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RESEARCH ARTICLE

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STUDY ON MECHANICAL AND DURBILITY CHARECTRISTICS OF CONCRETE ON PARTIAL REPLACEMENT OF CEMENT WITH METAKAOLIN AND FINE AGGREGATE WITH QUARRY DUST

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ABSTRACT

The present study is to understand the behaviour and performance of the concrete when partial replacement of Metakaolin and waste Quarry dust is used as the cement and fine aggregate. In these study two Mix's was carried out where Mix-1 was partial replacement of fine aggregate by Quarry dust as 10%, 15% and 20%. And Mix-2 was said to be the combined partial replacement of Quarry dust (Q.D) as fine aggregate and Metakaolin as the partial replacement of cement by 5%, 10%, 15%, 20% and 25% and fine aggregate will be considered which optimum at Mix-1 is. For analyzing the suitability of these wastes Quarry dust powder and Metakaolin in concrete of M30 mix. The compressive strength test, split tensile strength test, and flexural strength tests for 7 and 28 days has conducted for all mixes. And a Durability test has conducted for 28 days for the optimum mix in Mix-2

In this research, the effect of combined replacement of Metakaolin and Quarry dust on concrete which has boosted the Compressive, Flexural and Split tensile strength of concrete. Based on the laboratory experiment cube, beam and cylindrical specimens have been designed. The optimum percentage of cement replacing with Metakaolin and fine aggregate with Quarry dust was determined to be 20% and 15% for compressive strength, tensile and flexural strength

Key Words: Metakaolin, Quarry dust, Compressive Strength, Split Tensile Strength, Flexural Strength, Durability.

I. INTRODUCTION

Cement both in mortar and concrete, is the most important element of the infrastructure and can be a durable construction material. Generally in design of concrete mix, cement , fine aggregates and coarse aggregates are using from long back, which plays a crucial role in designing of a particular grade of concrete. But now a days there is a scarcity in aggregates. So, some new materials which are locally available for low cost have to introduced for replacing the fine aggregates, coarse aggregates and as well as cement to get the same strength.

In present world, huge amount of solid wastes are obtaining from manufacturing units and demolitions of construction from human daily habitats. Some researchers are working on solid waste as partial replacing substances based on the locally available industrial wastes such as Fly ash, Sugarcane bagasse ash, Blast furnace slag, Rice husk ash, Palm oil fuel ash, Wheat straw ash, Silica fumes, Metakaolin, Quarry dust material, glass powder, over burnt bricks, coconut shells, etc are being used as supplementary cement and fine aggregate additive and replacement materials.

A. Metakaolin

Metakaolin is one of recently developed mineral admixture used to replace a part of cement in the manufacture of cement of HPC. Metakaolin is a manufactured by pozzolanic material. The production of Portland cement is not only costly and energy intensive, but it also produces large amount of carbon emission.

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The production of one to of Portland cement produces approximately one ton of CO2 in the atmosphere. Limestone is a raw material available in nature; it is primary need for production of cement material. Earlier it was used directly to form silica flume mortar as a binding material in construction. Supplementary cementitious materials are often used to reduce cement contents and improve the workability of fresh concrete, increase strength and enhance durability of hardened concrete.

SCMs used in the manufactured concrete products industry as well as a review of blended cements. There are various types of supplementary cementitious material as fly ash, silica fume, slag cement, Metakaolin, rice husk ash, coconut shell etc. Out of above Supplementary Cementitious Materials (SCMs) we use Metakaolin as partial replacement of cement and experimental investigation is carried out.

Metakaolin is a mineral admixture which confirms class-N pozzolanic specifications. By heating purified kaolin clay within specified temperature range 650-900^{o}c.The water processed, refined and dried kaolin is thermally activated to make highly reactive Metakaolin. Alkali-silica reaction is a reaction between calcium hydroxide (the alkali) and glass (the silica) which can cause decorative glass embedments in concrete to pop out. Because Metakaolin consumes calcium hydroxide, it takes away the alkali and the reaction does not occur.

B. Quarry Dust Material

The Quarry dust is one of the mineral admixtures used as a partial replacement of cement and aggregates. It is available in different sizes and shapes. The Quarry dust is durable, hard and highly resistant to biological, chemical and physical degradation forces. Due to the pozzolanic property of Quarry dust the durability is increased.

