Strength and Durability Properties of Concrete with Partially Replaced Cement with Egg Shell Powder and Fine Aggregate with Quarry Dust

A. Kanaka Ramya, A. V. Phani Manoj, G.T.N. Veerendra, P.Kodanda Rama Rao

Abstract- In present scenario concrete is highly consumed material in construction field due to its advantages, because of this the natural resources are depleting day by day at an alarming rate and there is an immediate need for finding alternate materials to the natural materials in concrete. In this paper an effort is made to find alternate partial replacement materials for cement and fine aggregate (FA). M40 grade concrete is adopted and the cement was replaced with egg shell powder with different percentages of 5%, 10% and 15%. The optimum percentage egg shell powder (ESP) is obtained at 10%. At optimum ESP the FA is replaced with Quarry Dust (QD) with percentages of 25%, 50%and75%. The maximum strength properties are obtained at 10% ESP and 50% QD and the concrete is also durable at 10% ESP and 50% QD with Water Cement Ratio is 0.38.

Key Words:-Egg Shell Powder (ESP), Quarry dust (QD), Cement, Fine aggregate, Coarse aggregate, Specific gravity (SG).

I. INTRODUCTION

Concrete is combination of various types of materials like cement, FA, CA and water. In the present world which is termed as concrete jungle the carbon dioxide release to atmosphere is increasing with natural resources depletion at same time, in order to address this issues the alternate partial replacement materials are to be found. In this paper an attempt is made to find alternate replacement materials.

A. Fine Aggregate

Table: 1 Physical Properties of cement

Material property	Tested value
Fineness	5%
Initial setting time	45 min
Final setting time	480 min
Specific Gravity	3.12

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II. CONCRETE MATERIALS AND THEIR PROPERTIES

B. A. Cement

OPC of Ultratech brand of 53 grade confirming to IS4031-1988.

S.no	Description	Natural Sand
1	Water Absorption	0.90%
2	Fineness Modulus	2.81
3	Specific Gravity	2.6

Table: 2 Physical Properties of FA

C. Coarse Aggregate

S.no	Material property	Coarse Aggregate
1.	Fineness Modulus	7.45
2.	Relative Density	2.80
3.	Water Absorption	0.6%

Table: 3 Physical Properties of CA

D. Egg Shell Powder

It is a natural source of calcium and other desired elements. In Egg hatcheries million tons of curing.

III. WATER

Fresh water was used for the purpose of egg shells are being produced. Most of the egg shells are used as landfills. The egg shells are collected from Hotels and are kept open to atmosphere at 32 degrees. Those dried egg shells are powdered in home mixtures. The powder sieved in 90µ sieve,

Figure1: ESP

Table: 4 Properties of ESP

S.no	Property	Tested Value
1.	SG	2.15
2.	Colour	White

E. Quarry Dust

The quarry dust is obtained after the rocks are crushed. The powdered rock is known as QD.

Figure2 : QD

Table5 : Physical properties of QD and FA

Property	QD	FA
Relative Density	2.7	2.6
Water Absorption	1.8	0.9
Fineness Modulus	3.035	2.81

IV. III .GLENIUM B233 (Chemical Admixture)

Glenium B233 increases the workability of the mix. It also offers higher resistance to carbonation and improves durability. So it used to get better results in terms of durability.

V. EXPERIMENTAL INVESTIGATION

In this experimental investigation egg shell powder was replaced with cement at different proportions and fine aggregate was replaced with quarry dust at different proportions. Strength and Durability properties were studied.

VI. MIX PROPORTIONS

1:1.61:2.87 mix ratio with a water-cement ratio of **0.38**. is fixed after many trails are made

Table6: Mix Proportion of Concrete

Cement (Kg)	FA (Kg)	CA (Kg)	W/C(lit)
430	692	1245.58	163.2

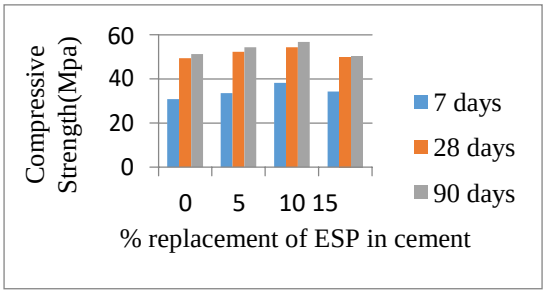
VII. RESULTS

A. Compressive strength

Table7: Compressive Strength of ESP Concrete ESP was replaced with cement for every

S.no	%Replacement Of ESP	Compressive Strength(N/mm^2)		
		7days	28 days	90 days
1	0	30.8	49.4	51.3
2	5	33.5	52.2	54.2
3	10	38.2	54.3	56.7
4	15	34.4	49.9	50.3

5% up to 15%. The optimum was attained at 10%. After 10% replacement of ESP percentage in cement the compressive strength reduced.



