Sustainable Materials -Quarry Waste and Waste Plastic as Fine Aggregate for Improving Elastic Properties of Concrete

B. V. Bahoria, A. M. Pande

***Abstract**: The present paper focuses on the effective utilization of byproduct of stone mines and waste plastic causing harm to the environment. It signifies sustainable utilization of quarry dust to their full potential to meet the needs of the present, while at the same time conserving natural resources and finding ways to minimise the environmental impacts associated both with quarry fines production. Mathematical modeling for interpreting modulus of elasticity of concrete mixes using ordinary river sand and compared with 0, 25%,50%,75%, 100% replacement with quarry dust in combination with waste plastic in fabriform is discussed. The addition of fine quarry dust with ldpe as waste plastic in concrete resulted in improved matrix densification compared to conventional concrete as well as . Matrix densification has been studied qualitatively through petro graphical examination using digital optical microscopy. The structure was evaluated using SEM in quarry dust and ldpe composites. It is observed that the modulus of elasticity values found to be maximum for 50% replacement of natural sand by quarry dust and waste plastic. The effects of quarry dust on the elastic modulus property were found to be consistent with conventional natural sand.*

Keywords: modulus of elasticity, natural sand; quarry dust; regression analysis.

I. INTRODUCTION

The main Ingredients of Conventional concrete are cement, sand and aggregate. Performance of concrete is affected by properties of aggregate, so fine aggregate is an essential component of concrete. The mostly used fine aggregate is the sand extracted from river banks. Natural sand is costly due to the excessive cost of transportation from natural sources. Also large-scale extraction of river banks depletes natural resources. To endeavor this aim , one way is to go for long lasting solutions i.e., To opt for sustainable building materials for construction from the byproducts that are generated by manufacturing industries, mines , as waste is certainly a good potential resource and a lot of energy can be recovered from it; and the term 'green' in the present scenario implies to take into consideration use of long term materials like stone dust or recycled stone, recycled metal and other products that are not harmful , can be reused and recycled. In addition to this suitable substitution for the replacement of natural aggregates in concrete is a matter of concern. As a result reasonable research with intended solutions has been done to find the feasibility of quarry dust in conventional concrete. Quarry dust is a byproduct that is generated from the crushing plants and which is abundantly available to an extent of millions of tonnes per year associated with disposal problems and serious environmental effects

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II. BRIEF REVIEW

Research has been done to investigate the use of quarry fines in various concrete applications. The International Center for Aggregates Research (ICAR) identified the use of microfines (particles below 75 µm) in concrete. Studies suggested that artificial fine aggregate mortars with high fines content had higher flexural strength, improved abrasion resistance, higher unit weight and lower permeability due to filling of pores with micro fines. Hence concrete can be manufactured using all of the aggregate, including micro fines from 7 to 18% without the use of admixtures (Ahn and Fowler, 2001) [9]. Hanson considered structural concrete (Craig-yr-Hesg) using 12% unseparated sandstone quarry fines. The product is being sold as standard C35 strength concrete (35 N/mm2). However results showed that the strength of the ultimate product would be considerably higher than 35 N/mm2 after 28 days. Hence, it was put forth that, if the filler material was to be replaced , and then much higher content of the coarser grained material have to be mixed , while retaining the desirable strength value (Lamb, 2005)[5]. Galetakis and Raka (2004) studied the effect of varying replacement proportion of sand with quarry dust (20, 30 and 40%) on the properties of concrete in both fresh and hardened state [6]. Saifuddin (2001)[8] studied the influence of partial replacement of sand with quarry dust and cement with mineral admixtures on the compressive strength of concrete (Gambhir, 1995), whereas Celik and Marar investigated the effect of partial replacement of fine aggregate with crushed stone dust at different percentages in the properties of fresh and hardened concrete [10]. It is worthy to consider that the hardened concrete properties as tensile and flexure strength can be increased by incorporating closely spaced fibers. These fibers may arrest the propagation of micro cracks, resulting in delay of onset of tensile cracks and enhancing the tensile strength of the material. (Zainab Z. Ismail, Enas A. AL-Hashmi, 2007)[4].

The study carried out by B.V.Bahoria, D.K.Parbat (2013)[1][2][3] on concrete revealed that the optimum modifier content as 6% the strength was found to be comparable with the conventional concrete. From the test results it was observed that the compressive strength value of the concrete mix increased with the addition of quarry dust and waste plastic fibers as modifier.

