The Study of Effects of Quarry Dust on the Strength of Non-Traffic Paver Block

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Abstract— Quarry dust is generated as a waste during the process of cutting and crushing. Crushing industry produces large amount of quarry dust which causes environmental problems. To reduce disposal and pollution problems the innovative use of quarry dust in concrete by replacing fine aggregate with this material is another alternative of the traditional concrete. The aim of this research is to replace sand by quarry dust accordingly in range of 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70% for M30 grade concrete. This research is concerned with the experimental investigations on workability and strengths of concrete and optimum percentage of partial replacement of sand via 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70% of quarry dust. Ultimately it was observed that the strength increases on replacing sand in concrete due to filler effect of quarry dust.

Key words: Quarry Dust, Sand, workability and strength

I. INTRODUCTION

Now a day, the most widely used construction material is concrete, commonly made by mixing cement with sand, crushed rocks and water. Last year only in US 63 billion tons of Portland cement were converted into 500 billion tons of concrete, five times the consumption by weight of steel. In many countries the ratio of concrete consumption to steel consumption exceeds ten to one. The total world consumption of concrete is estimated at 11billion metric tons every year. Man consumes no material except water in such tremendous quantity. Despite this fact, worldwide the concrete production is major concern that affects the environment with major impact being global warming due to CO_2 emission during production of cement. It is estimated that cement production is responsible for about 3% of the global greenhouse gas emission and for 5% of the global CO_2 emission. Since 50% of the CO_2 released during cement production is concerned with the decomposition of limestone during burning, the mixing of clinker with supplementary materials is considered to be very effective way to reduce CO_2 emission. Most common blending materials used for cement production are industrial wastes. This is due to the fact that recycling of industrial wastes has technical, economic and environmental benefits besides the reduction of CO_2 emission from cement production. The technical reason of using wastes and by-products in concrete production is the improvement of performance of concrete and this will be economical too. Generally fly ash, blast furnace slag and silica fume are used industrial wastes in cement and concrete production due to their pozzolanic behaviour. In addition to pozzolanic materials, other inert by-products and waste materials are also used in concrete and cement production as inert filler material. Among these, quarry sand, a by-product of stone crushing quarry is suggested by many researchers for its use in concrete production as sand replacing or cement replacing material. Most of the researches showed positive results and benefits. The research will cover studying the setting time of quarry dust blended Portland cement and workability, compressive strength, flexural strength and split tensile strength of concrete produced by quarry dust blended cement, and quarry dust blended sand. Throughout the investigation, the research is limited to quarry dust obtained from the stone crushing quarries of Sagour.

II. METHODOLOGY

Ordinary portland cement of grade 43 along with natural fine aggregate with 10 mm size natural coarse aggregate is used in this project. Stone dust or quarry fine is collected from stone crushing plant located in sagour. For studying the effects of replacing parts of cement and sand by quarry dust waste powder and addition of quarry dust waste powder, three groups of concrete specimens were prepared. The first group was designed by replacing cement with quarry dust waste powder from 0-20% replacement ranges with 5% increment to study the effects on performance of concrete. The second group was designed by just adding quarry dust waste powder from 0-20% addition ranges with 5% increment to study the effects on performance of concrete. The first group was designed by replacing sand with quarry dust waste powder from 0-20% replacement ranges with 5% increment to study the effects on performance of concrete. Mix proportion of concrete is given in table 1. Curing is done in clean water at room temperature and on fresh concrete workability test is performed whereas on blocks compressive strength test, Flexural strength and spilt tensile strength is performed.

Volume of block = $.15\times.15\times.05\ m^3 = 1.125\times10^{-3}\ m^3$,
Volume of 72blocks = $72\times1.125\times10^{-3}\ m^3 = 0.081m^3$
Therefore, total volume of concrete = $0.081m^3$

Mix	% of replacement	Cement (Kg)	QD(Kg)	Sand(Kg)	Coarse Aggregate (Kg)	Water(Kg)
M30	0%	4.54	0	9.68	8.01	2.04
	10%	4.54	0.96	8.71	8.01	2.04
	20%	4.54	1.93	7.74	8.01	2.04
	30%	4.54	2.90	6.77	8.01	2.04
	40%	4.54	3.87	5.80	8.01	2.04
	50%	4.54	4.84	4.84	8.01	2.04
	60%	4.54	5.80	3.87	8.01	2.04
	70%	4.54	6.77	2.90	8.01	2.04

Table 1: Mix Proportion of concert

III. Result and Discussion

Increment in strengths was observed when sand was replaced by quarry dust. Maximum increment was obtained on 40% replacement of sand with quarry dust. After that the reduction in strength was observed. But overall values of strength were higher than the strength of standard mix. The complete analysis of results is as follows.

