A COMPARATIVE STUDY ON STRENGTH PROPERTIES OF COCNCRETE BY PARTIAL REPLACEMENT OF FINE AGGREGATES WITH QUARRY DUST

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ABSTRACT

This experimental study presents the variation in the strength of concrete when replacing sand by quarry dust from 0% to 100% in steps of 20%. M30 and M40 grades of concrete were taken for study keeping a constant slump of 60mm. In such a situation the quarry dust can be an economic alternative to the river sand. Quarry dust can be defined as residue, tailing or other non-voluble waste material after the extraction and processing of rocks to form fine particles less than 4.75mm. Usually, dust is used in large scale in the highways as a surface finishing material and also used for manufacturing of follow blocks and lightweight concrete draws serious attention of researchers and investigators. From test results it was found that the maximum compressive strength is obtained only at 40% replacement at room temperature and net strength after loss due to hike in temperature was above the recommended strength value due to 40% replacement itself. We are using the M30 and M40 grade concrete by adding 20% and 40% quarry dust used was designed by a modified IS method were casted and compression, split tensile strengths conducted for the age 3days of 7 and 28 days were obtained at room temperature. The quarry dust as a partial replacement of fine aggregate with super plaster (VARA PLASTER SP 123) to obtained high workability and high strength as a chemical mixture. This result gives a clear that quarry dust can be utilized in concrete mixtures as a good substitute for natural river sand giving higher strength at 50% replacement.

Index Terms- Concrete, quarry dust, river sand, super plaster, compressive strength split tensile strength.

INTRODUCTION

1.1 GENERAL

Common river sand is expensive due to cost of transportation from natural sources. Also large-scale depletion of these sources creates environmental problems. As environmental transportation and other constraints make the availability and use of river sand less attractive, a substitute or replacement product for concrete industry needs to be found. River sand s most commonly used fine aggregate in the production of concrete poses the problem of acute shortage in many areas, whose continued use has started posing serious problem with respect to its availability, cost and environmental impact. The increasing demand is also leading to hike in its price and large excavations in river beds. It is in turn posing a problem to the existing water bodies. In such a situation the quarry rock dust can be an economic alternative to the river sand. Quarry rock dust can be defined as residue, tailing or other non-voluble waste

material after the extraction and processing of rocks to from fine particles less than 4.75mm. Usually, quarry rock dust is used in large scale in the highways as a surface finishing material and also used for manufacturing of hollow blocks and lightweight concrete prefabricated elements. Use of quarry rock dust as a fine aggregate n concrete draws serious attention of researchers and investigation. Currently India has taken a major initiative on developing the infrastructures such as express highways, power projects and industrial etc. To meet the requirements of globalization, in the construction of buildings and other structures concrete plays the rightful role and a large quantum of concrete is being utilized. River sand, which is one of the constituents used in the production of conventional concrete, has become highly expensive and also scarce. In the backdrop of such a bleak atmosphere, there is large demand for alternative materials from industries. The utilization of quarry rock dust which can be called as quarry dust has been accepted building material in the industrially advanced countries of the west for the past three decades. As a result of sustained research and developmental works undertaken with respect to increasing application of this industrial waste, the level of utilization of quarry rock dust in the industrialized nations like Australia, France, Germany and UK has been reached more than 60% of its total production. The use of quarry dust in India has not been much, when compared to some advanced countries. Lack of awareness among people and less classified research on quarry dust is the reason.

1.2 IMPORTANCE OF THE STUDY

The objective of our project to find a substitute for fine aggregate which is more economical and durable without reducing the strength of the concrete. Such a substitute should comply with the existing standards stipulated for fine aggregate. It also should be available at cheaper rates in abundant quantities. However, though the inclusion of fly ash in concrete gives many benefits, such inclusion causes a significant reduction in early strength due to the relatively slow hydration of fly ash. Nevertheless, fly ash causes an increase in workability of concrete. 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, but it causes a reduction in the workability of concrete. When examining the above qualities of fly ash and quarry dust it becomes apparent that if both are used together, the loss in early strength due to one may be alleviated by the gain in strength due to the other, and the loss of workability due to the one may be partially negated by the improvement in workability caused by the inclusion of the other.

