International Journal for Modern Trends in Science and Technology
Volume: 03, Issue No: 07, July 2017
ISSN: 2455-3778
http://www.ijmtst.com

Behavior of Concrete with Quarry Dust as Partial Replacement of Fine Aggregate

Shaik Fayaz[1] | Shaik Rashid[2] | K.Yugandhara Reddy[3]

[1,2] Assistant Professor, Department of Civil Engineering, Narayana Engineering College, Nellore, AP, India.
[3]Professor, Department of Civil Engineering, Narayana Engineering College, Nellore, AP, India.

To Cite this Article
Shaik Fayaz, Shaik Rashid and K.Yugandhara Reddy, "Behavior of Concrete with Quarry Dust as Partial Replacement of Fine Aggregate", *International Journal for Modern Trends in Science and Technology*, Vol. 03, Issue 07, July2017, pp.105-112.

ABSTRACT

The intention for taking up this research due to the fact that now a day's natural sand confirming to Indian Standards is becoming scarcer and costlier due to its non availability in time for the reason that of Law of Land, illegal dredging by sand mafia, ease of access to the river source during rainy season, non confirming with IS 383-1970. Therefore the present research was taken up with a view to authenticate the suitability, feasibility and prospective use of quarry dust, a waste produce from aggregate quarry plant in concrete mixes, in context of its compressive strength and workability and in terms of slump, compacting factor, flow table and modified flow correspondingly.

Within view of above conversation, an attempt is made to substitute the natural sand in concrete control mixes of M20 and M30 grades designed for 25-50mm slump at replacement levels of 20%, 40%, 60% ,80% and 100% using normal portland zuari Cement. There were in all mixes in each grade of concrete together with control mix and five mixes with quarry dust as a partial replacement of natural sand.

It was experimental that with use of quarry dust at all replacement levels, the workability of concrete was abridged from 1-6%. As of the test results, it was practical that the replacement of natural sand by quarry dust increased the compressive strength of concrete by 5-22%. It was also bring into being that in the middle of all the mixes, the uppermost compressive strength was obtained for 40% replacement of sand by quarry dust. Consequently it could be concluded and recommended that quarry dust could be successfully used in concrete of above grades for replacement levels of sand by 40-60% cost-effectively leading to sustainable development and improvement.

KEYWORDS: *Compressive Strength , Durability, Quarry Dust, Split tensile strength, Flexural strength*

I. INTRODUCTION

Compressive strength of concrete is essential for the reason that the main properties of concrete, such as elastic modulus and tensile strength, are qualitatively and quantitatively associated to this property. It is also significant because in structural design, load-bearing capacity of structures is linked to the concrete compressive strength. At the same time it is well known, there are two types of standard test specimens used for the purpose of compressive strength: cubes and cylinders. Cubes are commonly used in Great Britain, Germany and Singapore, while the standard specimens in the United States, Australia, France and Canada are cylinders. In Scandinavia, tests are prepared on both cubes and cylinders. Cubes are whichever 100 or 150mm in size with aspect ratio of 1. Cylinders have characteristic ratio of 2 and are either 100mmφ×200mm high or 150mmφ×300mm high.

Concrete is an assemblage of cement, aggregate and water. The most frequently used fine aggregate is sand derived from river banks. The worldwide utilization of natural sand is too high due to its widespread use in concrete. The insist for natural sand is quite high in developing countries due to rapid infrastructural growth which results make available scarcity. consequently, construction industries of developing countries are in stress to recognize substitute materials to replace the demand for natural sand. In contrast, the advantages of utilization of byproducts or aggregates obtained as waste materials are distinct in the aspects of lessening in environmental load & waste management cost reduction of production cost as well as augment the superiority of concrete. In this framework, fine aggregate has been replaced by quarry dust a byproduct of stone crushing unit and few admixtures to find a proportional analysis for different parameters which are tested in the laboratories to find the appropriateness of the replacement adhere to the Indian Standard specifications for its strength. Quarry dust has been used for diverse activities in the construction industry such as road construction and fabricate of building materials such as light weight aggregates, bricks, and tiles. Crushed rock aggregates are more appropriate for production of high strength concrete compared to natural gravel and sand.

