Experimental Study on Concrete Mixes by Concurrent use of Fly Ash and Quarry Dust

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***Abstract* - The use of fly ash in concrete is desirable because of benefits such as useful disposal of a byproduct, increased workability, reduction of cement consumption, increased sulfate resistance, increased resistance to alkali-silica reaction and decreased permeability. However, the use of fly ash leads to a reduction in early strength of concrete. The use of quarry dust in concrete is desirable because of benefits such as useful disposal of a byproduct, reduction of river sand consumption, and increased strength. However, the use of quarry dust leads to a reduction in the workability of concrete. Therefore, the concurrent use of quarry dust and fly ash in concrete will lead to the benefits of using such materials being added and some of the undesirable effects being negated. The increase in workability by the addition of quarry dust is reduced by the addition of fly ash. The concurrent use of the two byproducts will lead to a range of economic and environmental benefits.**

Keywords – Fly Ash, Quarry Dust, sulfate resistance, alkali-silica reaction, the concurrent use of quarry dust and fly ash

1. INTRODUCTION

Concrete is the most popular building material in the world. However, the production of cement has diminished the limestone reserves in the world and requires a great consumption of energy. River sand has been the most popular choice for the fine aggregate component of concrete in the past, but overuse of the material has led to environmental concerns, the depleting of securable river sand deposits and a concomitant price increase in the material. Therefore, it is desirable to obtain cheap, environmental friendly substitutes for cement and river sand that are preferably byproducts. Fly ash (pulverized fuel ash) is used extensively as a partial replacement of cement. More fly ash may also be produced worldwide in the future with the establishment of many coal power plants. However, though the inclusion of fly ash in concrete gives many benefits, such inclusion causes a significant reduction in early strength due to the relatively slow hydration of fly ash. Nevertheless, fly ash causes an increase in workability of concrete. Quarry dust has been proposed as an alternative to river sand that gives additional benefit to concrete. Quarry dust is known to increase the strength of concrete over concrete made with equal quantities of river sand, but it causes a reduction in the workability of concrete. When examining the above qualities of fly ash and quarry dust it becomes apparent that if both are used together, the loss in early strength due to one may be alleviated by the gain in strength due to the other, and the loss of workability due to the one may be partially negated by the improvement in workability caused by the inclusion of the other. This paper is generated from a research project designed to determine whether such benefits could be obtained by the use of these two materials together, and to quantify such benefits. Positive results will lead to the possibility of using the two byproducts in large quantities, while reducing the dependency on chemical admixtures.

1.1 BACKGROUND OF THE STUDY

Now-a-days, India is one of the fast growing countries. That develops lot of invention and innovation in the technology. For example Mumbai skyline world trade centre, Ruby tower, longest railway bridge and also that smart tunnels are the symbolic of India for its construction development. In term of engineering technology, India also produce lots of engineer's researches and create lots of implementations regarding to the technology in construction industry. Then Indian government spent 50% of money for construction based works, like roads, bridges, power plants, dams etc.,

1.2 PROBLEM STATEMENT

Cement, river sand is the basic components of concrete. The cost of cement, river sand is increasing due to the high demand on the construction industry. Further more if using the cement, literate sand as the material in concrete the cost becomes extremely high.

This study is conducted and constructed in order to know the effectiveness as the partial replacement of the cement, normal river sand in concrete making with different types replacements of the percentages constitutions. The source of materials added and proportion of the material according to IS 10262-1984.

1.3 OBJECTIVE

The objectives of this study are:

- To measure the compressive strength of concrete cubes.
- Compare the water requirements for cement, river sand and the concrete made up of fly ash, quarry dust with super plasticizer.

- Compare the workability of concrete with different percentages of replacement in fly ash, 50% river sand + 50% quarry dust.
- Compare the compressive strength of concrete with different percentages of replacement in fly ash, 50% river sand + 50% quarry dust.