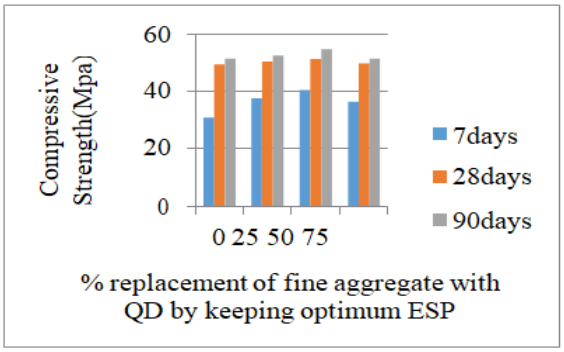
Graph1:Compressive Strength Vs % replacement of ESP in cement.

For 0% ESP the 90 days compressive strength was 51.3N/mm^2, 5% ESP was 54.2 N/mm^2, 10% ESP was 56.7N/mm^2 and for 15% ESP was 50.3 N/mm^2.

Table8: Compressive Strength of concrete when fine aggregate was replaced with quarry dust with Optimum ESP.

Optimum ESP(10 %)	Percentage Replacement of QD	Compressive Strength(N/mm^2)		
		7days	28 days	90 days
	0	30.8	49.4	51.3
	25	37.5	50.2	52.3
	50	40.4	51.2	54.6
	75	36.2	49.6	51.3

Fine aggregate was replaced with quarry dust at optimum ESP(10%). It was replaced for every 25% up to 75%. The optimum was attained at 50%. After 50% replacement of QD in Fine aggregate compressive strength reduced.



Graph2 :(Compressive Strength) v/s (%replacement of fine aggregate with QD by keeping optimum ESP)

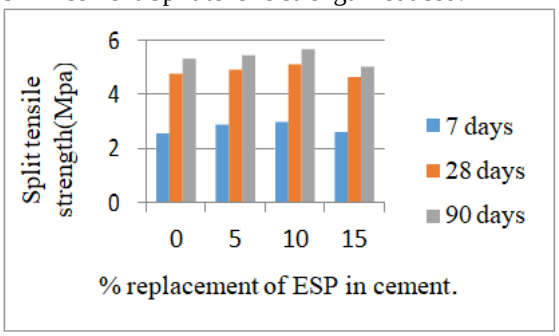
For 25% QD the 90 days Compressive strength was 52.3 N/mm^2, 50% QD was 54.6 N/mm^2 and 75% QD was 51.3N/mm^2.

B. Split tensile strength

S.no	% Replacement of ESP	Split Tensile Strength(N/mm^2)		
		7 days	28 days	90 days
1	0	2.5	4.7	5.3
2	5	2.8	4.9	5.4
3	10	2.9	5.1	5.6
4	15	2.6	4.63	5.0

Table9: Split Tensile Test of ESP Concrete

ESP was replaced with cement for every 5% up to 15%. The optimum was attained at 10%. After 10% replacement of ESP in cement Split tensile strength reduced.



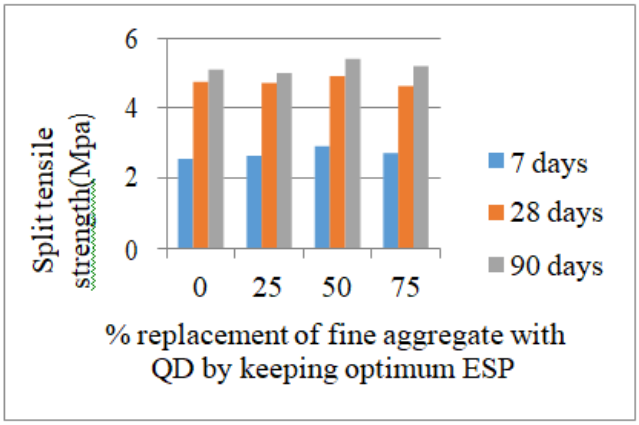
Graph 3: Split tensile strength v/s % replacement of ESP in cement.

For 0% ESP the 90 days split tensile strength was 5.3 N/mm^2, 5% ESP was 5.4 N/mm^2,10% ESP was 5.6N/mm^2 and for 15%. ESP was 5.0N/mm^2.

Optimum ESP(10%)	% Replacement of QD	Split Tensile strength(N/mm^2)		
		7 days	28 days	90 days
	0	2.5	4.75	5.1
	25	2.6	4.72	5.0
	50	2.9	4.9	5.4
	75	2.7	4.6	5.2

Table 10 :Split Tensile Strength of concrete when FA was replaced with quarry dust with Optimum ESP.

