
[1, 2] Lucknow Institute of Technology, Lucknow

Abstract- *The globe nowadays is widely using high strength and high-performance concretes. Use high strength concrete in contemporary buildings has culminated in both technological and socioeconomic benefits in advanced nations. For high-strength concrete, the water-cement ratio must be reduced and, for general, the cement content increased. Different types of 'pozzolanic mineral admixtures and super plasticizer' are used to achieve the necessary durability to resolve the low workability problems. At almost the same moment, the shortage of concrete components and its prices are rising year by year, requiring the advancement of the use of substitutes of appropriate recyclable materials. Specially because of many social, environmental, economic and expenditure difficulties, substitutes of traditional sand in the concrete are given paramount importance. This work focuses on the advancement of quarry dust concrete and the total substitution of traditional sand with quarry dust, and the study will be conducted in consecutive steps with a systemic methodology.*

Using ACI, BS and IS methods a conventional concrete mix design of M30 grade was produced and the experimental study recommended an ideal mix on basis of 7-day strength. The designed mixture was intended to replace sand with only a weight of 0%, 20%, 40%, 60%, 80% and 100% with quarry dust. Beton with these six blend ratios has been prepared and no plastifier is being used for the sake of proprietary truth. Workability studies have been carried out, and specific measurements with strength and water absorption properties have been cast, treated and checked. Regardless of the proportion of replacement of sand with quarry mud, when we find marginal improvements in intensity tests, for further research, a total 100% substitution of sand by quarry dust was considered.

Keywords- Tyre rubber, Bitumen, Aggregate.

I. INTRODUCTION

Concrete is the world's best-known material for building and by its ecstasy, conventional components are not replaced with concrete. Nevertheless, it is rarely possible to sustain construction operation in the long run to meet future building demand through the use of energy-intensive materials and building technology or techniques available at the moment. The building industry leads greenhouse gas (GHG) pollution (22 percent) to the ecosystem and raises great concern for climate change as a result of the increasing degree of global warming and the rise in sea level;The challenge of concrete technologists is to lead future developments in a manner that seeks to protect the quality of the environment while designing concrete as a choice building material. Naturally, today's environmental issues are well connected to technological advances choices aimed at making robust and environmentally sound concrete.

About 60 percent of its output has been impacted by the degree of quarry rock dust use in industrialized countries including Australia, France, Germany and the United Kingdom. In Japan, minimally processed crushers are generally considered only suitable in a mix of natural sand and only if they are of excellent quality and inexpensive enough here to render a substitute desirable. While quarry dust causes serious respiratory problems for people living close to quarries by dumping quarry dust and an environmental problem, the significant upside use as a combination will become an additional benefit.

It should, nevertheless, be stressed that quarry fines are required as waste material to differ in terms of time and quarry characteristics. In comparison, flaky, badly classified, finely formed and extremely fine aggregates is crushed waste. With further fines, water demand is increasing, so that intensity declines and granite fines could also contribute to long-lasting problems. These concerns should be discussed first if the content is to be used in the construction industry with trust.

II. LITERATURE REVIEW

GENERAL

It is because of the over-exploitation of river sand and its associated harms that an alternative for river sand is needed. The next plausible replacement for river sand has been described as quarry mud. The crushing method developed in the quarries, which are distinct from the authors ' called quarry dust (QD), some 10-15 percent of unstated waste. Nearly all parts of the world have been protected by the use of quarry powder, but work has still taken up practical use of quarry powder. A good number of studies have been done in India and other countries in the area of the use of quarry dust in structural concrete.Many writers ' attempts have been compiled and essential articles are briefly discussed here.

EXPERIMENTATAL INVESTIGATION

The experimental portion of the study is a preliminary study for a detailed and essential analysis. The former preliminary study is to examine the strength development for conventional river sand of M30 grade concrete with a quarry staub. The sand substitution levels by QD comprised 0% (control) to 100%. The later detrimental is to study how quarry dust concrete with total substitution of conventional river sand can be used. Workability, strength and durability are taken into account as the three-dimensional features of the concrete.

III. CONSTITUENT MATERIALS

The following are the constituent materials, adjustments or admixed products for the preliminary and primary study in order to develop carry dust ceiling: Cement — Sand — Super plasticizer — Super plasticizer — Substantial material, additives and admixtures for the preliminary and primary study for the development of quarry dust concrete:-

The primary material for this experimental work was the locally available quarry dust. Basic studies based on the first principle were only used for ordinary Portland cement (OPC). Furthermore, both river sand and quarry and crushed stone granite were used as a rough aggregate (Padalam quarry). Also in combination with other materials of concrete where necessary additives such as fly ash and silica fume and admixtures were used.. One day before using cement and admixtures. All other components except cement and admixtures were obtained and stored in the laboratory as well as heaps in order to maintain uniformity.

components in accordance with Indian standards the design and general parameters as engineering properties were determined. The component test results are shown in Table 4.1. Tables 4.2 and Table 4.3 provide similarities between the particle fraction and the chemical composition. Examples of the QD fractions are provided in Appendix D.