1.4 SCOPE OF STUDY

The fly ash samples will be taken from the from honey impex in Madurai, and the quarry dust samples will be taken from the periyakulam stone quarry in Theni district. The experiment result will be used to ensure the effectiveness this ratio fly ash, quarry dust in concrete batching to determine the compressive strength of the concrete cube. The percentages use in fly ash replacement in concrete is starting from 0%, 10%, 20% and 30% with the samples must be completed about 36 samples of concrete cube.

Table1- Samples of concrete cubes for compressive test

Samples of concrete cubes by	% of replacements			
Duration of curing	River sand+Quarry dust (50 % + 50%)			
	0% Fly ash	10% Fly ash	20% Fly ash	30% Fly ash
7 days	3	3	3	3
21 days	3	3	3	3
28 days	3	3	3	3

The testing of this study is based on the sources of material added and proportion of the material according to Indian standard 10262-1984.

- Test method for compressive strength of concrete is based on IS 516.
- The fineness of fly ash will be tested by using 90micron sieve.
- The abundant quarry dust will be sieved by sieve analysis of fine and coarse aggregate is based on IS 383.
- Silt content in quarry dust must be tested by using 90micron sieve.
- The experiment use common cube size IS 516 is 100mmx100mmx100mm

1.5 SIGNIFICANT STUDY

The important of this study is replacing abundant fly ash, quarry dust in concrete on the fly ash, quarry dust is new material that might for long life structure. In addition, study of concrete contains fly ash, quarry dust in terms of physical properties. Such as shapes, fineness, size and color and also chemical composition which in silt content would be done.Therefore this study signifies to propose on alternative way in replacing fly ash as cement and quarry dust as fine aggregate of concrete.

2. MATERIALS AND METHODS

2.1 MATERIAL SELECTION

2.1.1 CEMENT

The cement, we have chosen is OPC 53 grade. OPC 53 grade cement have some specifications according to IS 12269.The specifications are as follows.

Table2-Specifications for OPC 53 grade

Initial setting time	Not less than 30 minutes
Final setting time	Not more than 10 hours
Fineness of cement	Not more than 10% of weight of cement
Specific gravity	3.15

2.1.2 FLYASH

Fly ash is the waste material andrate is very cheap, the material for making concrete. The Specific gravity of fly ash is 2.87.

Fig no.1

2.1.3 WATER

The quality of the water is very important for strength of concrete. Because the chemical contamination of water will affect the strength of concrete as well as life of the structure also the water is used for curing of concrete for attaining the design compressive strength of concrete. The quality is compared with IS 456-2000. The water used in this work is tap water, available in laboratory.

2.1.4 RIVER SAND

River sand is naturally available fine aggregate at river beds in our country. River sand has good properties to make concrete.

2.1.5QUARRY DUST

Normally quarry dust does not prefer for concrete because of excess chloride content present inquarry dust. Theexcess silt content present in quarry dust is removed by washing it with water. After washing, certain amount of silt content in quarry dust is removed. Thus the quarry dust can be used for making concrete.

Fig no.2

2.1.6 SUPER PLASTICIZER

Addition of more water makes the concrete more workable but it reduces the strength of the concrete. So we can make use of super plasticizer. The use of super plasticizer can reduce the amount of water content about 20% - 30% in concrete making and also it increase the strength of concrete. It is very economic one. We using sulphonated naphthalene formaldehyde based Rheo build 1126nd.

2.2 COLLECTION OF MATERIAL

2.2.1 CEMENT

Cement collected from local shop. One bag of cement collected as OPC 53 grade.

2.2.2 FLYASH

Fly ash is collected from honey impex in Madurai.

2.2.3COARSE AGGREGATE

The coarse aggregate collected from our college of 70 kg. (20mm size coarse aggregate)

2.2.4 FINE AGGREGATE

Table3-Collection of fine aggregates

Sl. No	Name	Place	Amount in kg
1	River sand	Kuchanur river	40 kg
2	Quarry dust	Periyakulam	40 kg

2.2.5 WATER

Tap water from college laboratory is utilized for this project in required amount.

2.2.6 SUPER PLASTICIZER

The super plasticizer collected for this process is sulphonated naphthalene formaldehyde based Rheo build 1126nd.