The key purpose is to make available more information about the sound effects of various proportion of dust content as partial replacement of crushed stone fine aggregate on workability, air content, compressive strength, tensile strength, absorption percentage of concrete. challenge have been made to investigate some property of quarry dust and the suitability of those properties to enable quarry dust to be used as partial replacement material for sand in concrete. The use of quarry dust in concrete is advantageous because of its benefits such as useful clearance of by products, reduction of river sand consumption as well as growing the strength parameters and increasing the workability of concrete. It is used for special activities in the construction industries such as road construction, manufacture of building materials, bricks, tiles and autoclave blocks.

II. Materials

A. Cement

Cement is a binder, a matter that sets and hardens and can bind other resources together. The declaration "cement" traces to the Romans, who used the term opus caementicium to explain masonry resembling modern concrete that was made from crushed rock with burnt lime as binder. Cements used in construction can be characterized as being whichever hydraulic or non-hydraulic, depending up on the capability of the cement to be used in the company of water.

B. Fine Aggregates

Sand is a naturally and obviously occurring granular material collected of finely divided rock and mineral particles. The composition of sand is extremely variable, depending on the local rock sources and conditions, but the for the most part frequent constituent of sand in inland continental settings and non-tropical coastal settings is silica (silicon dioxide, or SiO_2), usually in the form of quartz.

C. Coarse Aggregates

Construction aggregate, or simply "aggregate", is a wide group of coarse particulate material used in construction, as well as sand, gravel, crushed stone, slag, recycled concrete and geo synthetic aggregates. Aggregates are the majority mined materials in the world. Aggregates are a constituent of composite materials such as concrete and asphalt concrete; the aggregate serve as reinforcement to insert strength to the overall composite material.

D. Quarry Dust

The quarry dust is been procure from quarry plant in badvel, kadapa dist, Andra pradesh. The cement used was 43 grades normal Portland cement (OPC). Water used was plain tap water and the calculations of the mix design was as per IS 10262-2009.The quarry dust is the by-produce which is produced in the processing of the granite stones which broken down into the coarse aggregates of dissimilar sizes.

III. Experimental Program

During this experimental program, the principal stage includes the groundwork re-search on selecting the raw materials. Number of conservative trails is prepared and the mix proportions for both M20 and M30 grades are chosen by altering different water cement ratios. The chief experimental works involve the replacement of Quarry dust in 20%, 40%, 60%, 80% and 100% for M20 and M30 grades. The strength and durability properties are premeditated in this work by comparing both grades.

Concrete is a masterpiece composition of three raw materials. They can be stated as Cement, Fine aggregate and Coarse aggregate. These three raw materials play an imperative role in manufacturing of concrete. By changeable of the properties and amount of these materials, the properties of concrete will change. The major raw materials used in this experimental work are cement, fine aggregate, coarse aggregate and quarry dust.

IV. Testing method

A. Tests on cement:

- Specific Gravity of Cement
- Normal Consistency of Cement
- Fitness of Cement
- Initial and final setting time

B. Tests on Fine Aggregate:

- Sieve Analysis of Fine Aggregate
- Specific Gravity of Fine Aggregate
- Bulk Density of Fine Aggregate
- Water Absorption of Fine Aggregate

C. Tests on quarry Dust:

- Particle size Distribution of Quarry Dust
- Specific Gravity of Quarry Dust
- Bulk Density of Quarry Dust
- Water Absorption of Quarry Dust

D. Tests on Coarse Aggregate:

- Sieve Analysis of Coarse Aggregate(IS 2386 part-1)
- Specific Gravity of Coarse Aggregate(IS 2386 part-3)
- Bulk Density of Coarse Aggregate(IS 2386 part-3)
- Water Absorption of Coarse Aggregate(IS 2386 part-3)

E. Testing of Specimens

Computation of Fresh and Hardened properties is the most important era in concrete testing. The fine cured specimens in curing tank are tested for compressive strength, split tensile strength and modulus of rupture. With taking out the specimens from the curing tank, the specimens were out in the open to sun light for surface drying. Following the drying process, the specimens are process for testing. The specimens are tested for both 7 days and 28 days strengths.