III. RESEARCH SIGNIFICANCE

The main objective of the present work was to systematically study the effect of percentage replacement of natural sand by quarry dust & waste plastic (ldpe) in fabri form as 0%, 25%, 50%, 75%, and 100% respectively on the strength properties of concrete. The study was carried out on M20, M30, and M40 grade concrete with 0.5 water cement ratio. Waste plastic was mixed as 2, 4, 6, and 8% along with quarry dust to make full combinations. Regression analysis was done to co-relate the results of compressive strength for 7, 14, 28, 90 days represented in Figure 1, 2, 3. An attempt was done to develop a model predicting the progressive compressive strength 7, 14, 28 & 90 days. The results analyzed in excel were further compared with SPSS software. Regression analysis was done to co-relate the results of modulus of elasticity of concrete for 7, 14, 28, 90 days represented in Figure 7, 8. Model predicting the modulus of elasticity of concrete for 28 & 90 days was developed. Waste plastic (ldpe) have been incorporated with a view to enhance mechanical properties of concrete. It was well concluded that ldpe used in above percentage contributed to compressive strength and the modulus of elasticity of concrete. [1] [2] [3]

A. Modulus of Elasticity

The modulus of elasticity (E) is influenced by the properties of the aggregates, age of the concrete, conditions of curing, the type of cement and mix proportions. The additions of materials would not be expected to greatly alter the modulus of cement composites. The modulus of elasticity is normally related to the compressive strength of concrete. The static modulus of elasticity of modified concrete can be determined by using formulae given by IS:456-2000 and BS: 8110 P-2 (1985) depending upon compressive strength of concrete. It was calculated by using following equations 1 and 2 and same is reported and compared with experimental values.

As per IS: 456-2000

$Ec= 5\sqrt{fcu}$ -------------- 1

As per BS:8110--P2(1985)

$Ec= 9.1 (fcu)^{0.33}$ --------------- 2

Where,

Ec= static modulus of elasticity in Gpa,

fcu= cube compressive strength of concrete in Mpa

IV. STATISTICAL ANALYSIS

The correlation analysis was carried out between compressive strength of M20,M30,M40 grade concrete considering 7,14,28,90 days strength as shown in Table.no 1. Co-relation was established between 7days & 14 days, 7 days & 28 days, 28 days &90 days compressive strength. It was observed that there is good correlation between these combinations. A power relationship in the form of $y = ax^b$ seems to best fit the data with R2 values. Its co-relation is shown in Fig 1, 2, 3 and its validation in Fig.4, 5, 6. The results obtained are lying within 0 to 5% error limit. The high values of correlation coefficient indicate that there is strong relationship between 7th day and 14th, 28th day compressive strength, similarly 28th day and 90th day compressive strength. Coefficient of correlation amongst compressive strength is (from 0.897 to 0.937).

The modulus of elasticity values of 7,14,28,90 days for M20, M30, M40 are represented in Table.no2. It was observed that there is good correlation between these combinations.

A relationship in the form of y = 0.4158x + 14.89, seems to best fit the data with R2 values=0.9976.

Its co-relation is shown in Fig 7, 8. The high values of correlation coefficient indicate that there is strong relationship between 7th day and 28th, 28th day and 90th day elasticity values. Coefficient of correlation for modulus of elasticity of concrete is varies from 0.9405 to 0.9976.

Table I. Development and validation of Mathematical models compressive strength of concrete