1.3 SCOPE OF THE STUDY

- Identification of quarry with different mineralogical composition in and around Nellore region.
- Collection of quarry dust from two different quarries.
- Testing of the collected samples for various physical and chemical properties.
- Testing of fresh concrete containing quarry dust for workability.

- Identification and usage of admixtures for better workability and strength.
- Testing of hardened concrete cubes for strength at different ages.

2. LITERATURE REVIEW

G.Balamurugan, Dr.P.Perumal

This experimental study presents the variation in the strength of concrete when replacing sand by quarry dust from 0% to 100% in steps of 10%. M20 and M25 grades of concrete were taken for study keeping a constant slump of 60mm. The compressive strength of concrete cubes at the age of 7 and 28 days were obtained at room temperature. Also the temperature effect on concrete cubes at 100oC on 28th day of casting was carried out to check the loss of strength. From test results it was found that the maximum compressive strength is obtained only at 50% replacement at room temperature and net strength after loss due to hike in temperature was above the recommended strength value due to 50% replacement itself. This result gives a clear picture that quarry dust can be utilized in concrete mixtures as a good substitute for natural river sand giving higher strength at 50% replacement. The following are the conclusion points of their study

- Concrete acquires maximum increase in compressive strength at 50% sand replacement. The percentage of increase in strength with respect to control concrete is 24.04 & 6.10 in M20 and M25 respectively.
- After heated to 100oC, the maximum compressive strength is obtained at 50% sand replacement. The percentage of reduction in strength with respect to control concrete is 6.67 & 13.80 in M20 and M25 respectively.

An Innovative Method of Replacing River Sand by Quarry Dust Waste in Concrete for Sustainability Ref4 GHOSH One of the earliest investigations on the suitability of quarry dust for making quality concrete was Ghosh and others at Central road Research Institute (CRRI), New Delhi. They carried out the various tests on physical properties of quarry dust obtained from a few sources in U.P to determine their suitability as a fine aggregate. Mortar making property, compressive strength, flexural strength, abrasion loss, drying shrinkage and bond strength of concrete were determined for all the samples and concluded that quarry dust used as fine aggregate to produce quality concrete. However, split tensile strength and durability studied were not conducted to determine the relative performance of quarry dust concrete.

STRENGTH AND DURABILITY PROPERTIESOF CONCRETE CONTAINING QUARRY ROCK DUST AS FINE AGGREGATE Ref 5 ILANGOVAN AND NAGAMANI

According to Ilangovan and Nagamani, there was up to 10% increase in compressive strength and flexural strength when natural sand is fully replaced by crusher rock dust. Workability

decreased which can be rectified by adding super plasticizer based on codal provision. Maximum permissible particles of size finer than 0.075mm are 15%.

METHOD OF REPLACING RIVER SAND BY QUARRY DUST WASTE IN CONCRETE FOR SUSTAINABILITY Ref 6 NAGARAJ According to Nagaraj, if sand replacement completely by quarry dust as a means of marginal material is desired; to care of workability use of super plasticizer can be very helpful. On the other hand if partial replacement is contemplated, with reduced dosage of super plasticizer and adjustment in water content the required workability can be obtained. With 2% increase in super plasticizer a dramatic increase of slump value from 5mm to 130mm is produced. When 50% sand and 50% quarry dust is used the slump value increased from 5mm to 15mm only. Nagaraj and zahida banu used quarry dust and pebbles as fine aggregate and CA in concrete and used the method of reproportioning concrete to obtain M65 concrete and has concluded that the above combination of CA & fine aggregate can be used with confidence in concrete. Use of Quarry Dust to Replace Sand in Concrete – An Experimental Study PRAKASH RAO AND GIRIDHAR Ref 7 According to Prakash rao and Giridhar, usage of quarry dust has no detrimental effect on strength and performance of concrete when designed correctly. The concrete cubes with quarry dust developed about 17% higher strength in compression, 7% more split tensile strength and 20% more flexural strength than the concrete cubes or beams with river sand as fine aggregate. The difference in strength are possibly due to sharp edges of stone dust providing stronger bond with cement compared to the rounded shape of river sand. The investigation indicates that quarry dust has potential as fine aggregate in concrete structures with reduction in cost of concrete by 20% compared to conventional concrete.