2.3 METHODS OF ANALYSIS

2.3.1 SPECIFIC GRAVITY

- Specific gravity of cement = 3.15
- Specific gravity of fly ash = 2.87
- Specific gravity of river sand = 2.60
- Specific gravity of quarry dust = 2.46
- Specific gravity of 50%river sand, 50%quarry dust = 2.53
- Specific gravity of coarse aggregate = 2.64

2.3.2 FINENESS

- Fineness of cement is 2.5%.
  The fineness of cement is acceptable.
- Fineness of fly ash is 2%.
  The fineness of fly ash is acceptable.
- Silt content of quarry dust is 4.2%.
  The silt content of quarry dust is acceptable.
- Fineness modulus of river sand is 2.456.
  The fineness of river sand is acceptable.
- Fineness modulus of aggregate is 3.70.
  The fineness of river sand is acceptable.

2.3.3 CONSISTENCY OF CEMENT

Table 4-consistency on cement

Sl.No	Quantity of water added (W) in ml	Percentage of water added	Penetration from bottom of the mould in mm
1	100	25	42
2	108	27	26
3	116	29	14
4	124	31	6

The consistency of cement (P) = 31%

2.3.4 INITIAL AND FINAL SETTING TIME OF CEMENT

%of water added = (0.85xconsistencyof cement)
= 0.85 x 31
= 26.35

Table5-Initial setting time of cement

Sl.No	Time in minutes	Weight of cement in gm	Percentage of water added	Volume of water added in ml	Penetration from bottom in mm
1	0	400	26.35	105	0
2	5	400	26.35	105	0
3	10	400	26.35	105	0
4	15	400	26.35	105	1
5	20	400	26.35	105	2
6	25	400	26.35	105	4
7	30	400	26.35	105	6

Initial setting time of cement is 30 minutes.

Table6-Final setting time of cement

Sl. No	Time in minutes	Penetration from the bottom
1	10	0
2	15	1
3	20	2
4	25	2
5	30	3
6	45	4
7	60	4

The final setting time of the cement is 10 hours

2.3.5 SILT CONTENT IN QUARRY DUST

Silt content of quarry dust is 4.2%.

The silt content of quarry dust is acceptable

2.3.6 CHLORIDE CONTENT TESTING

Percentage of chloride in water = 0.00187%.

The percentage of chloride in water is acceptable for making reinforced concrete.

2.4 MIX PROPORTION FOR M_{30} GRADE CONCRETE

2.4.1 MIX PROPORTION FOR CONCRETE WITH 0% FLY ASH

Weight of water = 191.58kg/ m^3
Weight of cement = 425.73kg/ m^3
Weight of river sand = 390kg/ m^3
Weight of quarry dust = 390kg/ m^3
Weight of coarse aggregate = 1138.1kg/ m^3
Mix proportion is 1: 1.83: 2.67

2.4.2 MIX PROPORTION FOR CONCRETE WITH 10% FLY ASH

Weight of water = 191.58kg/ m^3
Weight of super plasticizer = 2.98kg/ m^3
Weight of cement = 380.16kg/ m^3
Weight of fly ash = 42.57kg/ m^3
Weight of river sand = 390kg/ m^3
Weight of quarry dust = 390kg/ m^3
Weight of coarse aggregate = 1138.1kg/ m^3
Mix proportion is 1: 1.83: 2.67

2.4.3 MIX PROPORTION FOR CONCRETE WITH 20% FLY ASH

Weight of water = 191.58kg/ m^3
Weight of super plasticizer = 2.98kg/ m^3
Weight of cement = 340.58kg/ m^3
Weight of fly ash = 85.15kg/ m^3
Weight of river sand = 390kg/ m^3
Weight of quarry dust = 390kg/ m^3
Weight of coarse aggregate = 1138.1kg/ m^3
Mix proportion is 1: 1.83: 2.67