cement	natural sand	quarry dust	waste plastic	Coarse Agg.				7	14	Model 1				28	Model 2				90	Model 3			
CEM	NTSA	QUDT	WP	CA10	CA20	F/C	Agg/cem	CS7	CS14	Predicted	% Error	+10 %	-10 %	CS28	Predicted	% Error	+10 %	-10 %	CS90	Predicted	% Error	+10 %	-10 %
383	181.8	487.1	58.2	367.7	735.3	0.2	2.9	20.1	22.5	22.1	1.8	24.3	19.9	24.3	23.5	3.4	25.8	21.1	26.2	27.8	-6.0	30.6	25.0
383	181.8	545.3	0.0	367.7	735.3	0.2	2.9	20.3	22.1	22.3	-0.9	24.5	20.1	24.3	23.7	2.6	27.2	21.3	27.4	27.8	-1.4	30.6	25.0
383	0.0	668.8	58.2	367.7	735.3	0.0	2.9	21.3	23.0	23.4	-2.0	25.8	21.1	25.2	25.0	0.6	28.8	22.5	29.2	28.7	1.5	31.6	25.9
383	181.8	530.7	14.5	367.7	735.3	0.2	2.9	22.1	23.1	24.2	-4.8	26.7	21.8	25.3	26.0	-2.7	29.9	23.4	30.2	28.9	4.4	31.8	26.0
383	181.8	516.2	29.1	367.7	735.3	0.2	2.9	22.5	24.3	24.7	-1.7	27.2	22.2	26.1	26.6	-2.0	30.6	23.9	30.5	29.7	2.7	32.7	26.7
383	0.0	545.3	0.0	367.7	735.3	0.0	2.9	22.5	25.0	24.7	1.3	27.2	22.2	27.1	26.6	1.9	30.6	23.9	30.5	30.8	-0.9	33.9	27.7
413	0.0	706.0	0.0	372.3	744.7	0.0	2.9	23.1	26.7	25.4	4.9	27.9	22.8	27.6	27.4	0.6	31.5	24.7	31.0	31.3	-1.0	34.4	28.1
383	181.8	501.6	43.6	367.7	735.3	0.2	2.9	24.0	26.8	26.3	1.8	29.0	23.7	27.6	28.6	-3.7	32.9	25.7	31.4	31.3	0.5	34.4	28.1
383	0.0	712.5	14.5	367.7	735.3	0.0	2.9	24.0	25.5	26.3	-3.4	29.0	23.7	27.9	28.6	-2.6	32.9	25.7	31.4	31.6	-0.6	34.7	28.4
413	0.0	691.9	14.1	372.3	744.7	0.0	2.9	24.0	26.4	26.3	0.1	29.0	23.7	27.9	28.6	-2.6	32.9	25.7	31.9	31.6	0.9	34.7	28.4
383	727.0	0.0	0.0	367.7	735.3	0.7	2.9	24.1	26.1	26.5	-1.6	29.2	23.9	28.4	28.8	-1.2	33.1	25.9	32.9	32.2	2.1	35.4	29.0
383	0.0	697.9	29.1	367.7	735.3	0.0	2.9	24.4	26.4	26.8	-1.7	29.5	24.1	29.3	29.2	0.5	33.6	26.3	33.3	33.2	0.5	36.5	29.8
383	0.0	683.4	43.6	367.7	735.3	0.0	2.9	24.6	28.4	27.0	5.1	29.7	24.3	29.6	29.4	0.8	33.8	26.4	33.3	33.5	-0.4	36.8	30.1
383	545.3	123.6	58.2	367.7	735.3	0.5	2.9	25.5	27.4	28.0	-2.0	30.8	25.2	29.6	30.6	-3.2	35.2	27.5	33.8	33.5	0.9	36.8	30.1
413	0.0	649.5	56.5	372.3	744.7	0.0	2.9	25.8	26.2	28.3	-7.9	31.1	25.5	29.8	31.0	-4.1	35.6	27.9	35.1	33.6	4.2	37.0	30.3
383	545.3	181.8	0.0	367.7	735.3	0.5	2.9	25.9	27.3	28.5	-4.4	31.3	25.6	30.2	31.2	-3.2	35.9	28.1	35.3	34.1	3.3	37.5	30.7
383	363.5	305.3	58.2	367.7	735.3	0.3	2.9	26.1	28.0	28.6	-2.2	31.5	25.8	30.2	31.4	-3.9	36.1	28.2	35.4	34.1	3.7	37.5	30.7
413	706.0	0.0	0.0	372.3	744.7	0.6	2.9	26.7	30.2	29.3	3.2	32.2	26.3	31.6	32.2	-2.0	37.0	29.0	35.4	35.5	-0.4	39.1	32.0
450	0.0	896.0	0.0	380.0	760.0	0.0	2.9	26.7	30.7	29.3	4.8	32.2	26.3	32.3	32.2	0.3	37.0	29.0	36.0	36.3	-0.9	40.0	32.7
383	545.3	167.2	14.5	367.7	735.3	0.5	2.9	27.0	29.0	29.6	-1.9	32.5	26.6	32.4	32.6	-0.5	37.5	29.3	36.1	36.5	-0.9	40.1	32.8
383	0.0	0.0	0.0	367.7	735.3	0.0	2.9	27.1	27.9	29.8	-6.8	32.7	26.8	32.6	32.8	-0.6	37.7	29.5	36.3	36.6	-0.9	40.3	33.0
450	0.0	878.1	17.9	380.0	760.0	0.0	2.7	27.4	32.6	30.1	7.7	33.1	27.1	32.7	33.2	-1.4	38.2	29.9	36.4	36.8	-1.0	40.5	33.1
450	0.0	824.3	71.7	380.0	760.0	0.0	2.7	27.9	35.0	30.6	12.6	33.6	27.5	32.9	33.8	-2.8	38.9	30.4	36.4	37.0	-1.4	40.7	33.3
450	224.0	672.0	0.0	380.0	760.0	0.2	2.7	28.1	34.7	30.9	10.9	34.0	27.8	32.9	34.2	-4.0	39.4	30.8	37.0	37.0	0.2	40.7	33.3
383	545.3	152.7	29.1	367.7	735.3	0.5	2.7	28.6	30.4	31.4	-3.3	34.5	28.2	32.9	34.8	-5.9	40.1	31.3	37.3	37.0	1.0	40.7	33.3

Table I .Development and validation of Mathematical models compressive strength of concrete