Fine aggregate was replaced with quarry dust at optimum ESP (10%). It was replaced for every 25% up to 75%. The optimum was attained at 50%. After 50% replacement of QD in Fine aggregate Split tensile strength reduced.



Graph4: Split tensile Strength v/s % replacement of fine aggregate with QD by keeping optimum ESP.

For 25% QD the 90 days Split tensile strength was 5.0 N/mm^2,50% QD was 5.4 N/mm^2 and 75% QD was 5.2 N/mm^2

A. Flexural strength

Table 11: Flexural Strength of the ESP Concrete ESP was replaced with cement for every

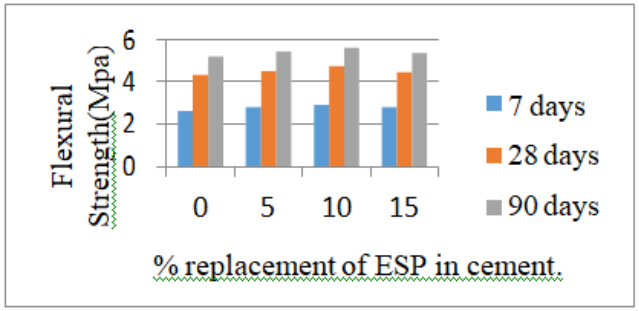
S.no	Percentage Replacement of ESP	Flexural Strength (N/mm^2)		
		7 days	28 days	90 days
1	0	2.6	4.3	5.2
2	5	2.8	4.5	5.4
3	10	2.9	4.7	5.6
4	15	2.7	4.4	5.3

5% up to 15%. The optimum was attained at 10%. After 10% replacement of ESP in cement Flexural Strength reduced. For 25% QD the 90 days Flexural strength was 5.3N/mm^2,50% QD was 5.6 N/mm^2 and 75% QD was 5.4N/mm^2.

VIII. DURABILITY PROPERTIES Acid Resistance

The specimens are tested for age of 90 days. The cubes were cured in acidic environment by adding different proportions of H_2SO_4 to normal water and cubes were tested for strength properties and the results were tabulated.

A. Durability test with H_2SO_4 Solution



Graph 5: Flexural strength v/s % replacement of ESP in cement.

For 0% ESP the 90 days Flexural strength was 5.2N/mm^2, 5% ESP was 5.4 N/mm^2,10% ESP was 5.6N/mm^2 and for 15% ESP was 5.3N/mm^2.

Figure3: H_2SO_4

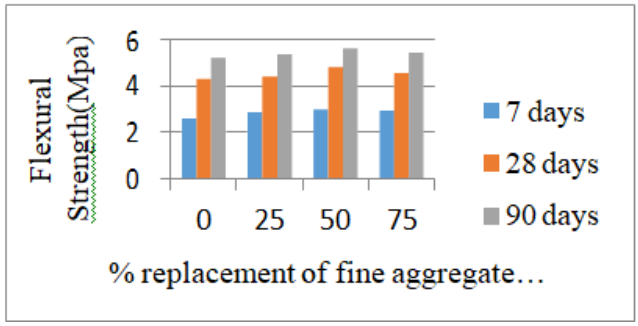
Solution.

Optimum ESP(10 %)	Percentage replacement of QD	Flexural Strength(N/mm^2)		
		7 days	28 days	90 days
	0	2.6	4.3	5.2
	25	2.8	4.3	5.3
	50	2.9	4.8	5.6
	75	2.9	4.5	5.4

Table 12: Flexural Strength of concrete when FA was replaced with QD with Optimum ESP.

Fine aggregate was replaced with quarry dust at optimum ESP(10%). It was replaced for every 25% up to 75%. The optimum was attained at 50%. After 50% replacement of QD in Fine aggregate Flexural strength reduced.

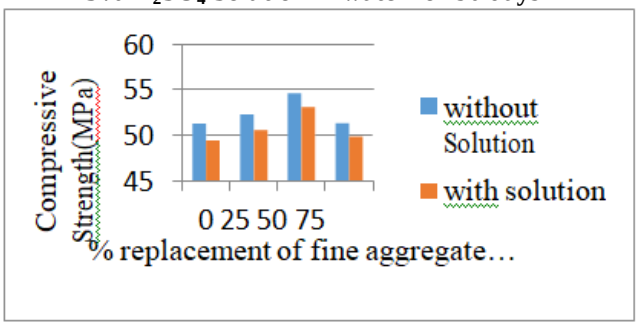
S.no	Optimum ESP	10% ESP and QD	% Weight loss after 90 days	Compressive Strength (N/mm^2)	
				Without olution	With Solution
1		0	2.34	51.3	49.4
2		25	2.32	52.3	50.5
3		50	2.2	54.6	53.0
4		75	1.9	51.3	49.8



Graph 6: Flexural strength v/s % replacement of fine aggregate with QD by keeping optimum ESP.