F. Workability of Concrete

The workability of concrete is practical by the Slump Cone technique. The assortment of slump was selected from IS Mix design methods. The slump choice was 25-50mm.

Table -1 Slump obtained for M20 and M30 grades

Mix	Slump (mm)	
	M20	M30
control	48	46
Trail 1	45	44
Trail 2	41	40
Trail 3	40	36
Trail 4	36	34
Trail 5	32	33

G. Split Tensile Strength (IS 516-1959)

Elsewhere of all the properties of concrete, tensile strength is extremely important one. The tensile strength is designed by testing cylindrical specimens of size 300mm height and 150mm diameter. Here each one set of specimens are tested for 7 days and 28 days of curing. The particulars of test results are summarize below

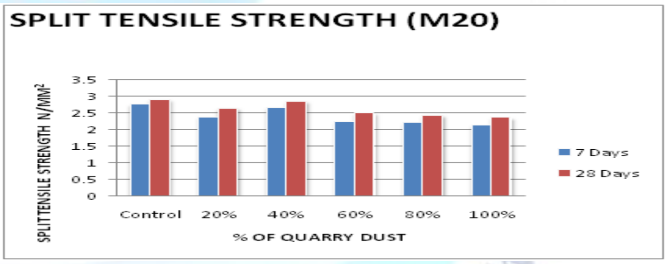


Fig-1 Split tensile strength variation for M20 grade at 7 & 28days

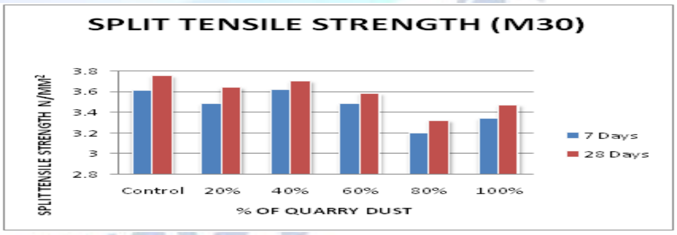


Fig-2 Split tensile strength variation for M30 grade at 7 & 28days

H. Flexural Strength: (IS 516-1959)

The modulus of rupture is the most important property for the flexural members. To get better the flexural strength of concrete is one main task in present construction activities. Flexural strength for concrete is resolute by casting beam specimens. The beam proportions are of 500mm x 100mm x

100mm. The modulus of rupture values for both grades are illustrate as follows

Table-2 Flexural strengths for M20 and M30grades

Mix	Flexural strength M20 (N/mm²)		Flexural strength M30 (N/mm²)	
	7 days	28 days	7days	28 days
Control	3.05	3.21	3.46	3.65
Trail 1	3.09	3.25	3.54	3.75
Trail 2	3.14	3.32	3.68	3.90
Trail 3	3.15	3.28	3.60	3.81
Trail 4	3.04	3.20	3.51	3.73
Trail 5	2.92	3.10	3.23	3.58

