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Effect of Quarry Dust and Fly Ash Mix on strength properties of M40 grade Concrete

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Abstract— this paper presents the variation in the strength of concrete when replacing sand by quarry dust and also effect of inclusion of Fly Ash with the addition Quarry Dust. Slump cone test, carried out on fresh concrete to check the workability while compressive strength, flexural strength, split tensile strength was carried out on hardened concrete. The reduction in the sources of natural sand and the requirement for reduction in the cost of concrete production has resulted in the increased need to identify substitute material to sand as fine aggregates in the production of concretes. In such a situation the Quarry dust can be an economic alternative to the river sand. The study analyses the effect on strength characteristics by various % of quarry dust as a replacement of natural sand in M40 grade concrete and also the combination of various % of quarry dust and Fly ash as a replacement of natural sand and cement in M40 grade concrete. Natural sand is replaced by quarry dust with 0%, 15%, 35%, 55%, and 75% and in combination Natural sand is replaced by quarry dust with 0%, 15%, 35%, 55%, 75% & Cement replaced by fly ash with 0%, 5%, 10%, 15% and 20%. Compressive strength, split tensile strength, and flexural strength were conducted according to Indian standard code procedure. The effect of % of Quarry dust and fly ash in cement concrete is studied in detailed. Test results for each variation are tabulated and discussed in details and some important conclusions are made.

Keywords— Natural Sand, Quarry Dust, Fly Ash, Workability, Compressive strength, Split tensile strength, Flexural strength.

INTRODUCTION

Basic Ingredients of Conventional concrete are cement, sand and aggregate. Natural sand derived from river banks is mostly used as fine aggregate. Common river sand is expensive due to the excessive cost of transportation from natural sources. Also large-scale depletion of these sources creates environmental problems [1]. The reduction in the sources of natural sand and the requirement for reduction in the cost of concrete production has resulted in the increased need to identify substitute material to sand as fine aggregates in the production of concretes. In such a situation the dust can be an economic alternative to the river sand. Fly Ash which is a waste material can be used as filler material and helps reduce total voids content in concrete. The decrease in early Strength by the addition of fly ash is compensated by addition of quarry dust also decrease in workability of concrete due to addition of Quarry dust can be improved by addition of Fly ash[2]

MATERIALS USED & METHODOLOGY

A. *Cement:*

An ordinary Portland cement (opc 53 grade) was used.

B. *Fly Ash*

Class F fly ash was used

C. Natural sand

Natural river sand passing through 4.75 mm was used as fine aggregate and was tested following Is: 383-1970. The sand conformed to zone II

D. Aggregate

The aggregates were selected based on the limitation of IS 881 and 882 and the aggregate was 20 mm and 12.5 mm crushed granite. In the proportion of 60:40 percentage

E. *Quarry Dust*

Quarry dust is collected from local stone crushing units of Ahmednagar, Maharashtra. The physical properties of Quarry dust obtained by testing the sample as per IS standard

F. *Water*

Potable tap water available in lab was used for casting and curing of concrete

G. *Admixture*

Commercially available super plasticizer is used

The physical properties of natural, coarse aggregate and quarry dust are mentioned in Table no I

TABLE NO I: PHYSICAL PROPERTY OF AGGREGATES

SR. NO	PROPERTY	RESULT FOR SAND	RESULT FOR QUARRY DUST	RESULT FOR COARSE AGGREGATE
1	Particle Shape	Round	Flaky	Flaky
2	Fineness Modulus	3.177	2.23	2.65
3	Specific Gravity	2.67	2.97	3.39
4	Bulk density	1793 Kg/m3	1893 Kg/m^3	1603 Kg/ mm^3
5	Surface moisture	Nil	Nil	Nil
6	Crushing value	-	-	15.9%
7	Impact value	-	-	6.67%

h. *Mix Proportioning:*

The mix design is done according to the IS design method
M 40 Grade concrete having mix proportion 1:1.707:3.62 was used with 0.4 W/ C ratios

h. Concrete Mixes

In this study, the early age properties of fresh concrete and mechanical performance and tensile strength of hardened concrete were examined. All tests were conducted using the following sample groups:

1. Conventional concrete,
2. Sand is replaced by Quarry dust with 15%, 35%, 55% and 75%.
3. Replacement of sand by Quarry dust and cement by Fly Ash together for various % that is (15%QD+5%FA, 35%QD+10%FA, 55%QD +15%FA and 75%QD +20% FA).
3. Each of the above samples was tested for compressive strength, split tensile strength and workability tests.

