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Study on Structural Properties of Concrete by Partial Replacement of Fly Ash and Quarry Dust

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Abstract

This research study presents the strength variations of concrete when replacing fine aggregate by quarry dust and cement by fly ash from 0%, 20%, 30%, 40% and 50% in step by step. For this study M25 grade of concrete are used. The experimental study of compressive strength of fly ash concrete cubes at age of 7, 14 and 28 days are taken at room temperature. Also, the split tensile strength of fly ash concrete cylinders was found at the age of 14 and 28 days. The flexural strength of the concrete beams is cured by water at 28 days. Following that the admixture of casein protein was added in fly ash and quarry dust concrete specimens while casting process. In this study the advanced method of chloride penetration method (RCPT) was conducted for the fly ash and quarry dust concrete. Finally, this study shows the structural properties like compressive strength, split tensile strength and flexural strength of fly ash and quarry dust concrete at various percentage of replacements and also describes the advanced testing of chloride permeability of concrete at 0% to 50% replacement of fly ash and quarry dust.

Keywords: Fly ash; Quarry dust; RCPT; Compressive strength

Introduction

Concrete is a most important material in construction field. Concretes are the composite materials and its composites of coarse aggregate, fine aggregate and bonded with cement. In concrete the Portland cements is most common material in general usage of concrete. Now a day’s the requirements of construction materials are high so that the lagging of cements and other raw materials are high. To avoid this type of problems in constructions means to improve the usage of alternative construction materials in construction fields.

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Fly ash is the most common and well known alternative material in concrete. Fly ash is a coal combustion product and it's composed of fine particles from the boiler with fuel gases [1-4]. These are the substitute material for the portland cement. Fly ash improves the workability and reduces the greenhouse gases. It will applicable for concrete structures and also the brick works, wall constructions etc.

Quarry dust consists of finely crushed rocks. This is also one of the alternative materials in construction side. It should be used as a fine aggregate in a concrete [5-7]. These are partially replaced at certain percentages in concrete. It will act as a filler material. Quarry dusts are additionally or partially added into the concrete means it will improve the quality of concrete and also to improve the workability of concrete (FIG. 1-9). It won't affect the properties of conventional concrete [8,9]. If fly ash and quarry dusts are partially replaced in concrete up to 50% means it improve the strength of the fly ash concrete and also this is one of the way to detect the problems placed in construction side lack of raw materials (TABLES 1-8).

Material and Methods

Super plasticizer

Casein protein: In this work casein protein was added to the concrete to reduce water cement ratio this increases durability of concrete.

TABLE 1. **Properties of materials.**

Property	Experimental Results
Fineness of Cement	10%
Specific Gravity of Cement	3.25
Initial setting time	31.30 Minutes
Final setting time	650 Minutes
Standard consistency	31%
Specific Gravity of Fly ash	2.81
Specific Gravity of Fine aggregate	2.7
Specific Gravity of Quarry dust	2.65

Experimental Results

Compressive strength

FIG. 1. **Compressive strength Test of FA and QD Cube.**

TABLE 2. **Compressive strength of FA and QD cubes.**

% of FA & QD	Compressive strength in N/mm^2		
	7 th day	14 th day	28 th day
0	13.6	20.4	24.3
20	12	18.2	27.1
30	19.7	20.5	23.3
40	25	29.4	34.7
50	21.9	34.6	40.3