S.no	Optimum ESP	10% ESP and QD	% Weight loss after 90 days	Compressive Strength (N/mm^2)	
				Without olution	With Solution
1		0	2.34	51.3	49.4
2		25	2.32	52.3	50.5
3		50	2.2	54.6	53
4		75	1.9	51.3	49.8

Table: 13 Compressive Strength of concrete when cured with 3% H_2SO_4 Solution in water for 90 days



Graph7:Compressive Strength V/s % replacement of fine aggregate with QD by keeping optimum ESP.

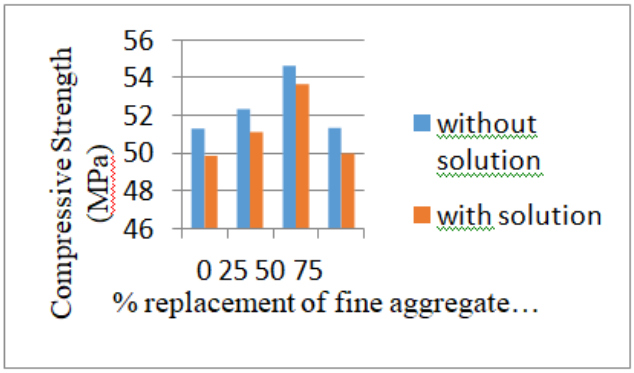
When cubes were induced in H_2SO_4 Solution the results was occur at 25% gives the 90 days compressive strength was 50.5 N/mm^2,50% strength was 53.0 N/mm^2 and 75% strength was 49.8 N/mm^2.

B. Durability test with HCL Solution

Figure: 4 HCL Solutions.

S.no	Optimum ESP	10% ESP and QD	% Weight loss after 90 days	Compressive Strength (N/mm^2)	
				Without Solution	With Solution
1		0	1.7	51.3	49.8
2		25	1.6	52.3	51.1
3		50	1.5	54.6	53.6
4		75	2.0	51.3	49.9

Table: 14 Compressive Strength of concrete when cured with 3% HCL Solution in water for 90 days



Graph 8: Compressive strength v/s % replacement of fine aggregate with QD by keeping optimum ESP.

When cubes were induced in HCL Solution the strength was occur at Optimum ESP, when QD was replaced with fine aggregate at 25% gives the 90 days compressive strength was 51.1 N/mm^2,50% strength was 53.6 N/mm^2 and 75% strength was 49.9 N/mm^2.

Figure 8: Specimens with Solutions

IX. CONCLUSIONS

In this experimental study by replacing cement with Egg Shell Powder and Fine aggregate with Quarry dust was studied. From the obtained results we can conclude the following.

1) By replacing 10% of Egg Shell Powder with binder, maximum compressive strength can be achieved which is 56.72 N/mm$^{2.}$ for 90 days.
2) The percentage increase when compared with normal mix is 9.6% which fetch a higher potential for replacing.
3) The maximum split tensile strength is obtained at replacement of 10% Egg Shell Powder which is 5.65 N/mm^2 for 90 days.
4) There is an increase of 6.2% when compared with normal mix. It was further noticed that increase in percentage of replacement can reduce strength.
5) The maximum flexural strength attained at replacement of 10% Egg Shell Powder for 28 days is 5.6 N/mm$^{2.}$. An increase of 7.2% is noticed in comparison with normal mix.
6) The maximum compressive strength of mix when replaced with 10% of Egg Shell Powder and 50% of QD with fine aggregate is 54.62 N/mm^2. There is an increase of 6.07% when compared with normal mix.
7) The percentage increase in split tensile strength is 5.5% when 10% of Egg Shell Powder is replaced in cement and 50% of QD is replaced in FA when compared with normal mix.
8) The flexural strength is increased by 7.1% when 10% of Egg Shell Powder is replaced in cement and 50% of QD is replaced in FA when compared with normal mix.
9) The durability of 10% ESP and 50% QD replaced concrete under sulphate is higher than conventional concrete. For H_2SO_4 immersed solution the strength properties for 10% ESP and 50% QD replaced concrete is higher.
10) The durability of 10% ESP and 50% QD replaced concrete under chloride is higher than conventional concrete. For HCL immersed solution the strength properties for 10% ESP and 50% QD replaced concrete is higher.
11) The combination of 10% ESP and 50% QD is yielding better results.

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