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Investigation of Quarry Fine Effects on Cement Plaster

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Abstract: *The necessity to find alternatives to sand as fine aggregates in the production of plaster has increased due to the diminishing sources of natural sand and the requirement to reduce the cost of cement plaster. One of these components is quarry dust, a by-product of the crushing operation during quarrying activities. Granite fines, also known as rock dust or quarry dust, are a byproduct of crushing granite boulders. The goal of the current work is to replace sand with quarry dust and improve the mixture of cementitious materials and quarry fines. The basic characteristics of quarry dust and the compressive strength of quarry dust concrete have been attempted to be studied. The compressive strength of cast cement mortar cubes was estimated. For plastering, cement mortar in the ratios of 1:3, 1:4, 1:5, and 1:6 is created, and water absorption in the quarry fines is measured as a percentage. The workability of quarry dust is comparable to that of traditional fine aggregate (sand), and it contains nearly identical components to those found in EDAX. In the current work, the behaviour of cement mortar paste has been experimentally investigated. A range of cement mortar properties, including workability and compressive strength tests after 3 and 7 days of curing, have been the subject of experimental research.*

Keywords: Quarry dust, Cement plaster, Compressive strength, EDAX, SEM

I. INTRODUCTION

Rock is crushed to create manufactured sand, an artificial sand used in cement or concrete building. In the construction business, manufactured sand, often known as M-sand, is used primarily for the preparation of concrete and mortar mixtures. Essentially, this is fine crushed aggregate made from a source material that has the right strength, durability, and form properties.

Large rocks can be crushed into smaller rocks, gravel, sand, or rock dust using a crusher. Slag, building materials, marble, and other soft, medium-hard, and high-hardness rocks and ores are all crushed using a jaw crusher. In order to smash materials, jaw crushers are frequently employed as primary and secondary crushing equipment. A cone crusher reduces material by crushing the material between a moving piece of steel and a fixed piece.For all abrasive, brittle, and wet materials, VSI is a third- or fourth-stage crusher that integrates the crushing and grinding processes into a single machine. Aggregates that have been washed have been subjected to a process that uses a lot of water pressure to remove dirt or other impurities. After the aggregate has been mined, the rock is washed to remove debris, dirt, and clay.

Quarry dust, a byproduct of the crushing process, is a concentrated material that can be used as aggregates for concreting, particularly as fine aggregates. The rock is crushed into different sizes during quarrying activities; the dust produced during the process is referred to as quarry dust and it is created as trash. As a result, it constitutes a waste of material and contributes to air pollution. Therefore, it is recommended that quarry dust be utilised in construction projects to save construction costs, conserve building materials, and ensure proper use of natural resources. The majority of developing nations are under pressure to partially or completely replace fine aggregate in concrete with an alternative material without sacrificing the quality of the concrete. Quarry dust has been utilised in the construction industry for a variety of purposes, including bricks, tiles, aggregates for roads, and building materials. The natural portion of an aggregate passing 0.063 mm is called quarry fines (63 microns). Since quarry fines are smaller than 150 microns, efforts are undertaken to use them in applications other than plastering and concrete. It was discovered that there is an increase in compressive strength in the experimental examination of the strength characteristics of cement mortar utilising quarry dust as fine aggregate.

II. OBJECTIVES

The main objectives of this study are to carry out the following systems:

- To characterize the properties of quarry fines.
- To analyse the better combination of cement, Ultrafine GGBS, quarry fines and water.
- To introduce the validation application of quarry fines.
- To evaluate the compressive strength of cement mortar cube for 3 and 7days by replacing fine aggregate with Quarry Rock Dust.

III. MATERIALS

3.1 Cement

Ordinary Portland cement used grade of 43 grade and affirming to the recommendation of IS: 8112 has been used.

3.2 Ground Granulated Blast Furnace Slag (GGBS)

It is a waste product from the production of iron, and when added to concrete, it gives the material better workability, strength, and durability. Affirming to the recommendation IS: 12089-1987 has been used.