Indian Quarry dust production is more than 100 Million ton per year. In the Quarry industry, about 15%- 30% waste material generated from the total production. This waste is not recycled in any form at present. However, the Quarry dust is durable, hard and highly resistant to biological, chemical, and physical degradation forces.

The Quarry industries are dumping the powder in any nearby pit or vacant spaces, near their unit although notified areas have been marked for dumping. This leads to serious environmental and dust pollution and occupation of a vast area of land, especially after the powder dries up so it is necessary to dispose the Quarry dust quickly and use in the construction industry.

As the Quarry dust is piling up every day, there is a pressure on Quarry industries to find a solution for its disposal. The advancement of concrete technology can reduce the consumption of natural resources. They have forced to focus on recovery, reuse of natural resources and find other alternatives.

The use of the replacement materials offer cost reduction, energy savings, arguably superior products, and fewer hazards in the environment.

II. Objectives of the work

The following objectives have to identify:

A. To identify the compressive strength, split tensile strength and flexural strength of M30 for 7 and 28 days with waste Quarry dust material replacement in fine aggregate by 10%, 15% and 20% say as Mix-1.

B. To identify the compressive strength, split tensile strength, flexural strength and Durability characteristic of M30 grade for 7 and 28 days with combination of waste Quarry dust material partially replaced in fine aggregate where maximum strength obtained by above mix and Metakaolin in cement by 10%, 15%, 20%, and 25% respectively say as Mix-2.

III. Scope of the work

The scope of this dissertation was carried out to study the parameters which influence the compressive strength, split tensile strength and flexural strength of the concrete mix M30 by replacing fine aggregate with waste Quarry dust material and combination by replacing fine aggregate with Metakaolin as the mixes designated in introduction M1, M2, M3, M4, M5, M6, M7, M8 These concrete mixes were produced, tested and compared with the conventional concrete which is designated as M0 and from M0-M3 was said to be MIX-1 and M4- M8 was said to be MIX-2.

Scope of our present work is cost reduction and at the same time reduction of waste disposal of Quarry

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dusts. By using Metakaolin the compressive strength also increases when compared with conventional mix. It also reduces pollution which is caused due to cement production.

IV. Literature review

Beulah M. Asst Professor, Prahallada M. C. Professor (2012) [3]: The study of "Effect of Replacement of Cement by Metakalion on the Properties of High Performance Concrete Subjected To Hydrochloric Acid Attack" It has been concluded that the compressive strengths of High performance concrete mixes decreases with increasing water binder ratio. Compressive strength after 30, 60 and 90 days of acid immersion decreases with increasing water binder ratio.

.V.S.Sai.Kumar1, Krishna Rao B2 (2014) [2]: The study of "A Study on Strength of Concrete with Partial Replacement of Cement with Quarry Dust and Metakaolin" .It was observed that the compressive strength at the age of 28 days reached its target mean strength. The degree of workability was found to be almost same.

Aiswarya S, Prince Arulraj G, Dilip C (2013) [1]: The study of "A Review on use of Metakaolin in concrete". It was found that cement can be replaced effectively with Supplementary Cementations Materials (SCM's) like Metakaolin. In the case of strength and durability, the SCM's shows better results than normal mixes.

SatyendraDubey, Rajiv Chandak , R.K. Yadav (2015) [5]: The study of "Experimental Study of Concrete with Metakolin in as Partial Replacement of OPC". The addition of Metakaolin in the concrete as partial replacement of OPC increases the 28 days compressive strength significantly.

Nikhil Kishor Kulkarni,Ajay A. Hamane (2015) [16]: The study of "Evaluation of Strength of Plain Cement Concrete with Partial Replacement of Cement by Meta Kaolin & Fly Ash" It reveals that with 10%Meta kaolin and Fly ash each partial replacement of cement were found to be most favorable combinations for casting of concrete flexural members. Using the optimum mix proportion giving the best results in compressive strength of cube testing.

VenkataSai Ram Kumar N. (2014) [6]: The study of "A Review on Use of Metakaolin in Cement Mortar and Concrete". It was treated as economical and also due to its pozzolanic action increases strength and durability properties of concrete. In view a review was done in utilization of Metakaolin in concrete as a partial replacement material to cement which has given excellent results.

P. Dinakar , Pradosh K., G. Sriram (2013) [4]: The study of "Effect of Metakaolin Content on the Properties of High Strength Concrete" was observed That 10 % replacement level was the optimum level in terms of compressive strength. Beyond 10 % replacement levels, the strength was decreased but remained higher than the control mixture.