cement	natural sand	quarry dust	waste plastic	Coarse Agg.				7	14	Model 1				28	Model 2				90	Model 3			
CEM	NTSA	QUDT	WP	CA10	CA20	F/C	Agg/ cem	CS7	CS14	Predicted	% Error	+10 %	-10 %	CS28	Predicted	% Error	+10 %	-10 %	CS90	Predicted	% Error	+10 %	-10 %
383	363.5	349.0	14.5	367.7	735.3	0.3	2.7	28.7	30.7	31.5	-2.8	34.7	28.4	34.1	35.0	-2.8	40.3	31.5	37.9	38.2	-0.8	42.0	34.4
413	529.5	176.5	0.0	372.3	744.7	0.5	2.7	28.9	31.6	31.7	-0.5	34.9	28.5	34.2	35.2	-3.0	40.5	31.7	37.9	38.4	-1.2	42.2	34.5
413	176.5	529.5	0.0	372.3	744.7	0.2	2.7	28.9	31.1	31.7	-1.9	34.9	28.5	34.2	35.2	-3.0	40.5	31.7	38.2	38.4	-0.4	42.2	34.5
413	353.0	353.0	0.0	372.3	744.7	0.3	2.7	29.0	32.0	31.9	0.4	35.0	28.7	34.7	35.4	-2.2	40.8	31.9	38.2	38.9	-1.6	42.7	35.0
450	896.0	0.0	0.0	380.0	760.0	0.8	2.7	29.2	36.9	32.0	13.2	35.2	28.8	34.7	35.6	-2.8	41.0	32.1	38.5	38.9	-0.9	42.7	35.0
413	176.5	473.0	56.5	372.3	744.7	0.2	2.7	29.3	31.0	32.2	-4.0	35.4	29.0	34.8	35.8	-3.0	41.2	32.3	39.1	39.0	0.3	42.9	35.1
383	545.3	138.1	43.6	367.7	735.3	0.5	2.7	29.8	31.6	32.7	-3.5	35.9	29.4	34.8	36.5	-4.7	41.9	32.8	39.4	39.0	1.0	42.9	35.1
413	0.0	677.8	28.2	372.3	744.7	0.0	2.7	29.8	31.6	32.7	-3.5	35.9	29.4	35.0	36.5	-4.3	41.9	32.8	39.7	39.2	1.3	43.1	35.3
413	176.5	515.4	14.1	372.3	744.7	0.2	2.7	29.9	30.8	32.8	-6.6	36.1	29.6	35.6	36.7	-3.1	42.2	33.0	39.9	39.8	0.1	43.8	35.8
450	0.0	860.2	35.8	380.0	760.0	0.0	2.7	30.1	35.7	33.0	7.6	36.3	29.7	35.9	36.9	-2.8	42.4	33.2	40.3	40.1	0.4	44.1	36.1
413	529.5	162.4	14.1	372.3	744.7	0.5	2.7	30.2	33.5	33.2	1.0	36.5	29.8	36.1	37.1	-2.6	42.6	33.4	40.4	40.4	0.0	44.5	36.4
413	0.0	663.6	42.4	372.3	744.7	0.0	2.7	30.2	30.7	33.2	-8.1	36.5	29.8	37.2	37.1	0.3	42.6	33.4	40.7	41.5	-2.0	45.7	37.4
383	363.5	334.4	29.1	367.7	735.3	0.3	2.7	30.5	32.0	33.5	-4.6	36.8	30.1	37.9	37.5	1.2	43.1	33.7	41.2	42.3	-2.8	46.6	38.1
450	224.0	654.1	17.9	380.0	760.0	0.2	2.7	30.5	36.7	33.5	8.9	36.8	30.1	38.1	37.5	1.5	43.1	33.7	42.1	42.5	-1.0	46.7	38.2
413	176.5	501.3	28.2	372.3	744.7	0.2	2.7	30.8	31.9	33.8	-6.2	37.2	30.4	38.7	37.9	2.0	43.6	34.1	42.4	43.1	-1.8	47.4	38.8
383	363.5	319.9	43.6	367.7	735.3	0.3	2.7	31.1	32.9	34.1	-3.8	37.5	30.7	39.9	38.3	3.9	44.1	34.5	42.7	44.4	-4.0	48.8	39.9
413	353.0	296.5	56.5	372.3	744.7	0.3	2.7	31.1	33.2	34.1	-2.9	37.5	30.7	40.0	38.3	4.2	44.1	34.5	43.3	44.5	-3.0	49.0	40.1
413	176.5	487.1	42.4	372.3	744.7	0.2	2.5	31.3	32.9	34.3	-4.3	37.7	30.9	40.0	38.5	3.7	44.3	34.7	43.6	44.5	-2.3	49.0	40.1
413	353.0	338.9	14.1	372.3	744.7	0.3	2.5	31.6	34.7	34.6	0.1	38.1	31.2	40.4	38.9	3.8	44.8	35.0	43.6	45.0	-3.4	49.5	40.5
450	224.0	636.2	35.8	380.0	760.0	0.2	2.5	32.0	38.2	35.1	8.1	38.6	31.6	40.4	39.5	2.2	45.5	35.6	44.1	45.0	-2.0	49.5	40.5
450	0.0	842.2	53.8	380.0	760.0	0.0	2.5	32.0	37.0	35.1	5.2	38.6	31.6	40.9	39.5	3.3	45.5	35.6	44.4	45.5	-2.4	50.0	40.9
450	224.0	600.3	71.7	380.0	760.0	0.2	2.5	32.3	40.7	35.4	13.0	39.0	31.9	40.9	40.0	2.3	46.0	36.0	44.4	45.5	-2.4	50.0	40.9
413	529.5	120.0	56.5	372.3	744.7	0.5	2.5	32.7	34.1	35.9	-5.4	39.5	32.3	41.5	40.6	2.2	46.7	36.5	44.9	46.1	-2.8	50.7	41.5
413	353.0	324.8	28.2	372.3	744.7	0.3	2.5	32.9	35.3	36.1	-2.3	39.7	32.5	41.5	40.8	1.7	46.9	36.7	45.0	46.1	-2.4	50.7	41.5
413	529.5	148.3	28.2	372.3	744.7	0.5	2.5	33.5	35.6	36.7	-3.3	40.4	33.1	42.7	41.6	2.5	47.9	37.5	45.6	47.4	-3.9	52.1	42.6
450	448.0	448.0	0.0	380.0	760.0	0.4	2.5	33.8	38.2	37.1	3.0	40.8	33.4	43.1	42.0	2.5	48.3	37.8	47.1	47.9	-1.6	52.6	43.1