3.3 Quarry Fine

Crusher dust is fine rock particles. When boulders are broken into the small pieces crusher dust is formed. It is gray in color and it is like fine aggregate.

3.4 Water

Potable fresh water, which is free from concentration of acid or organic substances, was used for mixing the concrete.

IV. SUITABILITY OF QUARRY ROCK DUST FOR PLASTERING

The particle size grading of sand for plaster work for internal as well as external wall. As per IS code 1542:1992, Grading of sand for internal wall or external wall.

The acceptable limit on 0.15 mm IS Sieve has been raised to 20% for crushed stone sands and crushed gravel sands. In the case of crushed stone and crushed gravel sands, the fineness modulus must be at least 1.4, and in the case of naturally occurring sands, it must be at least 1.5.

Grading of sand for internal wall or external wall. IS Sieve	Percentage Passing as per IS Code	Percentage Passing Quarry Rock Dust used for Plastering in this Thesis
10 mm	100	100
4.75 mm	95-100	98.9
2.36 mm	95-100	77.55
1.18 mm	90-100	55.9
0.6 mm	80-100	45.4
0.3 mm	20-65	33.3
0.15 mm	0-15	13.75

Table 1: Suitability of Quarry Rock Dust for plastering as per IS Code Recommendations

V. STRENGTH STUDIES ON CEMENT PLASTER

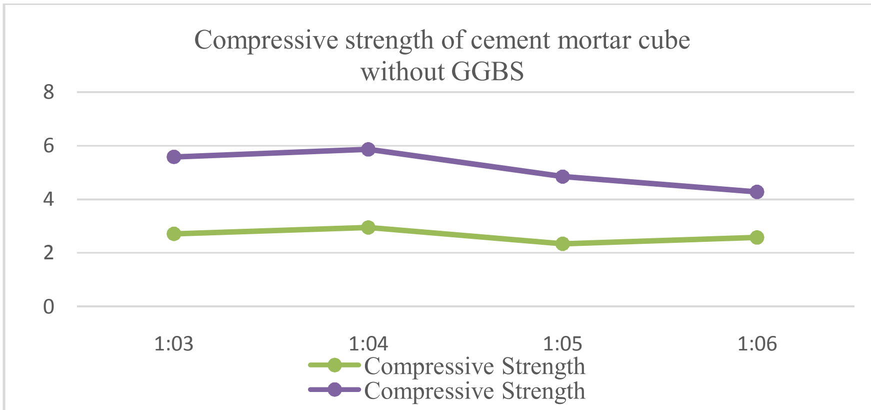
5.1 Compressive Strength Test For Cement Mortar Cube

To create the mortar specimens, weight-based ratios of 1:3, 1:4, 1:5, and 1:6 of cement to fine aggregate were utilised. The specimens were suitably crushed in a high frequency vibrating table after being prepared and cast in cube moulds measuring 70.6 mm x 70.6 mm x 70.6 mm. After 24 hours, specimens were removed from the mould and maintained in water for 3 and 7 days to cure. The samples were cured for 3 and 7 days before the apparent water absorption and compressive strength were assessed.

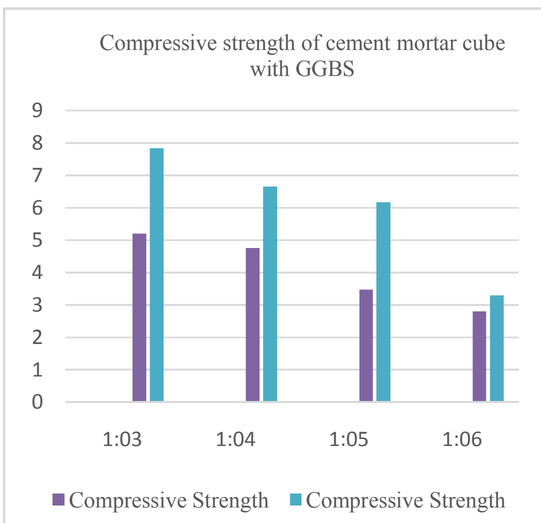
Compressive strength of mortar cube = P/A

Where, P = Compressive load

A = Area of the cube (70.6 X 70.6 mm)



Graph.1 Compressive strength of cement mortar cube without GGBS



Graph.2 Compressive strength of cement mortar cube with GGBS.