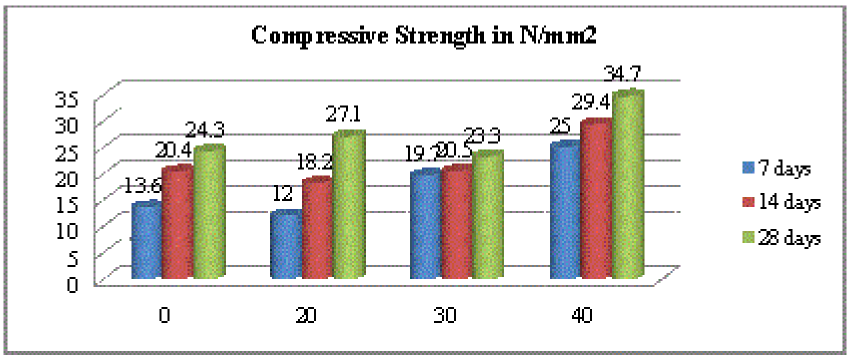

FIG. 2. **Compressive strength for FA and QD.**

TABLE 3. **Compressive strength of FA and QD cubes with admixture.**

% of FA & QD	Proteins %	Compressive strength in N/mm^2		
		7 th day	14 th day	28 th day
0	0.5	19.2	22.3	25.9
20	0.5	20.6	23.6	37.8
30	0.5	18.9	27.1	38
40	0.5	23.2	25.2	39
50	0.5	19.5	30.1	42.3

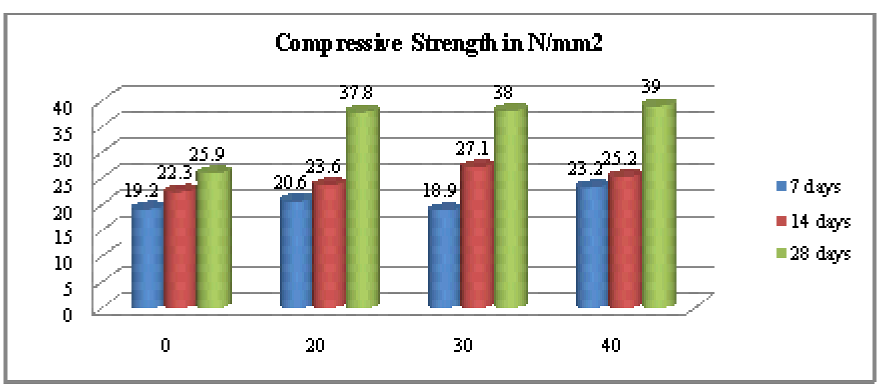

FIG. 3. **Compressive strength for FA and QD with admixture (0.5%).**

Split tensile strength

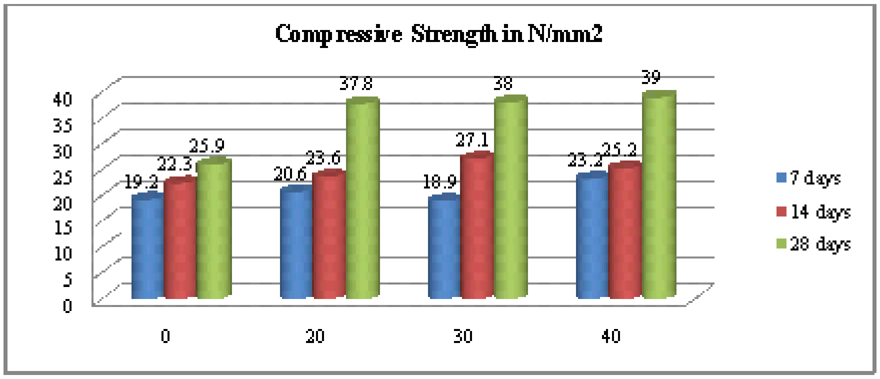

FIG. 4. **Split Tensile Strength for FA & QD.**

TABLE 4. **Split tensile strength of FA & QD specimen.**

% of FA & QD	**Curing days**		**Split tensile strength(N/mm^2)**	
	14 days	**28 days**	**14 days**	**28 days**
0	179	197	2.39	2.69
20	148	201	2.06	2.8
30	169	210	2.39	2.91
40	161	220	2.23	3.09
50	193	237	2.72	3.31