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cement	natural sand	quarry dust	waste plastic	Coarse Agg.				7	14	Model 1				28	Model 2				90	Model 3			
CEM	NTSA	QUDT	WP	CA10	CA20	F/C	Agg/cem	CS7	CS14	Predicted	% Error	+10 %	-10 %	CS28	Predicted	% Error	+10 %	-10 %	CS90	Predicted	% Error	+10 %	-10 %
413	529.5	134.1	42.4	372.3	744.7	0.5	2.5	34.7	36.4	38.0	-4.4	41.8	34.2	44.0	43.3	1.6	49.8	39.0	50.1	48.8	2.5	53.7	43.9
413	353.0	310.6	42.4	372.3	744.7	0.3	2.5	34.8	37.3	38.2	-2.3	42.0	34.4	44.9	43.5	3.1	50.0	39.1	52.0	49.8	4.3	54.7	44.8
450	448.0	430.1	17.9	380.0	760.0	0.4	2.5	35.1	38.8	38.5	0.8	42.4	34.7	46.2	43.9	5.0	50.5	39.5	52.4	51.2	2.4	56.3	46.1
450	448.0	412.2	35.8	380.0	760.0	0.4	2.5	35.6	40.0	39.0	2.5	42.9	35.1	46.7	44.5	4.6	51.2	40.1	52.6	51.7	1.8	56.8	46.5
450	672.0	152.3	53.8	380.0	760.0	0.6	2.5	35.9	37.5	39.3	-4.9	43.3	35.4	47.4	45.0	5.2	51.7	40.5	53.8	52.4	2.5	57.7	47.2
450	448.0	394.2	53.8	380.0	760.0	0.4	2.5	36.0	40.4	39.5	2.3	43.4	35.5	48.0	45.2	5.9	51.9	40.6	54.8	53.1	3.2	58.4	47.8
450	672.0	206.1	17.9	380.0	760.0	0.6	2.5	36.3	38.5	39.8	-3.4	43.8	35.8	49.2	45.6	7.3	52.4	41.0	55.0	54.3	1.1	59.8	48.9
450	672.0	188.2	26.9	380.0	760.0	0.6	2.5	37.8	40.1	41.4	-3.2	45.6	37.3	49.6	47.7	3.9	54.8	42.9	57.0	54.8	3.9	60.3	49.3
450	672.0	170.2	40.3	380.0	760.0	0.6	2.5	38.2	40.4	41.9	-3.7	46.1	37.7	50.1	48.3	3.5	55.6	43.5	59.1	55.3	6.5	60.8	49.8

Table II. Development of mathematical model for Modulus of Elasticity

cement	natural sand	quarry dust	waste plastic	Coarse Agg.				7 days	14 days	28 days	90 days		
CEM	NTSA	QUDT	WP	CA10	CA20	F/C	Agg/cem	CS7	CS14	CS28	CS90	28 EC	90 EC
383	727	0	0	367.66	735.33	0.66	2.88	24.148	26.074	29.333	35.407	27.08	29.75
383	545.25	181.75	0	367.66	735.33	0.49	2.88	25.926	27.259	29.630	36.148	27.22	30.06
383	545.25	167.21	14.54	367.66	735.33	0.49	2.88	26.963	29.037	31.556	37.037	28.09	30.43
383	545.25	152.67	29.08	367.66	735.33	0.49	2.88	28.593	30.370	32.444	37.926	28.48	30.79
383	545.25	138.13	43.62	367.66	735.33	0.49	2.88	29.778	31.556	32.889	39.111	28.67	31.27
383	545.25	123.59	58.16	367.66	735.33	0.49	2.88	25.481	27.407	29.630	36.296	27.22	30.12
383	363.5	363.5	0	367.66	735.33	0.33	2.88	27.111	27.852	30.222	32.889	27.49	28.67
383	363.5	348.96	14.54	367.66	735.33	0.33	2.88	28.741	30.667	32.889	38.519	28.67	31.03
383	363.5	334.42	29.08	367.66	735.33	0.33	2.88	30.519	32.000	34.667	39.407	29.44	31.39
383	363.5	319.88	43.62	367.66	735.33	0.33	2.88	31.111	32.889	35.852	40.444	29.94	31.80
383	363.5	305.34	58.16	367.66	735.33	0.33	2.88	26.074	28.000	30.222	36.000	27.49	30.00
383	181.75	545.25	0	367.66	735.33	0.16	2.88	20.296	22.074	24.296	26.222	24.65	25.60
383	181.75	530.71	14.54	367.66	735.33	0.16	2.88	22.074	23.111	25.185	30.519	25.09	27.62
383	181.75	516.17	29.08	367.66	735.33	0.16	2.88	22.519	24.296	26.074	31.407	25.53	28.02
383	181.75	501.63	43.62	367.66	735.33	0.16	2.88	24.000	26.815	28.444	33.778	26.67	29.06
383	181.75	487.09	58.16	367.66	735.33	0.16	2.88	20.148	22.519	24.296	27.407	24.65	26.18
383	0	727	0	367.66	735.33	0.00	2.88	22.519	25.037	27.111	30.222	26.03	27.49
383	0	712.46	14.54	367.66	735.33	0.00	2.88	24.000	25.481	27.556	30.963	26.25	27.82
383	0	697.92	29.08	367.66	735.33	0.00	2.88	24.444	26.370	27.852	31.407	26.39	28.02
383	0	683.38	43.62	367.66	735.33	0.00	2.88	24.593	28.444	29.778	36.444	27.28	30.18
383	0	668.84	58.16	367.66	735.33	0.00	2.88	21.333	22.963	25.333	30.519	25.17	27.62
413	706	0	0	372.33	744.67	0.63	2.70	26.667	30.222	34.222	37.926	29.25	30.79
413	529.5	176.5	0	372.33	744.67	0.47	2.70	28.889	31.556	36.148	40.296	30.06	31.74
413	529.5	162.38	14.12	372.33	744.67	0.47	2.70	30.222	33.481	38.074	42.074	30.85	32.43
413	529.5	148.26	28.24	372.33	744.67	0.47	2.70	33.481	35.556	39.852	43.556	31.56	33.00
413	529.5	134.14	42.36	372.33	744.67	0.47	2.70	34.667	36.444	40.444	43.556	31.80	33.00