The compressive, split tensile strength and flexural strength test on hardened concrete were performed on Universal testing machine. Concrete cubes of size 150×150×150mm were cast. Total 81 cubes were casted for determination of compressive strength. Compressive strength of concrete cubes was tested at 3 days, 7 days and 28 days. Total 27 concrete cylinders were casted for determination of split tensile strength and tests were taken at 28 days. Total 27 beam specimens were casted to determine flexural strength and the beam specimens were tested at 28 days.

RESULTS & DISCUSSION

A. Workability:

Various mixes of freshly mixed concrete were tested for workability by slump value. It was observed that, the workability decreases with increase in Quarry dust content in the mix. The mix with cement as the only binder, the workability was medium. As per the table below it shows that there is in increase in workability with the inclusion of Fly ash

TABLE NO II: WORKABILITY OF CONCRETE MIX

SR. NO.	QUARRY DUST CONTENT	FLY ASH CONTENT	SLUMP OF CONCRETE
1.	0%	0%	95mm
2	15%	0%	89mm
3	35%	0%	78mm
4	55%	0%	67mm
5	75%	0%	55mm
6	15%	5%	93mm
7	35%	10%	86mm
8	55%	15%	78mm
9	75%	20%	70mm

B. compressive strength:

Various mixes of concrete were tested for compressive test. Max compressive strength value at 28th day is obtained at 15% replacement of sand by QD is 45.18 Mpa. Compressive strength with 35% replacement of sand by quarry dust is 43.97 Mpa nearly equal to the compressive strength of CC which is 44.05 Mpa. And for the combination of Quarry Dust and Fly Ash, max compressive strength obtained at 15% QD and 5% FA is 44.78 Mpa.

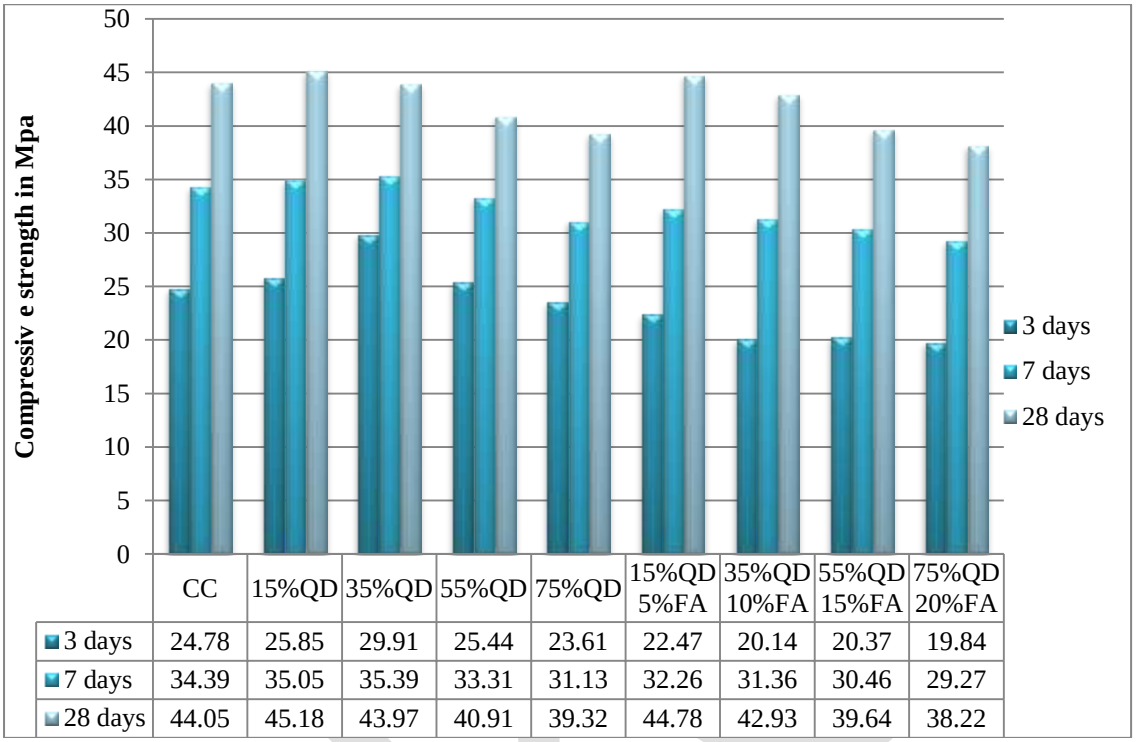
TABLE. NO III: 3, 7, 28 DAYS COMPRESSIVE STRENGTH OF CONCRETE MIX