Sabir.B.B et al (2001) [18]: carried out a study on the utilization of Metakaolin as pozzolanic material for mortar and concrete and mentioned about the wide range application of Metakaolin in construction industry . They mentioned that Metakaolin alters the pore structure in cement paste mortar and concrete and greatly improves its resistance to transportation of water and diffusion of harmful ions which lead to the degradation of the matrix.

Jian-Tong Ding et al (2002) [19]: experimentally found out the effects of Metakaolin and Silica Fume on the properties of Concrete. Experimental investigation with seven concrete mixtures of 0, 5, 10, and 15% by mass replacement of cement with high-reactivity Metakaolin or Silica fume, at a water cement ratio of 0.35 and a sand-to-aggregate ratio of 40% was carried out.

Chaturanga et al., [17]: is desirable because of the benefits such as useful disposal of a by-product, reduction of river sand consumption and increase in strength. Quarry dust has rough, sharp and angular particles, and as such causes a gain in strength due to better interlocking.

Shahul et al., [14]: observed that natural sand is usually not graded properly and has excessive silt, while quarry rock dust does not contain silt or organic impurities and can be produced to meet desired gradation and fineness as per requirement. This consequently contributes to improve the strength of concrete.

Agbede and Joel [13]: described quarry dust as a cohesionless sandy material acquired either naturally (which is rare) or artificially by the

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mechanical disturbance of parents rocks (blasting of rocks) for construction purposes, composed largely of particles with a diameter range of 0.05mm to 5.00mm. They found in their study on "suitability of quarry dust as partial replacement for sand in hollow block production" that quarry dust is cheaper than River Benue sand during rainy season.

Sridharan, et al., [12]: conducted shear strength studies on soil-quarry dust mixtures and observed that 20- 25% of the total production in each crusher unit in India is left out as waste-quarry dust. This waste problem may be avoided as it could be converted into useful application in concrete production. conventional concrete. Their workability results showed slump values ranging between 60 - 90mm and compacting factor 0.87 - 0.90 for grade 20 concrete. The range of 28 - day's compressive and flexural strengths for grade 20 concrete were found to be 23.7 - 34.50 N/mm2 and 3.45 - 6.40 N/mm2 respectively.

Joseph. O. Ukpata [11]: was identified that properties of tensile and flexural strength compared with conventional concrete. Hence, the proportion of concrete with lateritic sand and quarry dust is below 50% for construction purpose. Both flexural and tensile strength are increase with increase in lateritic content.

V. PREPARATION AND TESTING OF CONCRETE

In the present experiment Quarry dust and Metakaolin are used as the partial replacement of fine aggregate and cement respectively in concrete mixes. On replacing fine aggregate with Quarry dust of different weight percentages the compressive strengths, split tensile strength and flexural strength are studied at two different ages (7 days & 28 days) of concrete cured in normal water. And the combined replacement of fine aggregate with waste Quarry dust where optimum Quarry dust is taken by above mixes and cement with Metakaolin of different weight percentages the compressive strength, split tensile strength and flexural strength are studied at two different ages (7days & 28 days) of concrete cured in normal water. And durability test will be conducted for the optimum mix. The details of experimental investigations are as follows.

VI. MATERIALS USED

A. Cement:

Cement is the major ingredient in assembling of concrete. The qualities of concrete will be incredibly influenced by changing the Cement content.

OPC available in the local market of standard brand was used in the investigation. Care has been taken to see that the procurement made from a single batch is stored in airtight containers to prevent it from being affected by the atmospheric, monsoon moisture and humidity. The Cement used in this project is Ordinary Portland Cement of 53 grade confirming to IS 12269 – 1987.

Table - 1: Properties of cement:

S. No	Property	Test Result
1	Normal consistency	32%
2	Setting times a) Initial (Minutes) b) Final (Minutes)	 55 295
3	Specific Gravity	3.15
4	Compressive strength of cement (28 days)	54Mpa
5	Specific surface area	365 m2/Kg

Table - 2: Chemical composition percentage of cement:

Composition	Opc-53
SiO_2	21.52
Al_2O_3	6.16
Fe_2O_3	4.6
CaO	63.36
MgO	0.83
SO_3	1.87
IR	1.3
Loss of ignition	1.64