Fig.1: Testing of the specimen

VI. FLOW TEST

The purpose of the flow table test was to gauge the fluidity of recently mixed cement mortar. The flow table test was carried out in accordance with IS: 1199[C] recommendations. The table top and the interior of the mould were lubricated and free of any grit for this test. Two layers of concrete were poured into the mould, which was resting in the middle of the table. With the aid of a 2 cm diameter by 60 cm length tamping rod, each layer was uniformly crushed. The table was raised and lowered 25 times, each time by 12.5 cm, while the mould was lifted by a continuous upward pull. The spread diameter was measured, the result was computed using a formula, and it was then reported as a flow percentage.

Flow % = ((Spread diameter in cm – 25) / 25) x 100

Mix Ratio	Cement (gms)	GGBS (gms)	Quarry Fine (gms)	Flow %			Photo
				0^{th} min	15^{th} min	30^{th} min	
1:3 (0.5:0.5:3)	102	102	609	45.5	42.2	41.3	
1:3 (0.7:0.3:3)	143	61	609	41.8	36	42.3	
1:3 (1:0:3)	204	0	609	37	41	48	
1:4 (0.5:0.5:4)	82	82	656	42.3	42.5	40	
1:4 (0.7:0.3:4)	114	49	656	34.3	31.8	32.1	
1:4 (1:0:4)	163	0	656	36.2	40	46	
1:5 (0.5:0.5:5)	69	69	690	43	41	40.8	
1:5 (0.7:0.3:5)	95	41	690	42.7	39.5	41	
1:5 (1:0:5)	136	0	690	40	42	46.5	
1:6 (0.5:0.5:6)	60	60	697	37	36.4	38	
1:6 (0.7:0.3:6)	82	36	697	43	36.5	40	
1:6 (1:0:6)	118	0	697	52.5	46	54	

Table 2: Flow table result

VII. CHARACTERIZATION OF PROPERTIES OF QUARRY FINE

7.1 XRD

Quarry fines less than 6 mm may be used to make finished goods, sold as standalone products, or considered surplus to market requirements, or extra fines that are not used. The fines may contain a significant amount of ultra-fine (dust) particles (below 75 m), which could also be created in excess, as a by-product, or as part of an aggregate product.

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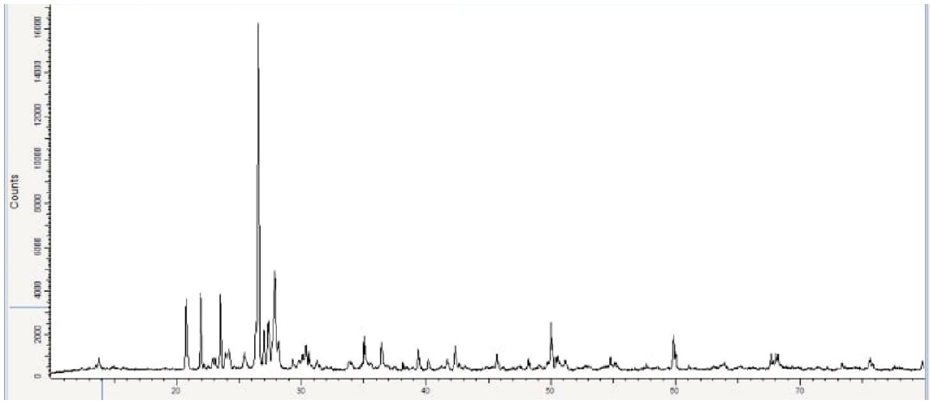