High Performance Concrete using Quarry dust as Fine aggregate SAHU AND SUNIL KUMAR

Ref 8 According to Sahu and Sunil Kumar, there is a significant increase in compressive strength, modulus of rupture and split tensile strength for both the concrete mixes when sand is partially replaced by stone dust. The workability of the concrete mixes decreased with an increase in percent of stone dust as partial replacement of sand. The workability of concrete mixes increased with an increase in percent of super plasticizer. It can be concluded that if 40% sand is replaced by stone dust in concrete, it will not reduce the cost of concrete but at the same time it will save a large quantity of natural sand and will also reduce the pollution created due to the disposal of this stone dust on valuable fertile land.

3. EXPERIMENTAL PROGRAMME

MATERIALS USED:

The different materials used in this investigation are:

- Cement
- Fine Aggregates
- Coarse Aggregates

- Quarry Dust
- Chemical Admixture-super plasticizer
- Water

4. CONCRETE MIX DESIGN

MIX DESIGN FOR PRESENT INVESTIGATION

Mix proportion of concrete for the reference mix using quarry dust as fine aggregate for two grades (M30 and M40) are done using IS method. The mix proportion obtained is summarized below. The concrete mix design for M30 and M40 were carried out according to Indian standard recommendation method is 10262-2009.

4.2 MIX DESIGN FOR M30

4.2.1 STIPULATIONS FOR ROPORTIONING

Grade designation = M30

Type of cement = OPC 53 grade

Mineral admixture = No

Maximum nominal size aggregate = 20 mm

Maximum water content = 0.4

Workability = 100mm (slump)

Exposure condition = Severe (reinforced concrete)

Degree of supervision = Good

Type of aggregate = Crushed angular aggregate

Chemical admixture = No

TEST DATE FOR MATERIAL:

Cement used = OPC 53

Specific gravity of cement = 3.15

Specific gravity

Coarse aggregate = 2.80

Fine aggregate = 2.70

Water absorption

Coarse aggregate = 0.5 percent

Fine aggregate = 1.0 percent free moisture

Free moisture

Coarse aggregate

Fine aggregate

=

=Nil

Nil

DESIGN:

Target strength for mix proportion f‟ck = fck + (1.65× s)

= 30+1.65×5

= 38.25 N/mm2

RESULTS AND DISCUSSIONS

The test data and results obtained from the tests conducted in the present investigation concrete 60 cubes and 60 cylinders have presented in tables and discuss in this chapter in the test carried out, importance has been given to workability, ultimate compressive strength, cracking and durability. The results of conventional concrete are compared with the quarry dust as a replacement of fine aggregate with individual percentage replacement of admixture of compared between the M30 and M40 grade concrete between the such as workability and compressive strength cracking have been observed and recorded. Graphs of compressive strength Vs compared between the above two grades. Table no:16

WORKABILTY TEST RESULTS Slump values for M30 and M40 grades by addition of Quarry Dust as partial replacement of fine aggregates.