B. Aggregate

Aggregate properties greatly influence the behavior of concrete, since they occupy about 80% of the total volume of concrete. The aggregate are classified as:

1. Fine aggregate
2. Coarse aggregate

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Table - 3: Properties of Fine Aggregate:

S.No.	Property	Test Result
1	Specific Gravity	2.32
2	Bulk density (Kg/m^3)	1534(loose state) 1745(dry rodded)
3	Fineness Modulus	2.74
4	Zone	II

Table - 4: Properties of Coarse Aggregate

S.No.	Property	Test Result
1	Bulk density (Kg/m^3)	1468 [loose state] 1611 [dry rodded]
2	Specific Gravity (G)	2.78
3	Fineness Modulus	7.17

C. Water

Clean potable water was used for mixing concrete. Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete and steel.

Table - 5: Analysis of Water (Limitations As Per IS: 456-2000)

S. No.	Impurity	Max. Limit	Results
1	PH Value	6 to 8.5	7
2	Suspended matter mg/lit	2000	220
3	Organic matter mg/lit	200	20
4	Inorganic matter mg/lit	3000	150
5	Sulphate (SO4) mg/lit	500	30
6	Chlorides (Cl) mg/lit	2000 for P.C.C. 1000 for R.C.C.	60

D. Quarry dust

The suitability of quarry dust as a sand replacement material shows that the mechanical properties are enhanced and also elastic modulus. The compressive strength analysed optimum by replacing fine with quarry. The integration of quarry waste and the equal amount of cement content generally reduced the super plasticizer requirement and improved the 28 days compressive strength of PCC. Normally the strength mixture of PCC contains nearly 300 to 310 kg of cement by inducing the quarry dust it can be increased a lot per cubic meter. Consumption of Quarry dust in Concrete is suggested particularly in regions where sand is not easily available.

Table - 6: Physical properties of Quarry dust

S.No.	Property	Test Result
1	Moisture content (%) Wet Dry	24.25 2.10
2	Bulk density (kg/m^3)	1750
3	Fineness modulus	2.35
4	Effective size (mm)	0.22
5	Coefficient of uniformity	4.50
6	Coefficient of gradation	2.20

Table - 7: Chemical composition of waste Quarry dust:

Composition	Quarry dust
SiO_2	75.25
Al_2O_3	13.63
Fe_2O_3	1.22
CaO	1.28
MgO	0.33
K_2O	5.34

E. Metakaolin

Metakaolin is one of recently developed mineral admixture used to replace apart of cement in the manufacture of cement of HPC. Metakaolin is a manufactured pozzolanic material. It is unique is not an by-product of an industrial process nor entirely natural .It is derived from naturally occurring mineral and manufactured specifically for cementing application. it is manufactured for a specific purpose under carefully controlled conditions.

Table - 8: Chemical composition percentage of Metakaolin:

Composition	Metakaolin powder %
Lime(cao) %	0.39
Silica(sio2) %	96.88
Fe2o3 and Al2o3	0.28
Magnesia(Mgo) %	0.08
Sulphur trioxide(So3) %	---
Loss on ignition %	0.68

Table - 9: Physical Properties of Metakaolin:

Property	Metakaolin
Colour	Off white
Specific gravity	2.5
Bulk density kg/m3	800
Fineness m2/kg	1500

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Table - 10: Comparison of Chemical Properties of Metakaolin and Cement:

S No	Component	Symbol	Percentage of Metakaolin	Percentage of Cement
1	Silica	SiO_2	96.88	21.52
2	Alumina	Al_2O_3	0.14	6.16
3	Ferric Oxide	Fe_2O_3	0.14	4.6
4	Calcium Oxide	CaO	0.39	63.36
5	Magnesium Oxide	MgO	0.08	0.83
6	Loss on Ignition	LOI	0.68	1.64
7	Sulphur trioxide	SO_3	---	1.87
8	Insoluble Residue		1.69	1.3

VII. MIX DESIGN

Mix Design is done as per Indian standards .Mix Design is the process of selecting suitable ingredients of concrete and determining their relative quantities for producing concrete of certain minimum properties as strength, durability and consistency etc., as economically as possible. Mix design done for M30 grade concrete.