SR. NO.	SAND REPLACEMENT BY QUARRY DUST	CEMENT REPLACEMENT BY FLY ASH CONTENT	3DAYS COMPRESSIVE STRENGTH (N/MM^2)	7DAYS COMPRESSIVE STRENGTH (N/MM^2)	28DAYS COMPRESSIVE STRENGTH (N/MM^2))
1	0%	0%	24.78	34.39	44.05
2	15%	0%	25.85	35.05	45.18
3	35%	0%	29.91	35.39	43.97
4	55%	0%	25.44	33.31	40.91
5	75%	0%	23.61	31.13	39.32
6	15%	5%	22.47	32.26	44.78
7	35%	10%	20.14	31.36	42.93
8	55%	15%	20.37	30.46	39.64
9	75%	20%	19.84	29.27	38.22

TABLE NO IV: COMPARISION OF 28 DAYS COMPRESSIVE STRENGTH OF THE CUBES CASTED FOR CC & VARIOUS REPLACEMENT % OF QD AND COMBINATION OF QD AND FA.

SR. NO.	REPLACEMENT OF SAND BY Q.D. (%)	COMPRESSIVE STRENGTH OF 28 DAYS (MPA)	REPLACEMENT OF SAND BY Q D.AND CEMENT BY FA (%)	COMPRESSIVE STRENGTH OF28 DAYS (MPA)
1	0%	44.05	0%	44.05
2	15%	45.18	15%QD5%FA	44.78
3	35%	43.97	35%QD10%FA	42.93
4	55%	40.91	55%QD15%FA	39.64
5	75%	39.32	75%QD20%FA	38.22

Fig no 1 present the 3, 7, 28 days compressive strength for various proportions of mixes. 3 days and 7 days compressive strength is max for 35% QD and 28 days compressive strength is max for 15% QD content from the fig it is also observed that with the addition of fly ash or increase in % of FA causes decease in compressive strength

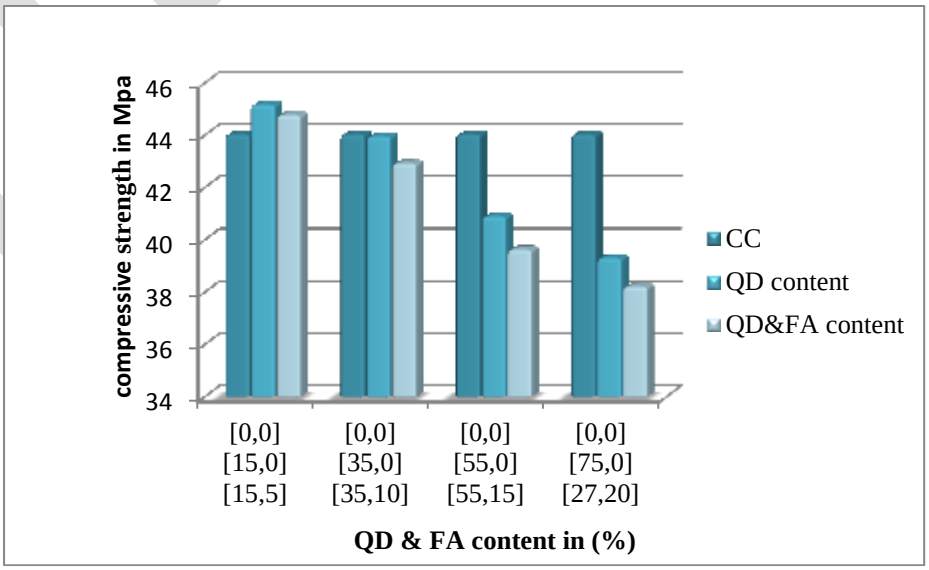


	CC	15%QD	35%QD	55%QD	75%QD	15%QD 5%FA	35%QD 10%FA	55%QD 15%FA	75%QD 20%FA
3 days	24.78	25.85	29.91	25.44	23.61	22.47	20.14	20.37	19.84
7 days	34.39	35.05	35.39	33.31	31.13	32.26	31.36	30.46	29.27
28 days	44.05	45.18	43.97	40.91	39.32	44.78	42.93	39.64	38.22