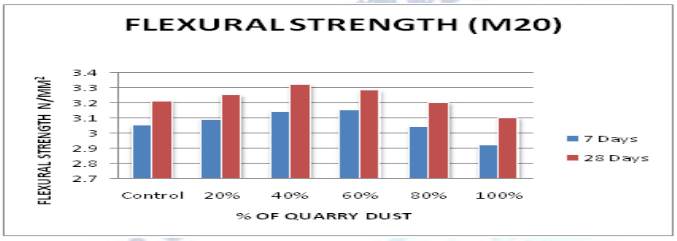


Fig-3 Flexural strength variation for M20 grade at 7 & 28days

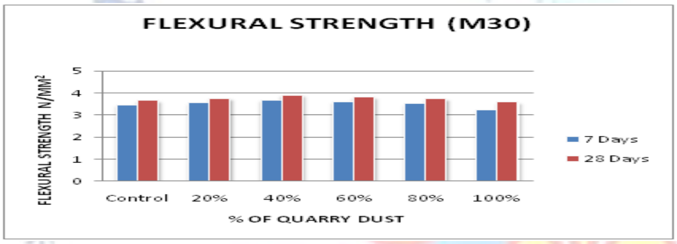


Fig-4 Flexural strength variation for M30 grade at 7 & 28days

Fig-5 Beams after Flexural strength test

Mix	M20 GRADE (N/mm²)						M30 GRADE (N/mm²)					
	Compressive (Mpa)		Split tensile (Mpa)		Flexural (Mpa)		Compressive (Mpa)		Split tensile (Mpa)		Flexural (Mpa)	
	7days	28days	7days	28days	7days	28days	7days	28days	7days	28days	7days	28days
Control	24.44	29.11	1.97	2.89	2.85	3.21	30.22	38.89	2.95	3.75	2.98	3.65
Trail 1	20.44	26.44	1.85	2.63	2.98	3.25	28.44	37.11	2.80	3.64	3.24	3.75
Trail 2	2 2	28.44	1.92	2.84	3.14	3.32	29.11	37.78	2.85	3.70	3.47	3.90
Trail 3	21.33	25.33	1.80	2.48	2.90	3.28	27.55	36.44	2.73	3.58	3.31	3.81
Trail 4	20.22	25.78	1.81	2.42	2.76	3.20	26.89	34.00	2 . 6	3.32	3.27	3.73
Trail 5	19.33	24.89	1.72	2.35	2.63	3.10	25.33	35.78	2.68	3.47	3.11	3.58

Table-3 Summary of strength properties of M20 and M30 Grades

V. Mix Design and composition of trail mix

A. *Mix Design Proportion of M20 grade of concrete*

Design Stipulations for M20

1. uniqueness strength of concrete specified : 20 N/mm²
2. Maximum size of aggregate to be used: 20 mm
3. Preferred workability of concrete: 25- 50mm slump (0.88 - 0.92 C F).
4. Exposure condition specified : Mild
5. Degree of quality control predictable to be exercised at site: Good

B. *Mix Design Proportion of M30 grade of concrete*

Design Stipulations for M30

1. uniqueness strength of concrete specified : 30 N/mm²
2. Maximum size of aggregate to be used: 20 mm
3. Preferred workability of concrete: 25- 50mm slump (0.88 - 0.92 C F).
4. Exposure condition specified : Severe
5. Degree of quality control predictable to be exercised at site: Good

C. *Composition of Trail Mixes*

The trail mixes were geared up according to the get hold of mix proportions for M20 and M30 grades. The procedure of feature includes the replacement of Natural sand with Quarry dust. To begin with Control mix was selected with 100% Natural sand without adding up any admixtures. From at this juncture onwards the manufactured sand takes part in action and the mixes are collected. Now from Trail 1 to Trail 5 are consecutively indicates the replacement of 20% Quarry dust, 40%Quarry dust, 60%Quarry dust,80% Quarry dust and 100% Quarry dust .

Material replacing	Percentage of replacement
River sand with Quarry dust	20%, 40%, 60%, 80%,100%

Table-4 Percentages of Material replacements

Mix	Fine aggregate (%)		Cementitious material (%)
	Natural sand	Quarry dust	Cement
Control	100%	0 %	100%
Trail 1	80%	20%	100%
Trail 2	60%	40%	100%
Trail 3	40%	60%	100%

Trail 4	20%	80 %	100 %
Trail 5	0 %	100%	100 %

Table-6 Trail mix details for M20 and M30 grades

Mix	Cementitious materials (Kg/m³)	Fine aggregate (Kg/m³)		Coarse aggregate (Kg/m³	Water (Lit
	Cement	Natural sand	Quarry dust		
Control	3 6 8	578	0	1 215	191.6
Trail 1	3 6 8	463	115	1 215	191.6
Trail 2	3 6 8	348	230	1 215	191.6
Trail 3	3 6 8	233	345	1 215	191.6
Trail 4	3 6 8	118	460	1 215	191.6
Trail 5	3 6 8	0	578	1 215	191.6