Graph 3: XRD Analysis of Quarry Fine

7.2 SEM

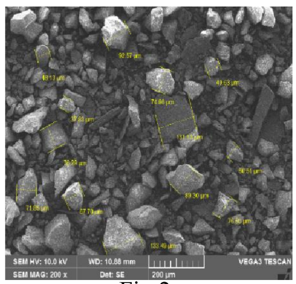


Fig.2

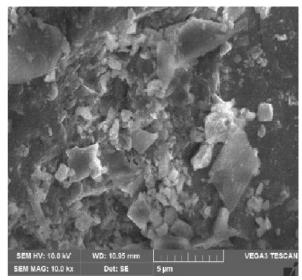


Fig.3

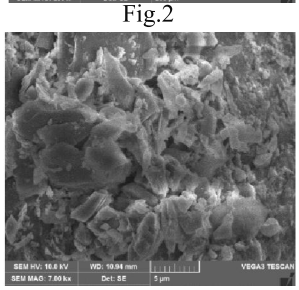


Fig.4

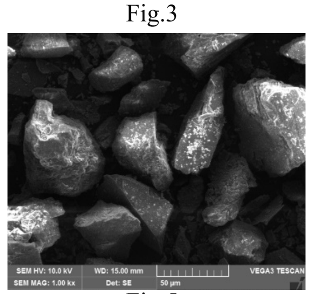
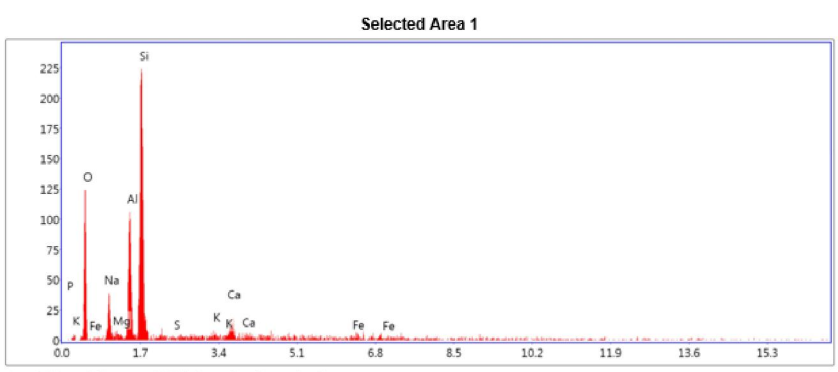


Fig.5

From fig.2,3,4,5, shows SEM results of quarry fine we can come to a conclusion that the sample which we are investigating is in angular shape. The results give a complete picture of both bulk and surface phase composition.

7.3 EDAX



Graph.4 EDAX Analysis of Quarry Fine

Elements	Weight %	Atomic %
Na_2O	10.47	11.39
MgO	1.49	2.49
Al_2O_3	21.87	14.46
SiO_2	57.66	64.71
P_2O_5	0.56	0.26
SO_3	0.68	0.57
K_2O	0.96	0.69
CaO	3.54	4.26
Fe_2O_3	2.78	1.17

Table.5 Chemical composition present in Quarry Fine

VIII. CONCLUSION

- Quarry fines can be used as a replacement for fine aggregates by studying their qualities.
- According to EDAX analysis, the chemical composition of quarry fine and M-sand is nearly same. so that it may be utilised as filler.
- According to a flow table test, GGBS-containing cement mortar is more workable than cement mortar without GGBS. The 1:3 mixture of 50% cement and 50% GGBS has proven to be more practical.
- It is demonstrated that the mortar cube addition of ggbs has greater strength than the mortar cube of mix only cement and quarry fine by comparing the compressive strength of the cement mortar cube of cement and quarry fine mix with the cement, ggbs, and quarry fines.

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