Table -11: Mix Proportions by WEIGHT

Cement Kg	Fine aggregate Kg	Coarse aggregate Kg	W/C ratio
386.36	678.01	1277.55	170
1	1.75	3.31	0.44

Table - 12: Different percentages of Metakaolin & Quarry dust powder

S.NO	MIX Designation	Percentage replacement of cement with Metakaolin	Percentage replacement of Fine aggregate with Quarry dust
1	M0	0%	0%
2	M1	0%	10%
3	M2	0%	15%
4	M3	0%	20%
5	M4	5%	15%
6	M5	10%	15%
7	M6	15%	15%
8	M7	20%	15%
9	M8	25%	15%

VIII. CASTING

The standard cast iron moulds are used for casting. The moulds are cleaned of dust particles and the bolts and nuts are well tightened to avoid the water loss. The moulds are applied with mineral oil on all sides before concrete is poured in to the moulds. The moulds are placed on a level platform. The well mixed concrete is filled in to the moulds and kept on vibration table. Excess concrete was removed with trowel and top surface is finished level and smooth as per IS 516-1969.

- For Compressive strength test standard cube size of 150mm x 150mm x150mm are used. An average of three specimens is taken for all mixes.
- For split tensile strength test standard cylinder size of dia 150mm and height of 300mm are used. An average of three specimens is taken for all mixes.
- For Flexural strength test standard prism of size 100mm x 100mm x 500mm are used. An average of three specimens is taken for all mixes.

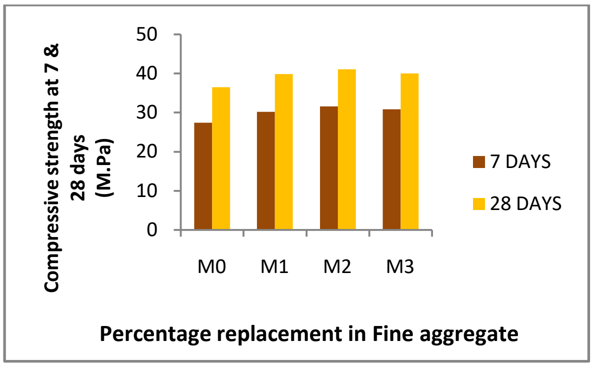
IX. TESTING, RESULTS AND DISCUSSIONS

A. Compression Test

Compressive strength is obtained by applying crushing load on the cube surface. So it is also called as Crushing strength. Compressive strength of concrete is calculated by asting 150mm x 150mm x 150mm cubes. The test results are presented here for the compressive strength of 7 days, 28 days and of testing.

Table: 13 Compressive strength results for MIX-1

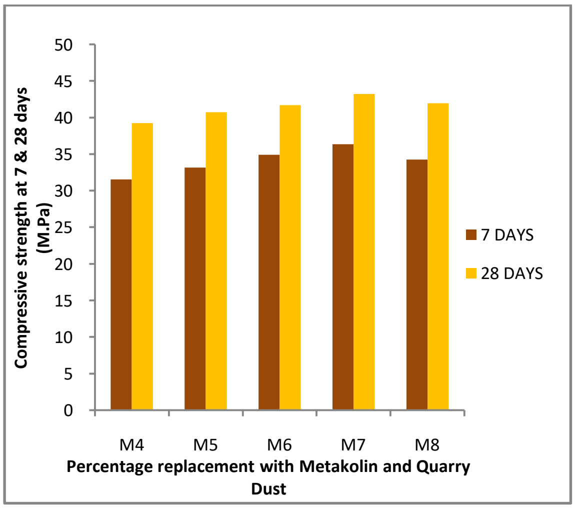
MIX Designation MIX-1	Percentage replacement in Fine aggregate		Compressive Strength N/mm2	
	F.A	Q.D	7 days	28 days
M0	100%	0%	27.42	36.5
M1	90%	10%	30.23	39.84
M2	85%	15%	31.56	41.09
M3	80%	20%	30.88	40.04



Graph 1: Compressive strength at 7 days and 28 days for nominal mix and partial replacement with Quarry dust for MIX-1

Table:14: Test result for Compressive strength by using Quarry dust and Metakaolin for MIX-2

MIX Designation MIX-2	Percentage replacement in cement		Percentage replacement in F.A		Compressive Strength N/mm2	
	Cement	Metakaolin	F.A	Q.D	7 days	28 days
M4	95%	5%	85%	15%	31.56	39.22
M5	90%	10%	85%	15%	33.16	40.72
M6	85%	15%	85%	15%	34.92	41.68
M7	80%	20%	85%	15%	36.36	43.24
M8	75%	25%	85%	15%	34.24	41.96