Table -7 Mix proportion quantities of M20 grade W/C Ratio=0.52

Mix	Cementitious materials (Kg/	Fine aggregate (Kg/m³)		Coarse aggregate (Kg/n	Water (Lit
	Cement	Natural sand	Quarry dust		
Control	426	551	0	1181	191.6
Trail 1	426	441	110	1181	191.6
Trail 2	426	331	220	1181	191.6
Trail 3	426	221	330	1181	191.6
Trail 4	426	111	440	1181	191.6
Trail 5	426	0	551	1181	191.6

Table -8 Mix proportion quantities of M30 gradeW/C Ratio=0.45

VI. Durability Studies and observation

Concrete with normal Portland cement is the chief composition in current constructional activities. A concrete structure was excellent in strength can also be superior in providing service life. Durability is of concrete structure is defensible only when it shows consistency in its life time. Extra durability means extra service life of structure. The concrete under marine environment and exposed to aggressive chemical attack through water are the most important problems in dropping the life time of structure. To conquer this problem, proper durability studies are desirable for concrete previous to concreting a structure.

To check the Acid resistances of concrete Hydro Chloric acid (HCL), Shulphuric Acid (H2SO4) are preferred. The concentration of acids in water is taken as 5%. The regular specifications for this study are IS 516-1959 and ASTM C666-1997.

Fig -6 cubes in acid curing

1. Tests on Durability

- Acid Attack Factor
- Acid Durability Factor

Table - 9 Summary of brief details for durability study

Acids used	HCL, H_2SO_4
Concentrations for trails	5% in water
Number of days of testing	7 days and 28 days
Termination period	28 days
Properties comparing	Acid Attack Factor Acid Durability Fact % of weight loss

Table -10 specifications of Trail mixes for durability

Mix	Quarry Dust (%)	Naturalsand (%)	Cement (%)
Control	0	100	100
Trail 1	20	80	100
Trail 2	40	60	100
Trail 3	60	40	100
Trail 4	80	20	100
Trail 5	100	0	100

2. Observation on Durability

During this investigational work, the properties of acid durability studies such as Acid Attack factor, Acid durability factor and % weight loss are cautiously observed and theresults are put into a table as tag along.

Table -11 Weight loss % for M_{20} Grade

Mix	Curing under 5% HCL		Curing under 5% H_2SO_4	
	After 7days	After 28days	After 7days	After 28days
Control	1.10	2.21	2.88	9.45
Trail 1	1.30	2.42	3.10	9.72
Trail 2	1.20	2.34	2.95	9.60
Trail 3	1.32	2.62	3.56	9.80
Trail 4	1.45	2.84	3.42	10.4
Trail 5	1.56	2.75	3.76	10.80

Table -12 Weight loss % for M_{30} Grade

Mix	Curing under 5% HCL		Curing under 5% H_2SO_4	
	After 7days	After 28days	After 7days	After 28days
Control	1.50	2.20	3.90	11.62
Trail 1	1.75	1.90	3.60	11.31
Trail 2	1.43	1.60	2.20	8.9
Trail 3	1.60	1.85	2.70	11.2
Trail 4	1.82	2.10	3.07	9.84
Trail 5	1.94	2.20	3.22	10.20