% of Quarry Dust added	Slump in „"mm""	
	M30	M40
0%	60mm	70mm
20%	65mm	60mm
40%	70mm	65mm

5.1.1 COMPRESSIVE STRENGTH TEST

Codings	Compressive strength for 3 days(MPa)			Compressive strength for 7 days(MPa)			Compressive strength for 28 days(MPa)		
	Cube no			Cube no			Cube no		
	1	2	Avg	1	2	Avg	1	2	Avg
C	13.77	14.00	13.88	18.88	19.77	19.32	37.80	40.00	38.90
Q1	23.56	22.22	22.89	25.78	27.56	26.67	44.44	55.55	50.00
Q2	22.22	22.44	23.33	26.67	30.00	28.33	52.00	48.88	50.44
S1	42.00	42.22	42.11	44.88	44.44	44.66	55.55	53.33	54.44
S2	28.88	28.00	28.44	41.33	37.33	39.33	57.77	55.55	56.66

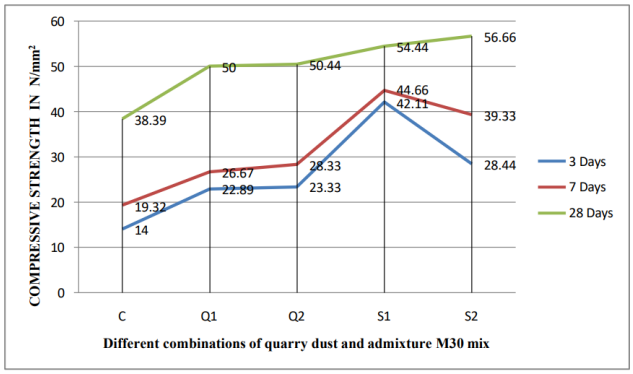
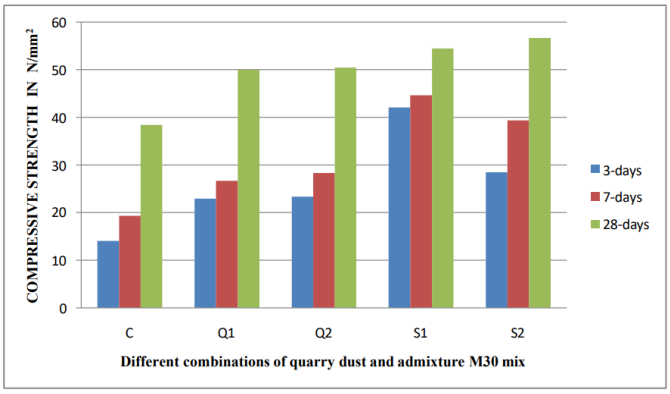


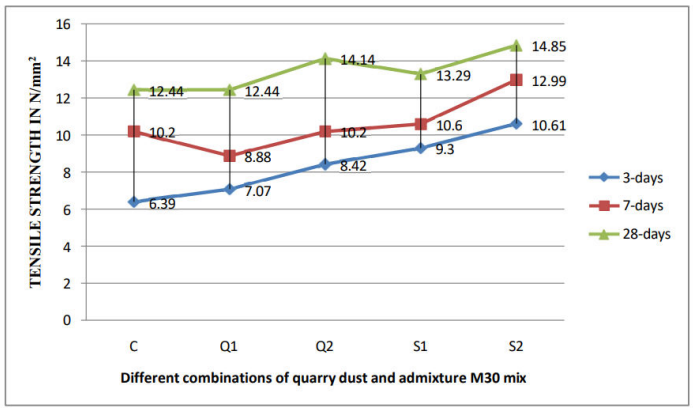
Fig no:16 Graph sheet showing different combinations of quarry dust and admixture M30 mix(compressive strength)