TABLE 5. **Split tensile strength of FA and QD specimen with admixture.**

% of FA & QD with admixture	**Curing days**		**Split tensile strength(N/mm^2)**	
	14 days	**28 days**	**14 days**	**28 days**
0	235	286	3.27	3.97
20	229	291	3.28	4.08
30	243	318	3.39	4,45
40	257	323	3.61	4.53
50	199	247	3.24	3.42

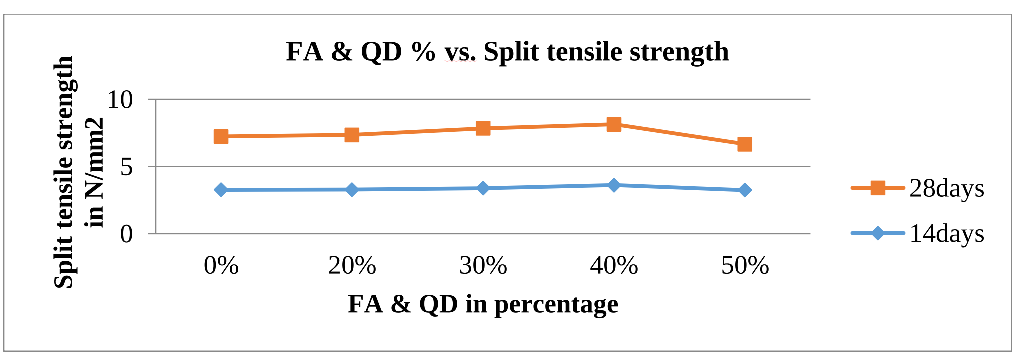

FIG. 5. **Split tensile strength for FA and QD.**

Flexural strength

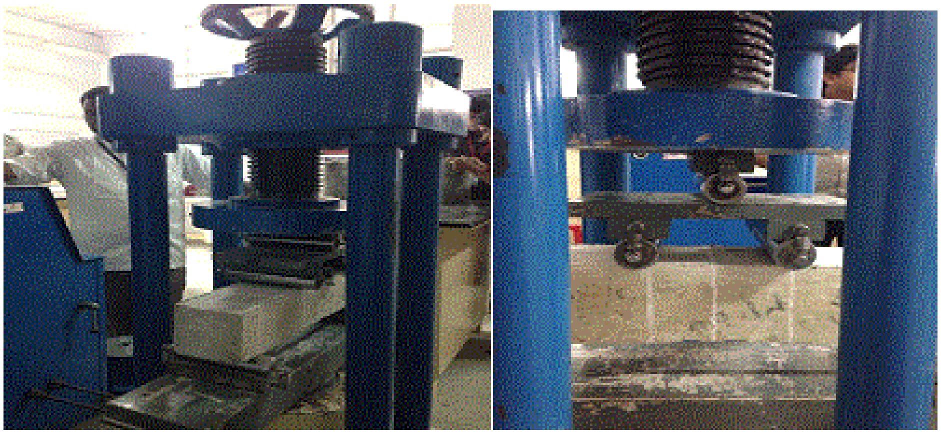

FIG. 6. **Flexural Strength for FA and QD beam.**

TABLE 6. **Flexural strength of FA and QD beam.**

% of FA & QD	Load(KN)			Flexural Strength (N/mm^2)
	Trial 1	Trial 2	Trial 3	
0	12	10	11	4.4
20	16	12	14	5.6
30	15	17	16	6.4
40	13	16	14.5	5.8
50	14	17	15.5	6.2

Rapid Chloride Permeability Test (RCPT)

FIG. 7. **Rapid chloride permeability test for FA and QD Specimen.**

TABLE 7. **RCPT current values after 28 days.**

Time (min)	Current values in mA				
	0%	**20%**	**30%**	**40%**	**50%**
0	78	107	96	164	140
30	87	115	114	168	144
60	92	122	117	172	147
90	94	135	121	179	149
120	97	143	124	182	158
150	100	149	126	185	167
180	101	153	129	189	169
210	107	155	131	190	170
240	111	141	133	195	190
270	114	168	133	199	210
300	117	168	134	207	224
330	120	170	133	211	239
360	121	171	137	212	241