IV. FINE AGGREGATE

Table.4.1 Properties of the concrete constituents

No	Material	Properties		Relevant codes
1		Fineness	5%	
2	Cement OPC 43 Grade	Specific gravity	3.15	IS: 12269-1987
3		Initial setting time	55mm	
4		Final setting time	525mm	
5	Fine Aggregate (Sand)	Fineness modulus	2.71	IS: 2386 (Part-I)-1963
6		Specific gravity	2.56	
7		Bulking factor	35%	
8	Fine Aggregate (Quarry Dust)	Fineness modulus	3.36	
9		Specific gravity	2.60	
10		Bulking factor	47%	
11	Coarse Aggregate	Maximum size	12mm	IS: 383-1987
12		Fineness modulus	7.14	
13		Specific gravity	2.61	

Table 4.2 Comparison of Percentage passing of aggregates

No	Sieve Size	% Passing (IS 383: 1970)		
		Fine aggregate		Coarse aggregate
		QD	Sand	
1	40 mm	-	-	100
2	20 mm	-	-	100
3	10 mm	-	-	94.2
4	4.75 mm	94.20	99.00	07.3
5	2.36 mm	77.40	95.70	-
6	1.18 mm	44.60	73.70	-
7	600	31.60	42.40	-
8	-	13.00	07.00	-
9	-	02.90	01.00	-
10	0	00.40	00.10	-
11	Residue silt	00.40	00.10	-
12	Fineness modulus	03.36	02.71	07.14
13	Grading zone	III	III	-

Table 4.3 Chemical composition of Quarry Dust and Sand

No	Constituents	QD (%)	Sand (%)
1	Loss of ignition	01.81	00.61
2	Silica as SiO_2	61.77	97.60
3	Iron as Fe_2O_3	06.03	00.028
4	Titanium as TiO_2	Nil	00.18
5	Aluminium as Al_2O_3	16.74	01.31
6	Calcium as CaO	07.57	00.06
7	Magnesium as MgO	06.08	00.01

Table 4.4 Specimen details for various tests

No		Nature of test
1	100 mm cubes	Compressive and indirect tension* tests
		Water absorption test up to 24 hours
		Ultrasonic pulse velocity (UPV) Test
		Rebound value (Schmidt's hammer)
		Sulphate resistance/ Acid resistance tests
2	100x200 mm cylinders	Compression and indirect tension tests
3	100x200 mm cylinders	Rapid chloride penetration test
4	100x100x500 mm prisms	Modulus of rupture (Flexural strength)
5	150x300 mm cylinders	Modulus of Elasticity of concrete
6	100 mm cubes with rebar	Pull out test
*Only limited specimens		

Weight batching is taken throughout the casting to produce a standard mix. The components were thoroughly mixed until a good mix of coherence and working properties on each batch were obtained. The samples were set over the table vibrator and shaped in the laboratory with polythene sheets for 24 hours. Until a date of 37 measurements at specific times they were unmolded and cured into water. For every concrete standard, a minimum of 288 specimens were made. (60 cube compression samples, 60 compression samples, 60 split voltage samples, 48 rupture module prisms, 10 acid test sampling, 48 acid test samples,12 Alkalin test cubes, 12 water absorbance test cubes, 12 RCPT test cylinder and 12 concrete module cylinders.

Table 4.5 Details of testing and curing days for various tests

No	Nature of test	Days of Curing before testing					
1	Compression tests (Cube)	3	7	14	28	60	90
2	Compression test (Cylinder)	3	7	14	28	60	90
3	Split (indirect) tension (cylinder)	3	7	14	28	60	90
4	Modulus of rupture (flexure)	3	7	14	28	60	90
5	Split (indirect) tension (cubes)*				28	60	90
6	Modulus of Elasticity of concrete*				28	60	90
7	Water absorption				28	60	90
8	Porosity				28	60	90
9	Rapid chloride permeability test				28	60	90
10	Sulphate resistance				28	60	90
11	Acid resistance tests				28	60	90
12	Alkalineresistance				28	60	90
* Only for limited days or cases							

All six different concrete combinations, as shown in figure 4.2, were workable tested. For the production of control specimens for several tests planned, weight batching, machine mixing, vibrated compaction and pool curing were used. 24 hours before testing, the specimens were taken from the treatment tank and kept to open drying. The tests were carried out according to the relevant standards as shown in Figure 4.3 to determine different strengths. Table 4.5 displays the working ability and strength characteristics of the six separate plastic-free concrete.

Rebound Hammer Test

Hammer rebound commonly used surface hardness measurement equipment. It is composed by a hammer that slides into a pipe inside a tube box. The mass recovery from the plunger when the plunger is pushed toward the concrete surface. The force of the spring is retracted. The hammer impacts the mass rebounds of concrete and spring control and takes the driver along the scale of the guide. By pressing a button, it is possible to hold the rider in position to read. The distance that the mass travels by means of a graduated ride is called the rebound number.