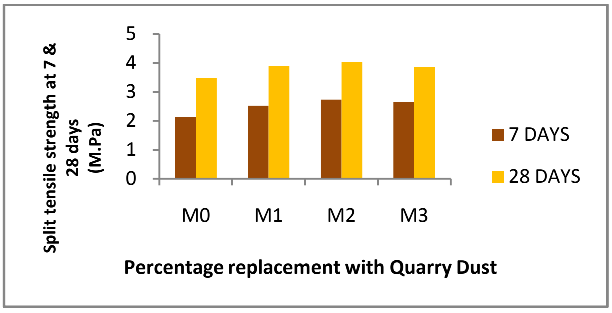
Graph 2: Compressive strength at 7 and 28 days Vs % replacement with Metakaolin & Quarry dust for MIX-2

B. *Split Tensile strength Studies:*

For split tensile strength test standard cylinder size of dia 150mm and height of 300mm are used. An average of three specimens is taken for all mixes after a curing period of 7 days & 28 days.

Table: 15: Split Tensile strength test result for 7 and 28 days for MIX-1

MIX Designation MIX-1	Percentage replacement in Fine aggregate		Split Tensile Strength N/mm2	
	F.A	Q.D	7 days	28 days
M0	100%	0%	2.12	3.47
M1	90%	10%	2.52	3.89
M2	85%	15%	2.73	4.03
M3	80%	20%	2.64	3.86



Graph: 3 split tensile strength for 7 and 28 days replacement with Quarry dust

Table: 16: Split Tensile strength at 7 and 28 days replacement with Metakaolin & Quarry dust for MIX-2

MIX Designation MIX-2	Percentage replacement in cement		Percentage replacement in F.A		Split Tensile Strength N/mm2	
	Cement	Metakaolin	F.A	Q.D	7 days	28 days
M4	95%	5%	85%	15%	2.48	3.84
M5	90%	10%	85%	15%	2.56	3.87
M6	85%	15%	85%	15%	2.64	4.11
M7	80%	20%	85%	15%	2.79	4.19
M8	75%	25%	85%	15%	2.81	3.94

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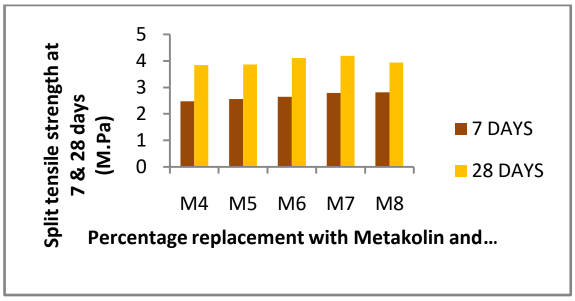


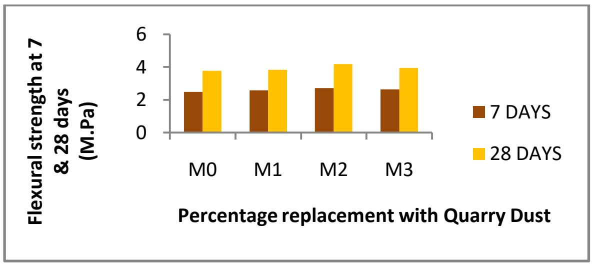
Graph: 4 Split Tensile strength at 7 and 28 days replacement with Metakaolin & Quarry dust for MIX-2

C. Flexural strength Studies

For Flexural strength test standard prism of size 100mm x 100mm x 500mm are used. An average of 3 specimens is taken for all mixes after a curing period of 7 days & 28 days.

Table: 17: Flexural strength test result at age of 7 and 28 days for MIX-1

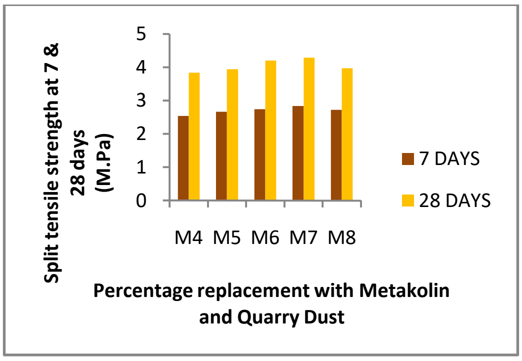
MIX Designation MIX-1	**Percentage replacement in Fine aggregate**		**Flexural Strength N/mm2**	
	F.A	**Q.D**	**7 days**	**28 days**
M0	100%	0%	2.48	3.78
M1	90%	10%	2.58	3.84
M2	85%	15%	2.72	4.18
M3	80%	20%	2.63	3.94