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Table II. Development of mathematical model for Modulus of Elasticity

413	529.5	120.02	56.48	372.33	744.67	0.47	2.70	32.741	34.074	34.667	38.222	29.44	30.91
413	353	353	0	372.33	744.67	0.32	2.70	29.037	32.000	37.185	40.741	30.49	31.91
413	353	338.88	14.12	372.33	744.67	0.32	2.70	31.556	34.667	38.667	42.370	31.09	32.55
413	353	324.76	28.24	372.33	744.67	0.32	2.70	32.889	35.259	40.000	42.667	31.62	32.66
413	353	310.64	42.36	372.33	744.67	0.32	2.70	34.815	37.333	40.889	44.889	31.97	33.50
413	353	296.52	56.48	372.33	744.67	0.32	2.70	31.111	33.185	34.815	39.704	29.50	31.51
413	176.5	529.5	0	372.33	744.67	0.16	2.70	28.889	31.111	32.889	35.407	28.67	29.75
413	176.5	515.38	14.12	372.33	744.67	0.16	2.70	29.926	30.815	34.222	36.444	29.25	30.18
413	176.5	501.26	28.24	372.33	744.67	0.16	2.70	30.815	31.852	34.815	37.333	29.50	30.55
413	176.5	487.14	42.36	372.33	744.67	0.16	2.70	31.259	32.889	35.556	38.222	29.81	30.91
413	176.5	473.02	56.48	372.33	744.67	0.16	2.70	29.333	30.963	32.296	35.259	28.41	29.69
413	0	706	0	372.33	744.67	0.00	2.70	23.111	26.667	27.852	33.333	26.39	28.87
413	0	691.88	14.12	372.33	744.67	0.00	2.70	24.000	26.370	32.593	31.852	28.54	28.22
413	0	677.76	28.24	372.33	744.67	0.00	2.70	29.778	31.556	32.741	33.333	28.61	28.87
413	0	663.64	42.36	372.33	744.67	0.00	2.70	30.222	30.667	34.074	35.111	29.19	29.63
413	0	649.52	56.48	372.33	744.67	0.00	2.70	25.778	26.222	27.556	29.185	26.25	27.01
450	896	0	0	380	760	0.79	2.53	29.185	36.889	43.556	47.556	33.00	34.48
450	672	224	0	380	760	0.59	2.53	34.074	37.333	44.889	50.074	33.50	35.38
450	672	206.08	17.92	380	760	0.59	2.53	36.296	38.519	46.222	52.593	33.99	36.26
450	672	188.16	26.88	380	760	0.59	2.53	37.778	40.148	48.000	53.778	34.64	36.67
450	672	170.24	40.32	380	760	0.59	2.53	38.222	40.444	49.185	54.963	35.07	37.07
450	672	152.32	53.76	380	760	0.59	2.53	35.852	37.481	43.852	52.444	33.11	36.21
450	448	448	0	380	760	0.39	2.53	33.778	38.222	46.667	52.000	34.16	36.06
450	448	430.08	17.92	380	760	0.39	2.53	35.111	38.815	47.407	54.815	34.43	37.02
450	448	412.16	35.84	380	760	0.39	2.53	35.556	40.000	49.630	57.037	35.22	37.76
450	448	394.24	53.76	380	760	0.39	2.53	36.000	40.444	50.074	59.111	35.38	38.44
450	448	376.32	71.68	380	760	0.39	2.53	34.222	39.111	40.444	48.889	31.80	34.96