% of Replacement	Compressive strength in N/mm2		Flexural strength in N/mm2	Split tensile strength in N/mm2	Workability (mm)
	7 days	28 days			
0	27.79	38.76	4.35	4.22	20
10	30.21	42.14	4.54	4.59	18
20	31.18	43.86	4.63	4.78	15
30	32.02	45.04	4.69	4.90	10
40	33.58	47.23	4.81	5.14	6
50	32.18	45.27	4.70	4.93	0
60	29.58	41.61	4.51	4.53	0
70	26.51	37.29	4.27	4.06	0

Table 2: Indicates the average values of strengths and workability achieved when sand replaced with QD

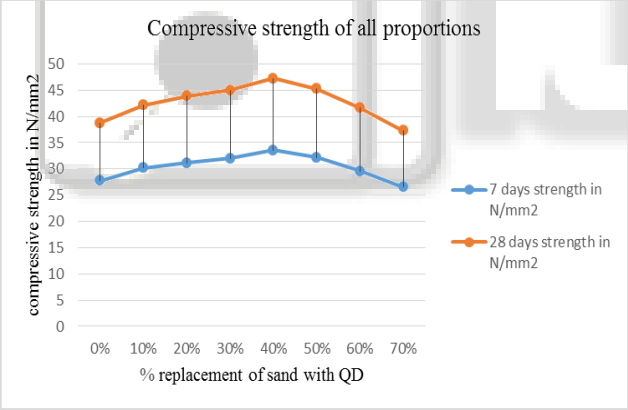

Fig. 1: Graph 1: Indicates the Compressive strength of concrete when sand replaced with QD

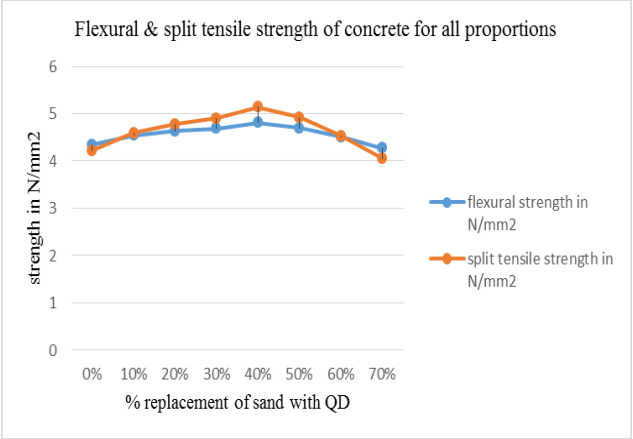

Fig. 2: Graph 2: Indicates the Flexural and Split tensile strength of concrete when sand replaced with QD

IV. Conclusion

1) The physical and chemical properties of quarry dust were found suitable for its proposed use.
2) None of the mineral constituents in waste is in undesirable concentration.
3) The workability of concrete decreases when sand is replaced with quarry dust.
4) Increment in the compressive, flexural and split tensile strengths were observed when sand was replaced by quarry dust. Maximum increment was obtained on 40% replacement. After that the reduction in strength was observed. But overall values of strength were higher than the strength of standard mix.
5) In concrete production, replacing of sand up to 70% by quarry dust gives similar strength as of concrete mixes with 100% sand both at early and latter ages.
6) The result indicates that the quarry dust up to 70% can replace sand with performance improvement of concrete strength.
7) As this waste is available free of cost, the use of quarry dust in concrete might be cost effective.
8) It will help in improving environmental problems as it will prevent the indiscriminate disposal of large quantity of waste generated from crusher plants.

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