Ultrasonic Pulse Velocity Test

The measurement of the time of electrosonically generated mechanical pulse through the concrete involves the ultrasound pulse velocity test. UPV is the measurement of the time of the ultrasonic pulse through the tested specimen. The pulse generator circuit consists of an electronic circuit to generate pulses and the electronic pulse transducer to transform it into mechanical energy with vibration frequencies of 15 to 50 KHZ.

Durability Studies

Concrete was considered a very durable and maintenance-friendly material. Most of the statement is valid, if it is under really violent circumstances. In many countries, concrete durability is a major issue. In IS 456-2000, the aspect "durability" is a major review of the durability of concrete structures in line with codes of practice from other countries. Cement concrete's durability is defined by its ability to withstand weathering, chemical attack, abrasion or any other deterioration process. When exposed to its environment, sustainable concrete will retain its original shape, quality and serviceability. Durability tests have been planned to evaluate the following:

(i) Porosity and saturated water absorption
(ii) Acid attack
(iii) Alkaline attack and
(iv) Rapid chloride Penetration test (RCPT)

Acid Resistance Test

Concrete cubes are exposed to chemical mediums in order to assess weight loss. The acid test was performed by a 5 percent HCl hydrochloric acid mixing with a litre of water in accordance with ASTM G20-8. The cubes were taken out and weight was noticed after normal curing for 28 days. Weighed cubes were submerged for 60 days in prepared hydrochloric acid. The cubes were taken out of acid after 60 days of immersion and the weight of the cubes were noticed. The weight loss is finally achieved.

Alkaline Test

A 5 per cent sodium hydroxide solution with one litre of water as per ASTM G20-8 has been packed. The cubes healed for 28 days and weight was measured. The weighed cubic samples were immersed for 60 days in a prepared solution of sodium hydroxide. Concrete cubes were removed and weighed after 60 days of immersion. This calculates the weight loss.

Rapid Chloride Penetration Test

Cylindrical disk specimens were tested for Rapid Chloride Engineering Test (RCPT). A total of 100 to 50 mm disks of concretes were used cut from 100 to 200 mm of cylinders of various concrete types.

V. SUMMARY

The test part was conducted satisfactorily and the results were presented in the order of the test. All 26 mixed proportional concrete grades have been grouped and presented with three directional characteristics, namely functionality, strength and length characteristics. The next chapter deals with the study and evaluation of test results.

VI. CONCLUSION

Quarry Dust was conducted as a fine aggregate in the experimental investigations. Four concrete categories were taken into consideration: M30, M40, M50 and M60. Partial substitution and complete sand replacements by quarry dust and a partial cement substitution by Fly Ash and Silica Fume were investigated. Super plasticizer is also used to improve the workability. The materials used in the concrete have determined their physical and chemical characteristics. Based on this, the designs and characteristics of the concrete mix made, the concrete prepared and the workability, strength and endurance were studied. Based on test results after findings and recommendations.

VII. RECOMMENDATIONS

The following recommendations are made following the research done on the development of a quarry dust concrete by totally replacing traditional river sand:

i. Quarry dust may be used in concrete as a fine aggregate (rather than sand from the river).
ii. For small, medium, medium, high strength and SCC applications, mixing designs can be made for quarry dust concrete similar to sand concrete.
iii. To improve the quarry's performance, its fine content and other impurities should be checked for quarry dust.
iv. Quarry dust may be washed and used for specific purposes in water rather than for sand manufactured.
v. Additives similar to conventional sand-concrete may be used in combination with admixtures.

REFERENCES

[1] ACI 211.4R-93: (Reapproved) Guide for selecting proportions for High strength concrete with Portland cement and fly ash.

[2] Aggarwal, P., Aggarwal, Y and Gupta, S.M (2007). Effect of bottom ash as replacement of fine aggregates in concrete, Asian Journal of Civil Engineering (Building And Housing), 8(1): 49-62.

[3] Arivalagan Soundararajan, Kandasamy Shanmugasundaram (2008). Flexural Behaviour of Concrete-Filled Steel Hollow Sections Beams, Journal of Civil Engineering and Management,14(2): 107–114.

[4] ASTM C1202, Electrical Indication of Concrete's ability to resist chlorde ion penetration, Annual Book of American Society for Testing materials standards,V ol,3,02,1994.

[5] Baalbaki, W., Benmokrane, B., Chaallal, O and Aitcin, P.C (1991). Influence of coarse aggregate on Elastic properties of High performance concrete, ACI Materials Journal, 88(5):499-503.

[6] Bonavetti.V.L. and Irassar.E.F (1996). Effects of stone dust content in Sand, Cement Concrete Research, 26 (7): 1121-1130.

[7] Clive Mitchell (2007). Waterless fines removal, Project MA/4/5/002, British Geological Survey, Nottingham.