V. RESULTS

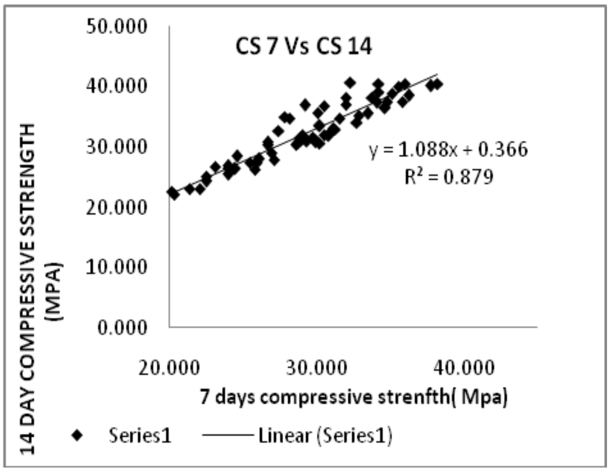

Fig. 1. Relation between 7 and 14 days compressive strength

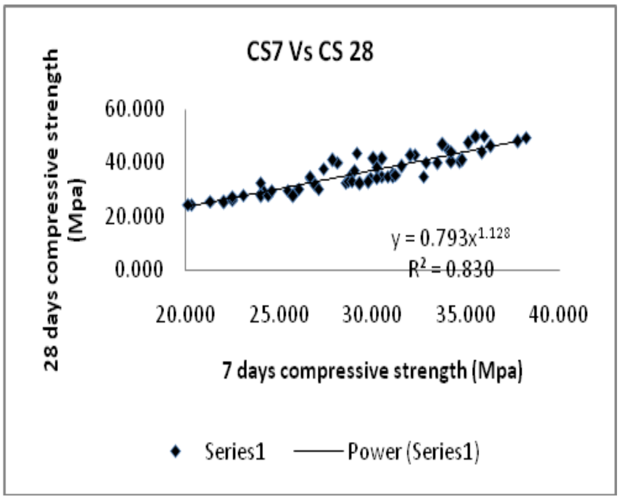

Fig .2. Relation between 7 and 28 days compressive strength

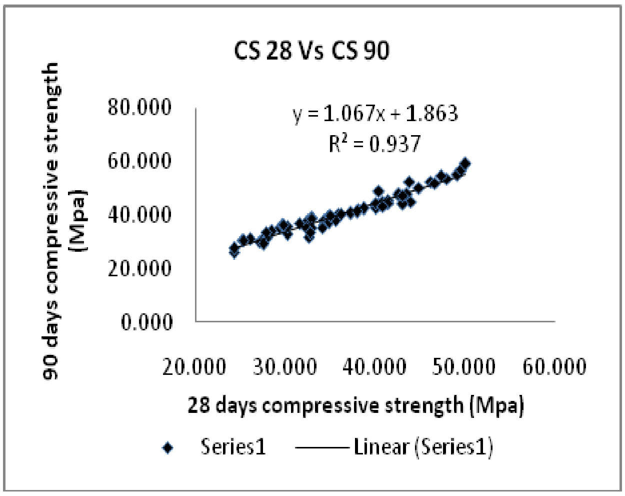

Fig.3. Relation of 28 days and 90 days compressive strength

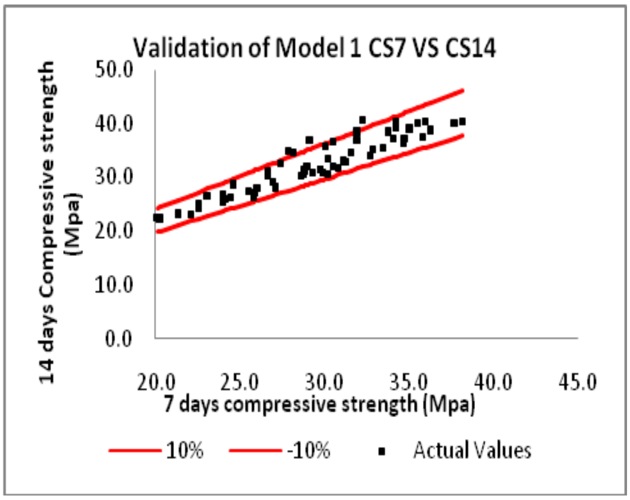

Fig. 4. Validation of Model 1 for 7days vs. 14 days compressive strength

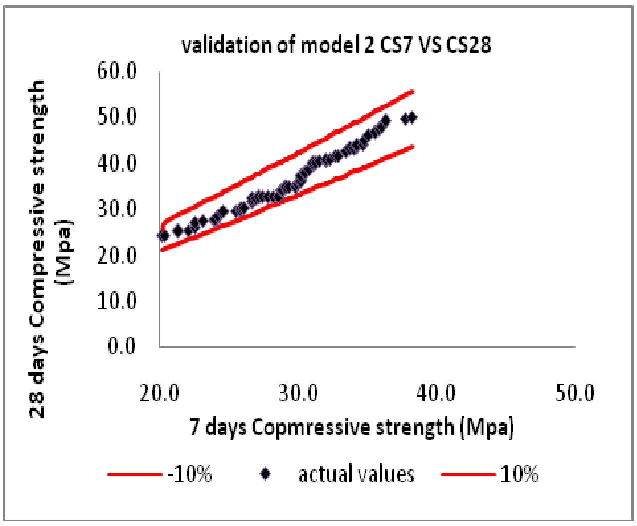

Fig. 5. Validation of Model 2 for 7days vs. 28days compressive strength

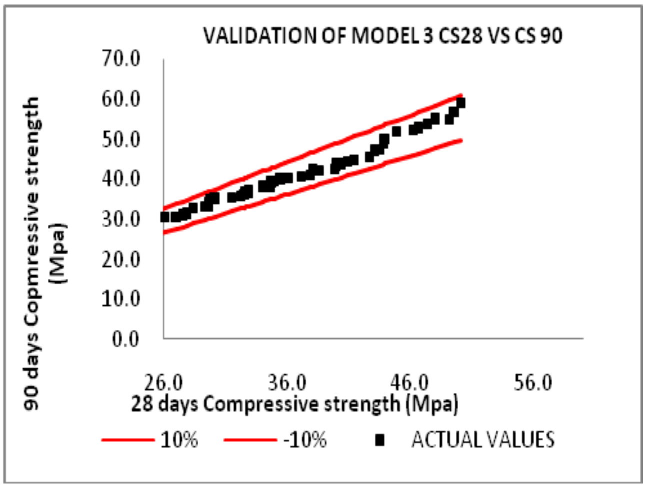

Fig. 6 .Validation of Model 3 for 28days vs. 90days compressive strength

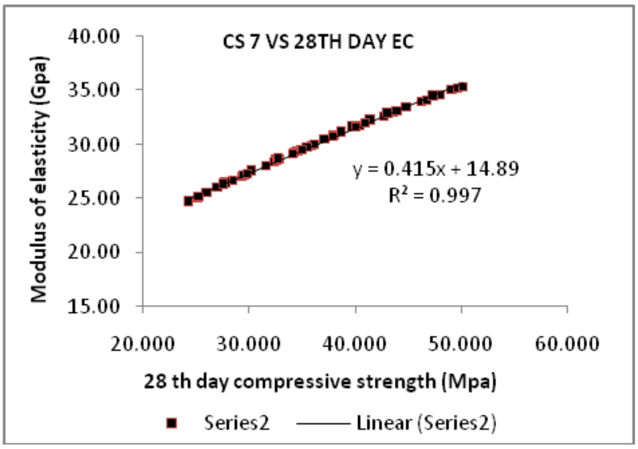

Fig.7. Relation between 7 Vs 28 days Modulus of Elasticity

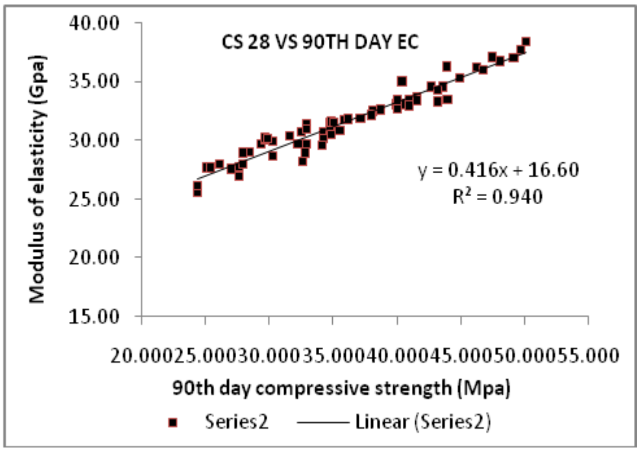

Fig. 8. Relation between 7 Vs 90 day Modulus of Elasticity

VI. CONCLUSION

1. The high values of correlation coefficient indicate that there is strong relationship between 7th day and 14th, 28th day compressive strength, similarly 28th day and 90th day compressive strength. Coefficient of correlation amongst compressive strength is (from 0.897 to 0.937).
2. From regression analysis and development of mathematical models considering 7,14,28,90 days compressive strength it is well concluded that there exist a relationship that can very well predict the compressive strength for the progressive days and the results lies within plus –minus 10 % of predicted values.
3. The modulus of elasticity at 28th day of the controlled concrete and modified concrete for M20 grade is found to be varying from 27.08 Gpa to 29.94 Gpa for the maximum value corresponding to 50% replacement of natural sand having 6% of waste plastic. For M30 it iis found to be 29.25 Gpa to the maximum of 31.97Gpa for the combination of 50% replacement whereas M40 grade follows the same pattern having the values varying from 33Gpa to 35.38 Gpa.
4. From the above study it is also concluded that the waste plastic(ldpe) used plays a significant role in enhancing the strength .
5. It can be concluded from the test results that the addition of alternative fine aggregate material such as quarry dust along with waste plastic in concrete can be a potential application for mass concreting works in order to reduce the river sand depletion.
6. Further it can be concluded that the utilization of dust along with waste plastics leads to eco friendly and economic construction.

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