Graph: 5 Flexural strength at 7 and 28 days Quarry dust

Table: 18: Flexural strength at 28 days Vs %replacement with Metakaolin & Quarry dust

MIX Designation MIX-2	**Percentage replacement in cement**		**Percentage replacement in F.A**		**Split Tensile Strength N/mm2**	
	Cement	**Metakaolin**	**F.A**	**Q.D**	**7 days**	**28 days**
M4	95%	5%	85 %	15 %	2.54	3.84
M5	90%	10%	85 %	15 %	2.66	3.94
M6	85%	15%	85 %	15 %	2.74	4.2
M7	80%	20%	85 %	15 %	2.84	4.29
M8	75%	25%	85 %	15 %	2.72	3.97



Graph: 6 Flexural strength at 28 days Vs %replacement with Metakaolin & Quarry dust

X. DURABILITY STUDY

Cement is not completely impervious to acids. Most corrosive arrangements will gradually or quickly break down Portland bond concrete contingent on the sort and convergence of corrosive. The strength of cement in this test work was completed by measuring corrosive resistance at various periods of curing.

The solid corrosive resistance was seen by two sorts of tests named as Acid assault component test and Acid toughness variable test. The convergences of acids in water are 0.5% HCL and H2SO4. Concrete can be assaulted by fluids with pH esteem under 6.5 and assault is extreme when pH quality is underneath 5.5.

At pH esteem beneath 4.5, the assault is exceptionally extreme. As the assault continues, all the concrete mixes are split down and drained away. Here HCL and H2SO4 which are having pH esteem 4.75 and 2.75 which cause an exceptionally extreme assault is utilized to consider the sturdiness properties.

Concrete with Ordinary Portland Cement is the significant arrangement in present constructional exercises. A solid structure was great in quality can likewise be great in giving administration life. Solidness is of solid structure is advocated just when it demonstrates unwavering quality in its life time.

More solidness means more administration life of structure. The solid under marine environment and presented to forceful synthetic assault through water are the significant issues in diminishing the life time of structure. To defeat this issue, legitimate solidness studies are required for cement before cementing a structure.

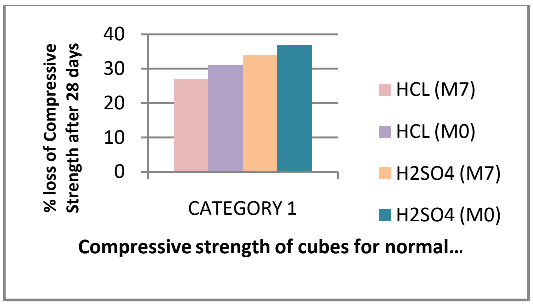
A. Compressive strength consideration:

Table: 19: Durability Compressive strength results for mix M7:

Combined replace of Metakaolin and Quarry dust	28 Days (HCl)	28 Days (H_2SO_4)
	% loss of Compressive Strength after 28 days of acid curing (M pa)	% loss of Compressive Strength after 28 days of acid curing (M pa)
20% & 15%	27	34

Table: 20: durability compressive strength results for mix M0:

Nominal Mix	28 Days (HCl)	28 Days (H_2SO_4)
	% loss of Compressive Strength after 28 days of acid curing (M pa)	% loss of Compressive Strength after 28 days of acid curing (M pa)
Mix (M0)	3	37



Graph 7: Compressive strength of concrete due to acid affect

XI. CONCLUSIONS

- The compressive strength at the age of 7 days and 28 days was increased at mix M7 of about 11.41% than the conventional mix M0.
- The split tensile strength at the age of 7 days and 28 days was more at mix M7 of about 9.63% when compared to conventional mix M0.
- The flexural strength at the age of 7 days and 28 days has increased at mix M7 of about 10.22% when compared to conventional mix M0.
- Durability compression strength results were satisfied when compared to mix M7 and nominal mix M0.
- From the experimental investigations we found a possible alternative solution of safe disposal of Quarry dust.
- By this experimental study we can reduce the cost of concrete. Now a day's river sand price is gradually increasing by replacing it with Quarry dust here will be economical benefit and the natural resource (River sand) is also saved.

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