VII. Analysis of Results

Fig-7 GRAPH ON SIEVE ANALYSIS FOR SAND

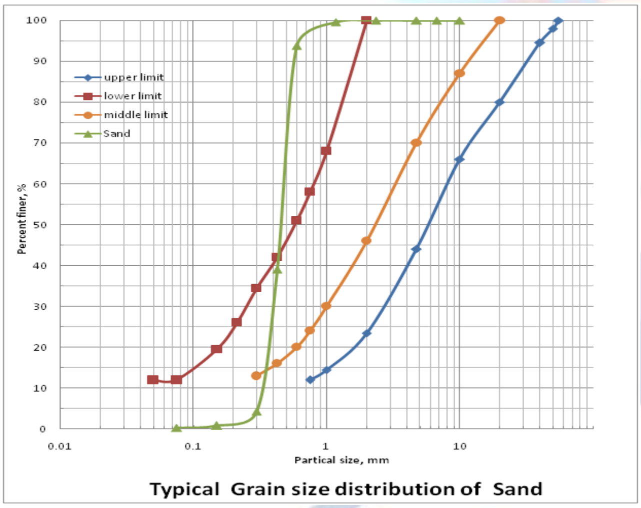


Fig -8 GRAPH ON SIEVE ANALYSISFOR QUARRY DUST

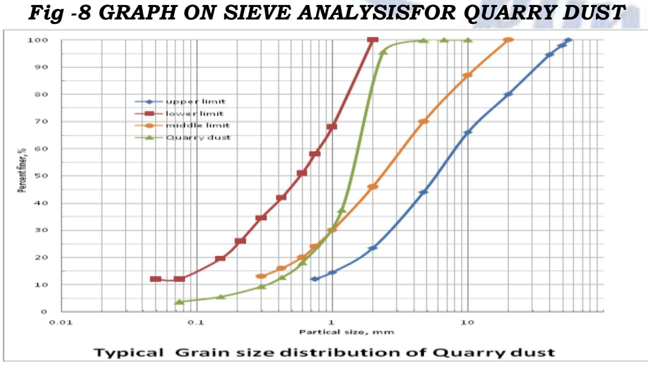
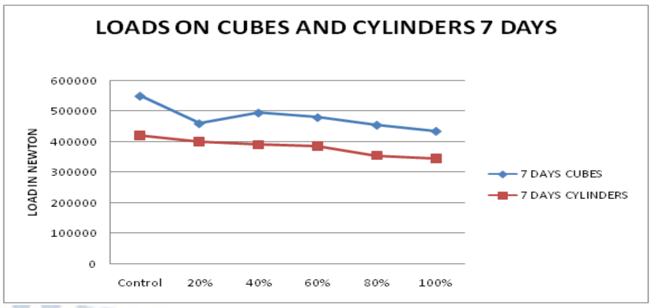


Fig-9& 10 LOADS OF CUBES &CYLINDERS FOR M_{20} GRADE CONCRETE



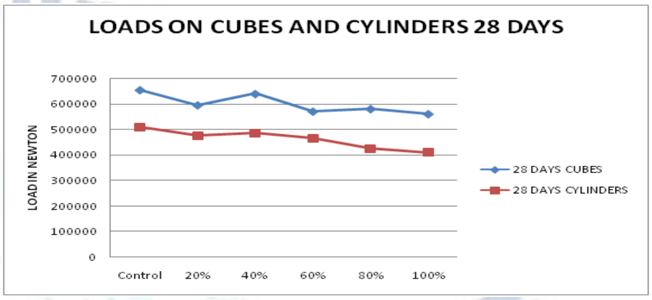


Fig-11 COMPRESSIVE STRENGTH OF CUBES &CYLINDERS (7-DAYS)

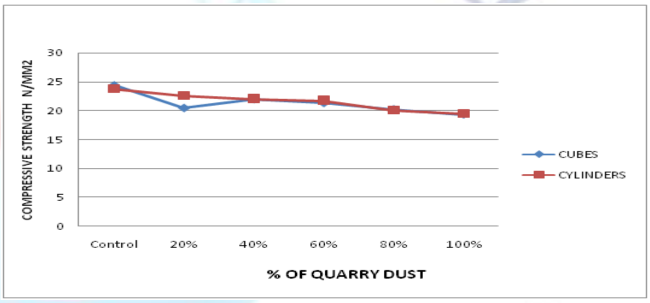


Fig-12 COMPRESSIVE STRENGTH OF CUBES &CYLINDERS (28-DAYS)