CC-Conventional concrete, QD- Quarry Dust, FA- Fly Ash

Fig no 1: 3, 7, 28 days compressive strength of the cubes casted for CC, various % of QD and combination of QD and FA.

Fig. 2 shows the comparison of 28 days compressive strength for various proportion which indicate that as the Quarry dust content increases compressive strength decreases still the compressive strength of 15%QD and combination of (15%QD & 5%FA) content is max as compare to conventional concrete



CC-Conventional concrete, QD- Quarry Dust, FA- Fly Ash

Fig NO 2: Comparison of 28 days compressive strength of the cubes casted for CC Various % of QD and Combination of QD and FA.

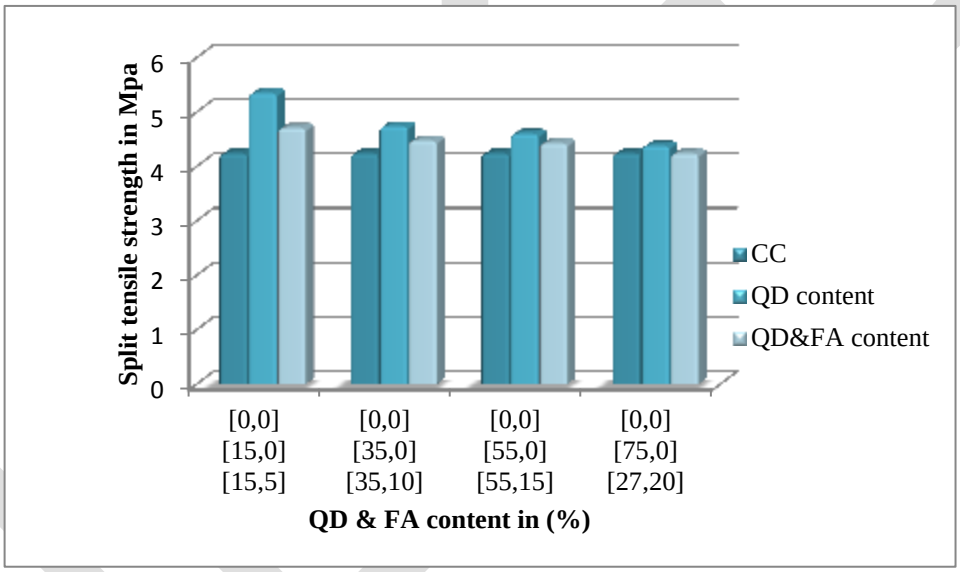
C Split tensile strength:

Various mixes of concrete were tested for compressive test. It was observed that, the workability decreases with increase in

TABLE NO V: COMPARISON OF 28 DAYS SPLIT TENSILE STRENGTH OF THE CUBES CASTED FOR CC AND VARIOUS % OF QD .AND COMBINATION OF QD AND FA

SR. NO.	REPLACEMENT OF SAND BY Q.D. (%)	SPLIT TENSILE STRENGTH OF CC (MPA)	REPLACEMENT OF SAND AND CEMENT BY Q.D AND FA (%)	SPLIT TENSILE STRENGTH (MPA)
1	0%	4.24	0%	4.24
2	15%	5.35	15%QD5%FA	4.71
3	35%	4.74	35%QD10%FA	4.48
4	55%	4.60	55%QD15%FA	4.43
5	75%	4.38	75%QD20%FA	4.24

Fig.3 shows the comparison of 28 days split tensile strength for various proportion which indicate that as the Quarry dust content increases Split tensile strength decreases still the split tensile strength of up to 75%QD and combination of (55%QD &15%FA) content is max as compare to conventional concrete



CC-Conventional concrete, QD- Quarry Dust, FA- Fly Ash

Fig. no 3: 28 days Split tensile strength of the cubes casted for CC and Various % of QD and FA.