TENSILE STRENGTH TEST

codings	Tensile strength for 3 days(MPa)			Tensile strength for 7 days(MPa)			Tensile strength for 28 days(MPa)		
	Cylinder no			Cylinder no			Cylinder no		
	1	2	Avg	1	2	Avg	1	2	Avg
C	6.00	6.79	6.39	10.00	10.41	10.20	11.31	13.58	12.44
Q1	7.35	6.76	7.07	8.70	9.05	8.88	11.31	13.58	12.44
Q2	8.71	8.14	8.42	9.62	10.78	10.20	13.58	14.71	14.14
S1	8.49	10.18	9.30	10.46	10.75	10.60	13.01	13.58	13.29
S2	10.47	10.75	10.61	12.44	13.58	12.99	14.71	15.00	14.85

Table No.18 Test Results For M30 Grade Concrete



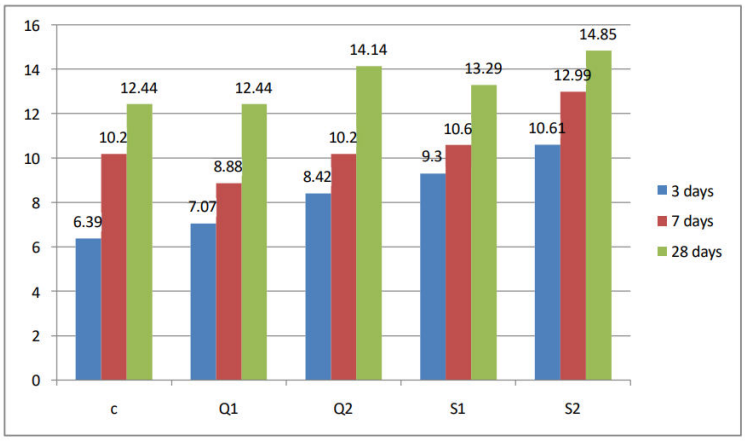


Fig no: 19 Bar chart showing different combinations of quarry dust and admixture M30

Codings	Compressive strength for 3 days(MPa)			Compressive strength for 7 days(MPa)			Compressive strength for 28 days(MPa)		
	Cube no			Cube no			Cube no		
	1	2	Avg	1	2	Avg	1	2	Avg
C	24.66	24.88	24.77	33.33	32.00	32.66	48.00	48.88	48.44
Q1	36.00	35.11	35.55	40.44	41.11	40.78	53.33	53.78	53.55
Q2	41.33	39.55	40.44	43.55	43.33	43.44	51.11	46.22	48.67
S1	46.88	43.55	45.21	47.33	50.44	48.90	57.77	60.00	58.90
S2	44.88	47.11	50.00	57.78	53.33	55.55	68.88	71.11	70.00

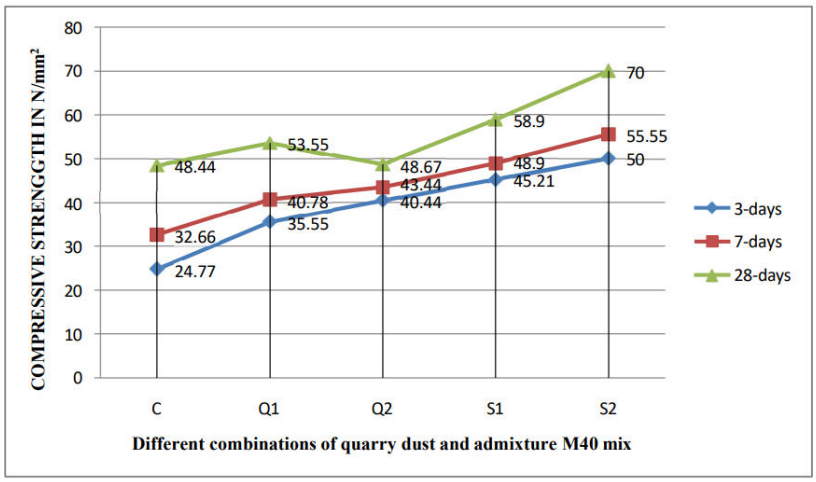


Fig no:20 Graph sheet showing different combinations of quarry dust and admixture M40

CONCLUSIONS

The following conclusions are arrived at based on the experiment investigation carried out in the study: Quarry dust obtained from various sources in and around Nellore and Prakasam Districts satisfies the requirement as specified in IS standards.