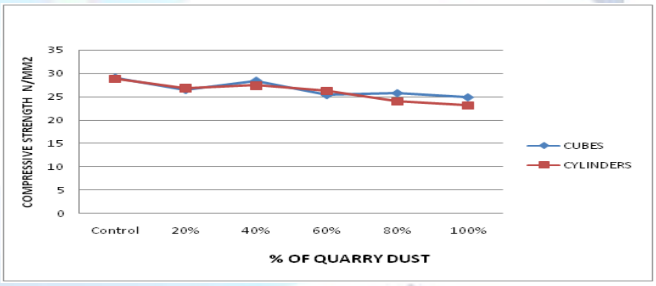


Fig-13 LOADS OF CUBES &CYLINDERS FOR M_{30} GRADE 7 DAYS

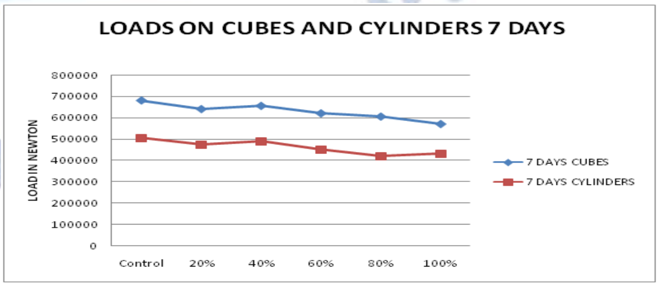


Fig-14 LOADS OF CUBES &CYLINDERS FOR M_{30} GRADE 28 DAYS

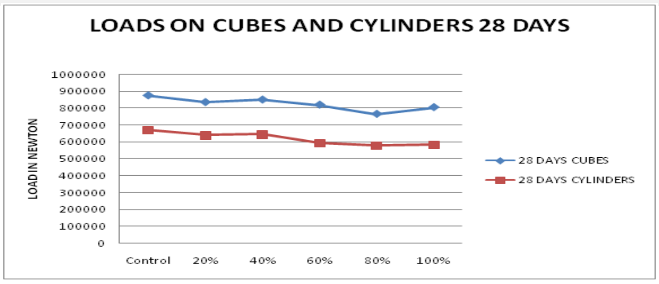


Fig-15 COMPRESSIVE STRENGTH OF CUBES &CYLINDERS(7-DAYS)

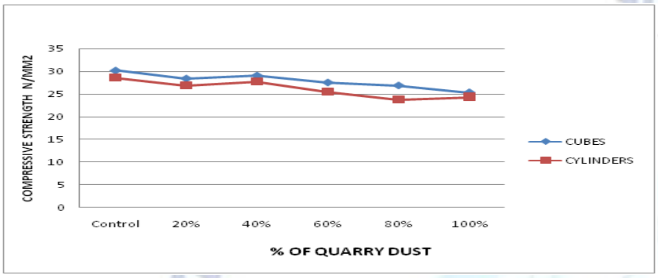
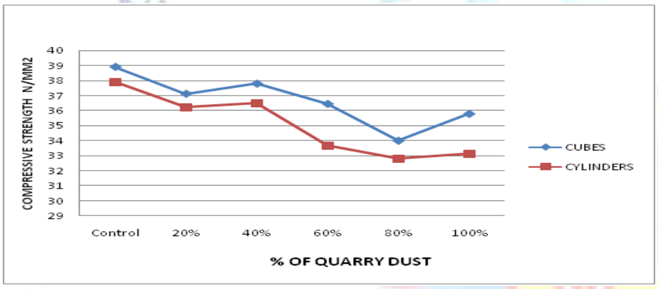


Fig-16 COMPRESSIVE STRENGTH OF CUBES &CYLINDERS (28-DAYS)



VIII. Conclusion

These subsequent conclusions are given based on the above investigational and experimental results

a) In the current investigation objective mean strength of concrete for M20 and M30 grades that are productively achieved.

b) The material Quarry dust is a good substitute to replace River sand that it satisfied all the necessities as well as natural sand and it can be used for all constructional purposes in place of natural sand for sustainable constructions.

c) For M20 grade, utmost compressive strength of 28.44Mpa, Split tensile strength of 2.84Mpa and Flexural strength of 3.32Mpa has take place for Trail 2 i.e., 40% Quarry dust.