2.4.4 MIX PROPORTION FOR CONCRETE WITH 30% FLY ASH

Weight of water = 191.58kg/ m^3
Weight of super plasticizer = 2.98kg/ m^3
Weight of cement = 298.01kg/ m^3
Weight of fly ash = 127.72kg/ m^3
Weight of river sand = 390kg/ m^3
Weight of quarry dust = 390kg/ m^3
Weight of coarse aggregate = 1138.1kg/ m^3
Mix proportion is 1: 1.83: 2.67

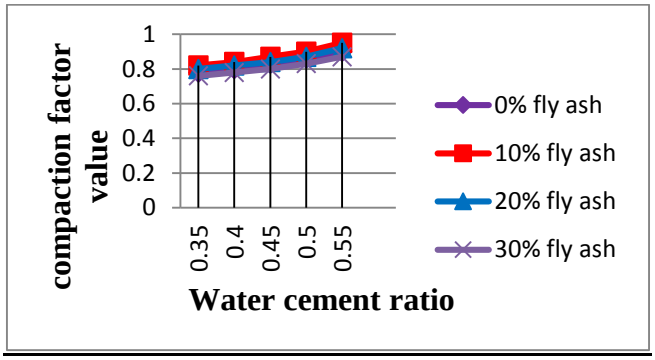
3. WORKABILITY OF CONCRETE

3.1 COMPACTION FACTOR TEST ON FRESH CONCRETE

Table7-Compaction factor values for different mix is obtained as follows

Sl.no	W/C Ratio	Compaction factor value of concrete with			
		0% fly ash, 50%quarry dust	10% fly ash, 50%quarry dust	20% fly ash, 50%quarry dust	30% fly ash, 50%quarry dust
1	0.35	0.78	0.82	0.80	0.76
2	0.40	0.80	0.84	0.82	0.78
3	0.45	0.83	0.87	0.84	0.80
4	0.50	0.86	0.9	0.87	0.83
5	0.55	0.9	0.95	0.92	0.87

Fig no.3

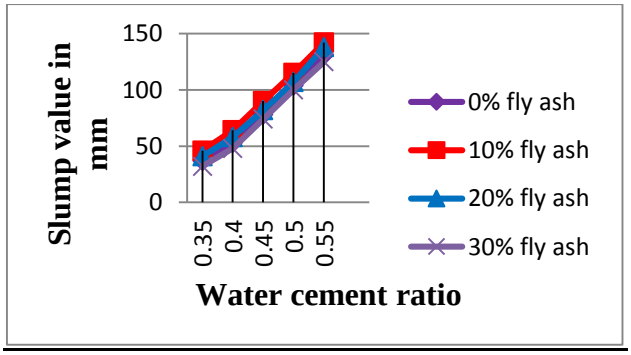


3.2 SLUMP VALUE OF FRESH CONCRETE

Table8-Slump values for different mix is obtained as follows

Sl. no	W/C Ratio	Slump value of concrete with				
		0% fly ash, 50%quarry dust	10% fly ash, 50%quarry dust	20% fly ash, 50%quarry dust	30% fly ash, 50%quarry dust	Remarks
1	0.35	37	46	41	32	True
2	0.40	53	64	58	48	True
3	0.45	78	90	82	74	True
4	0.50	104	115	107	100	Shear
5	0.55	131	142	138	125	Collapse

Fig no.4

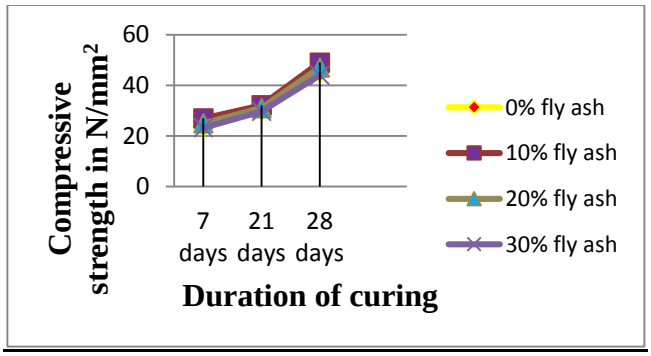


3.3 COMPRESSIVE STRENGTH OF CONCRETE

Table9-compressive strength on concrete

Age of curing	Different % of replacements in fly ash ,50% quarry dust			
	0%	10%	20%	30%
7 days	23.71 N/mm^2	26.9 N/mm^2	24.99 N/mm^2	23.22 N/mm^2
21 days	30.07 N/mm^2	32.12 N/mm^2	31.01 N/mm^2	29.7 N/mm^2
28 days	45.05 N/mm^2	48.99 N/mm^2	47.02 N/mm^2	44.02 N/mm^2

Fig no.5



4. CONCLUSION

The above project experiment was conducted and the following details are concluded and interpreted.