- The workability of the quarry dust concrete can be increased by adding super plasticiser.

- Quarry dust concrete has equal or slightly higher strength than reference concrete for all the two grades of concrete considered in this study (M30, M40). This shows that quarry dust concrete can be used with confidence as a building material.

- Concrete acquires maximum increase in compressive strength and tensile strength at 20% and 40% sand replacement. When compared with concrete with only river sand, the amount of increase in strength is M30 and for M40. 6.2 FOR COMPRESSIVE STRENGTH:

- When compared to conventional concrete 20% of the quarry dust is increased by 11.1% as per M30 grade concrete.

- When compared to conventional concrete 40% of the quarry dust is increased by 11.54 % as per M30 grade concrete.

- When compared to conventional concrete 20% of the quarry dust + 0.6 % super plasticizer is increased by 15.54 % as per M30 grade concrete.

- When compared to conventional concrete 40% of the quarry dust + 0.6 % super plasticizer is increased by 13.76 % as per M30 grade concrete.

- As compared to above conventional concrete the maximum value is 20% of the quarry dust + 0.6 % super plasticizer is 15.54 % as per M30 grade concrete of compressive strength.

• When compared to conventional concrete 20% of the quarry dust is increased by 5.11 % as per M40 grade concrete.

When compared to conventional concrete 40% of the quarry dust is increased by 0.23 % as per M40 grade concrete.

• When compared to conventional concrete 20% of the quarry dust + 0.8 % super plasticizer is increased by 10.46 % as per M40 grade concrete.

• When compared to conventional concrete 40% of the quarry dust + 0.8 % super plasticizer is increased by 21.56 % as per M40 grade concrete.

• As compared to above conventional concrete the maximum value is 20% of the quarry dust + 0.8 % super plasticizer is 21.56 % as per M40 grade concrete of compressive strength.

FOR TENSILE STRENTH

• When compared to conventional concrete 20% of the quarry dust is increased by 0% as per M30 grade concrete

• When compared to conventional concrete 40% of the quarry dust is increased by 1.7 % as per M30 grade concrete.

• When compared to conventional concrete 20% of the quarry dust + 0.6 % super plasticizer is increased by 0.85 % as per M30 grade concrete.

• When compared to conventional concrete 40% of the quarry dust + 0.6 % super plasticizer is increased 2.41 % as per M30 grade concrete.

• As compared to above conventional concrete the maximum value is 40% of the quarry dust + 0.6 % super plasticizer is 2.41 % as per M30 grade concrete of Tensile strength.

• When compared to conventional concrete 20% of the quarry dust is increased by 1.3% as per M40 grade concrete.

• When compared to conventional concrete 40% of the quarry dust is increased by 0.51 % as per M40 grade concrete.

• When compared to conventional concrete 20% of the quarry dust + 0.8 % super plasticizer is increased by 3.86% as per M40 grade concrete.

When compared to conventional concrete 40% of the quarry dust + 0.8 % super plasticizer is increased by 3.99 % as per M40 grade concrete.

• As compared to above conventional concrete the maximum value is 40% of the quarry dust + 0.8 % super plasticizer is3.99 % as per M40 grade concrete of Tensile strength.

6.4 SUGGESTIONS FOR THE FUTURE WORK

1. It is suggest that the study of concrete for the estimation of concrete durability may be extended.

2. The scope of using concrete in our constructional activities lies large, VIZ., precast, pre stressed bridges, and multi storied buildings, bridges and structures on coastal areas and like. To affect this change we will have to revive the designing to structures by encouraging use of workability of concrete.

3. As soon as micro crack appears, sudden failure is observed in the concrete cubes.

4. The same investigation can be carried out for different water cement ratios for mineral Admixture for M30 and M40 grade of concrete.

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