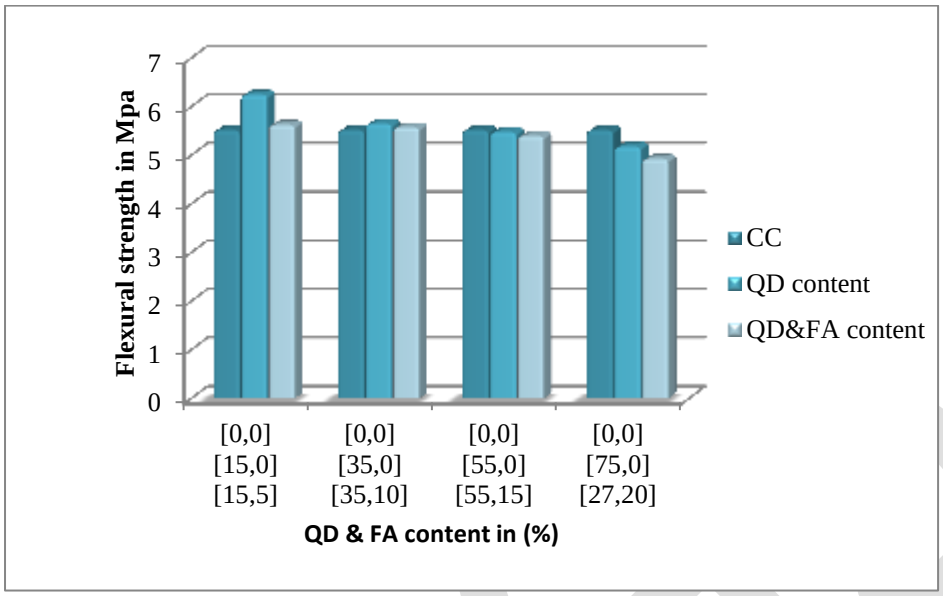
D Flexural strength:

Various mixes of concrete were tested for compressive test. It was observed that, the workability decreases with increase in

TABLE NO VI: COMPARISON OF 28 DAYS FLEXURAL STRENGTH OF THE CUBES CASTED FOR CC AND VARIOUS % OF QD. AND COMBINATION OF QD AND FA

SR. NO.	REPLACEMENT OF SAND BY Q.D. (%)	FLEXXURAL STRENGTH OF CC (MPA)	REPLACEMENT OF SAND AND CEMENT BY Q.D AND FA (%)	FLEXURE TEST RESULT (MPA)
1	0%	5.52	0%	5.52
2	15%	6.25	15%QD5%FA	5.63
3	35%	5.65	35%QD10%FA	5.58
4	55%	5.48	55%QD15%FA	5.40
5	75%	5.18	75%QD20%FA	4.93

Fig.4: shows the comparison of 28 days Flexural strength for various proportion which indicate that as the Quarry dust content increases Flexural strength decreases still the Flexural strength up to 35% QD and combination of (35% QD &10% FA) content is max as compare to conventional concrete



QD- Quarry Dust, FA- Fly Ash, CC- conventional concrete

Fig. no 4: 28 days Flexural strength of the cubes casted for CC and Various % of QD and FA

CONCLUSION

- As the sand is not available or use of sand creates environmental problems need to find alternative material. Quarry dust is a waste material from stone crusher plant as per physical properties of Quarry dust, it is a suitable substitute for sand at very low cost.
- QD and FA are the waste material so as per the environmental impact view use of waste material is helpful to maintain effective sustainable development
- From the above result it is concluded that use of QD causes decrease in workability but addition of fly ash is useful to improve workability and also loss in early strength due to fly ash can be improved by the use of QD. So it is beneficial to use both materials together.
- Optimum percentage of QD for max values for various strength in cement concrete is 15%. Even though sand can be replaced up to 35% quarry dust
- Optimum percentage of combination of QD and FA for max values of various strength in concrete is 15% QD and 5%FA.
- For the split tensile strength result up to75%QD shows greater strength than CC As compare to all characteristics strengths max replacement of QD can be possible to achieve split tensile strength when it is compared with CC
- Hence as per the results obtained, it can be suggested that use of quarry dust as a replacement for sand will be beneficial.

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