d) For M30 grade, utmost compressive strength of 37.78Mpa, Split tensile strength of 3.70Mpa, flexural strength of 3.90Mpa has occurred for Trail 2.

e) By the replacement of 40% Quarry dust in Trail 2 for M20grade, from 7days to 28days the rate of boost in compressive strength is of 22.64% and flexural strength is of 5.42% and split tensile strength is of 6.69%. For M30 grade, the rate of augment in compressive strength is of 22.94% and flexural and split tensile strengths are of 5.64% and 2.16%.

f) In case of durability the Trail mix 2 i.e., 40% Quarry dust as given away superior results in attaining resistance when compared with other Trail mixes.

g) Acid attack factor for both M20 and M30 grades is extra for cubes immersed in H_2SO_4 when compared with HCL.

h)For Acid durability factor, concrete with 40% Quarry dust has made known some enhanced durability properties.

i) For 5% HCL, the bare minimum percentage loss of weight occurred for M20 grade is 2.34% and M30 grade is 1.60% attain in Trail mix 2 and for 5% H_2SO_4 the minimum percentage loss of weight occurred for M20 grade is 9.60% and M30 grade is 8.90%.

j) In 5% HCL, the lowest amount Acid attack Factor is obtained at Trail 2 for M20 is 1.15 and for M30 is 2.10 and for 5% H_2SO_4 the bare minimum Acid attack Factor is obtained at Trail 2 for M20 is 2.45 and for M30 is 2.85.

k)In 5% HCL, the greatest durability factor attained for M20 grade is 83.69 and for M30 grade is 79.28 and in 5% H_2SO_4, the utmost Acid durability factor attained at for M20 grade is 80.70 and for M30 grade is 77.08.

l) As a result of comparing together M20and M30 grades, it is concluded that Quarry dust can be useful to make target mean strengths and the most favorable percentage is obtained at Trail 2 i.e., 40% Quarry dust.

References

[1] Urquhart, Leonard Church, "Civil Engineering Handbook" McGraw-Hill Book Company (1959) p.8-

[2] "Natural Cement Comes Back", October 1941, Popular Science

[3] Kosmatka, S.H.; Panarese, W.C. (1988). Design and Control of Concrete Mixtures. Skokie, IL, USA: Portland Cement Association. pp. 17, 42, 70, 184. ISBN 0-89312-087-1.

[4] Raman, Md. SafiuddinandZain "Non destructive evaluation of flowing concretes incorporating quarry waste". Asian Journal of Civil Engineering (Building and Housing). Vol 8 No 6 2007.

[5] Malathy and Shanmugavadivu "Effect of Fineness Modulus and Specific Gravity of Manufactured Sand as Fine Aggregate in Mix Proportioning of Concrete". International Journal of Earth Sciences and Engineering. Vol 3 No 5 October 2010

[6] Nagabhushana and Sharadabai "Use of crushed rock powder as replacement of fine aggregate in

mortar and concrete". Indian Journal of Science and Technology. Vol 4 No 8

[7] Devi, Rajkumar, and Kannan" Quarry dust as fine aggregate". International Journal of Advances in Engineering Sciences Vol 2.

[8] Indian standard recommended method of concrete mix design(IS 10262 - 2009).

[9] Department of the environmental, design of normal concrete mixes (BUILDING RESEARCH ESTABLISHMENT),Walord , UK.,1988.

[10] Nasser K W ,new and sample tester for concrete ACI journal ,October 1976.

[11] SINTEF Civil and Environmental Engineering, Cement and Concrete, N-7465 Trondheim, Norway. %7C Cement and Concrete Research 35 (2005) 315–323. "Mechanism for performance of energetically modified cement EMC".

[12] Bye G.C. (1999), Portland Cement 2nd Ed., Thomas Telford, 1999, ISBN 0-7277-2766-4, pp. 206–208

[13] United States Geological Survey. "USGS Mineral Program Cement Report. (Jan 2011)".