- Water cement ratio is reduced by adding of super plasticizer as an admixture on "Rheo build 1126 nd" and water consumption is reduced as 80%.
- When admixture was added to fly ash, quarry dust concrete there is considerable increase in strength of concrete.
- Normally the compressive strength of conventional concrete is 100%.
- The compressive strength of concrete with 0%fly ash, 50%quarry dust alone is about 150.16% of conventional concrete.
- The compressive strength of concrete with 10%fly ash, 50%quarry dust alone is about 163.30% of conventional concrete.
- The compressive strength of concrete with 20%fly ash, 50%quarry dust alone is about 156.73% of conventional concrete.
- The compressive strength of concrete with 30%fly ash, 50%quarry dust aloneis about 146.73% of conventional concrete.
- The concrete with fly ash, quarry dust is more economical than ordinary conventional concrete.
- Therefore fly ash may be satisfactorily used as cement, quarry dust may be satisfactorily used as fine aggregate for making concrete.

5. REFERENCES

1. Cyr, M., Lawrence, P., and Ringot, E. (2006), "Efficiency of mineral admixtures in mortars: Quantification of the physical and chemical effects of fine admixtures in relation with compressive strength," Cement and Concrete Research 36, pp. 264-277.
2. Popovics, S. (1992), Concrete Materials: Properties, Specifications and Testing, Noyes Publications, Park Ridge, New Jersey.
3. Neville, A. M. (1996), Properties of Concrete, Fourth and Final Edition, John Wiley & Sons, Inc, Malaysia, VVP. 1341
4. Dias, W. P. S., Nanayakkara, S. M. A., and Ekneligoda T. C. (2003), Performance of Concrete Mixes with OPC and PFA blends, Magazine of Concrete research, 55. No. 2. April. pp. 161-170.
5. Amarasiri, A. L. (2003), A Study of the Fracture Properties of Medium-Strength Concrete Using Notched Cylinders, Ph.D. Dissertation, Texas Tech University.
6. De Silva, S. H. Y. I., Pushpakumara, R. K. S., Rajapaksha, R. W. C. N., Sathyadasan, A. (2007), Engineering Properties and Structural Behaviour of Concrete, Undergraduate Project Report, Department of Civil and Environmental Engineering, University of Ruhuna.
7. Manasseh JOEL (2010), Use of Crushed Granite Fine as Replacement to River Sand in Concrete Production.
   Safiuddin. Md, Raman. S.N, Zain.M.F.M (2007), Utilization of quarry waste as fine aggregate in concrete, Journal of applied sciences research, Insinent publication.
8. IS: 6925-1973, Indian standard methods for determination of chlorides in admixtures, Bureau of Indian Standards, New Delhi.
9. IS: 383-1970, Specification for coarse and Fine Aggregates from natural sources for concrete, Bureau of Indian standards, New Delhi.
10. IS 4031: Part 4: 1988 Methods of physical tests for hydraulic cement: Part 4 Determination of consistency of standard cement paste.
11. IS 4031: Part 5: 1988 Methods of physical tests for hydraulic cement: Part 5 Determination of initial and final setting times.
12. IS 10086: 1982 Specification for moulds for use in tests of cement and concrete.
13. IS: 2386-1963 Part 1 to VIII, Indian Standard Methods of Test for Aggregate for concrete, Bureau of Indian Standards, New Delhi.
14. Manasseh JOEL (2010), Use of Crushed Granite Fine as Replacement to River Sand in Concrete Production.