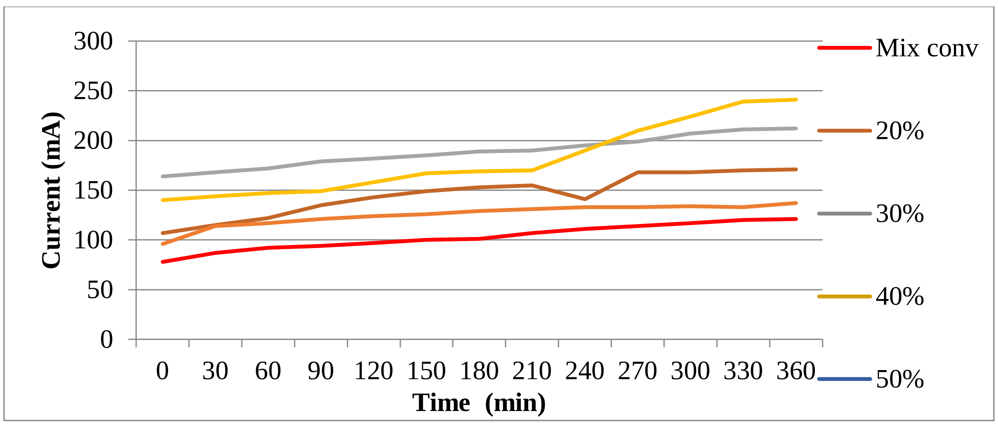

FIG. 8. **RCPT current values after 28 days.**

TABLE 8. **RCPT charge flow (Q) in coulomb (C) through the concrete specimen after 28 days.**

Mix	Charge flow (Q) in Coulomb (C)
Mix CON	2231.1
20%	3883.5
30%	1881.9
40%	4823.1
50%	4030.2

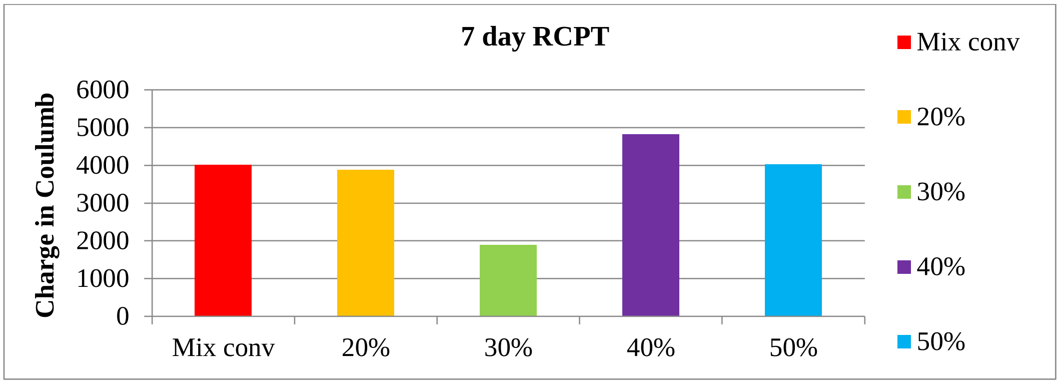

FIG. 9. **The flow of charge passed in coulombs through the mixes.**

Conclusions

- From the results the compressive strength of the fly ash and quarry dust concretes are high compare to conventional concrete
- The strength should be increase up to more than 65%.
- The maximum compressive strength was obtained at the 50% replacement of FA and QD.
- The split tensile strength should be increase up to more than 46%
- The maximum Tensile strength was obtained at the 50% replacement of FA and QD and 40% while adding the admixture.
- The percentage increase in flexural strength is 17.54% when compared with conventional concrete.
- In RCPT test the minimum charge flow obtained at 30% replacement of cement and fine aggregate.
- Maximum charge flow obtained the fly ash specimen was 4823.1 at 40% of replacement.

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