International Journal of Latest Research in Engineering and Technology (IJLRET)
ISSN: 2454-5031
www.ijlret.com || Volume 02 - Issue 08 || August 2016 || PP. 15-33

EFFECT OF FLY ASH AND QUARRY DUST AS A PARTIAL REPLACEMENT OF CEMENT AND FINE AGGREGATE IN CONCRETE

I Rohini
[1]*(Department of Civil, Jeppiar SRR Engineering College, India)*

V.Arularasi
[2]*(Depatment of civil,Jeppiar SRR engineering College,India)*

ABSTRACT: FLY ASH CONTAINS THE BASIC INGREDIENTS OF CEMENT LIKE SILICA, MAGNESIUM AND CALCIUM. CEMENT INDUSTRIES USE FLY ASH TO IMPROVE THE VOLUME. QUARRY DUST ALSO CONTAINS A SIMILAR PROPERTY OF RIVER SAND. QUARRY DUST IS USED IN CONCRETE TO MINIMIZE THE DEMAND OF RIVER SAND. MAXIMUM EXPLOITATION OF SAND IS TO BE MINIMIZED TO PROTECT THE RIVER BEDS, SHORE STRUCTURES FROM EROSION. TO REDUCE DISPOSAL AND POLLUTION PROBLEMS EMANATING FROM THESE INDUSTRIAL WASTES, IT IS MOST ESSENTIAL TO DEVELOP PROFITABLE BUILDING MATERIALS FROM THEM. INVESTIGATIONS WERE UNDER TAKEN TO PRODUCE LOW COST CONCRETE BY BLENDING IN VARIOUS RATIOS OF HYPO SLUDGE WITH CEMENT. THE CONCRETE COMPOSITION CAN ALSO BE SUITABLE FOR PARTIAL REPLACEMENT (UP TO 60%). THE FLY ASH, QUARRY ROCK DUST CAN BE USED FORM 20% REPLACEMENT OF CEMENT AND FINE AGGREGATE IN CONCRETE. IT WAS CONCENTRATED TO AVOID ENVIRONMENTAL DEGRADATION DUE TO INDUSTRIAL WASTES FORM CEMENT FACTORIES. THE RESULTS WERE ENCOURAGING IN THAT THEY REVEALED THAT CONCRETE OF THE REQUIRED COMPRESSIVE STRENGTH CAN BE PRODUCED. IT IS CONCLUDED THAT A NEW CONSTRUCTION MATERIAL WITH LOW COST CAN BE MADE AVAILABLE

KEYWORDS: FLY ASH, INDUSTRIAL WASTE, LOW COST CONCRETE, QUARRYDUST, RIVER SAND

1. INTRODUCTION

1.1 GENERAL

Due to the continuous usage of natural resource such as river sand in concrete, the demand increases inevitably regardless of usage. The abundant production of quarry dust from stone crushing units as a waste product is becoming problem for its disposal. Due to the scarcity of natural sand is overcome by utilization of quarry dust, which can be called as manufactured sand. Hence an attempt has been made to study the effect of partial replacement of fine aggregates by quarry dust and cement by fly ash on cement concrete.

1.2 NEED FOR INVESTIGATION

Quarry Dust These residues are generally less than 1% aggregate production in the normal concrete. The introduction of quarry dust for mixing is limited due to its high fineness. And it is available at low cost and locally available material. It has almost similar properties including texture of river sand, but it has sharp and angular edges. It minimizes the maximum exploitation of river sand and there by augmenting aquifer capacity. It also prevents the environmental degradation. Fly ash is one of the residues generated in the combustion of coal. Fly ash is generally captured from the chimneys of coal -fired power plants, whereas bottom ash is removed from the bottom of the furnace. Flyash is commonly used to supplement Portland cement in concrete production, where it can bring both technological and economic benefits, and is increasingly finding us in the synthesis of geo-polymers and zeolites.

1.3 SCOPE OF STUDY

- To provide a most economical concrete.
- It should be easily adopted in field.
- To reduce the cost of construction.
- To promote low cost housing for the people.
- To find the optimum strength of the partial replacement of concrete.
- To make the maximum usage of locally available materials.

1.4 OBJECTIVE

The main objectives of this project are:

- to compare compressive strength of normal concrete with partial replacement of fly ash and quarry dust;
- to compare compressive strength of partial replacement of cement with fly ash;
- to compare compressive strength of partial replacement of sand with quarry dust; and
- to compare the compressive strength of partial replacement of cement and fine aggregate with fly ash and quarry dust

2. METHODOLOGY

2.1 INTRODUCTION

- Material properties were tested as per IS – 383-1980 procedures.
- Mix design for concrete proportion has been developed as per IS 10262-1982.
- Concrete cube specimens were casted and cured as per IS procedure.
- The properties of fresh concrete was tested as per IS 1199-1959.
- The characteristic strength of hardened concrete specimen was tested as per IS 456 – 2000.
- Optimum strength for optimum replacement was determined.
- Results of conventional concrete were compared with that of partial replacement concrete.

2.2 PROPERTIES OF CEMENT

Cement is a binding material used in the preparation of concrete. It binds in the coarse aggregate and fine aggregate with the help of water to a monolithic matter. And also, it fills the voids in the fine and coarse aggregate.

Table2.1 Physical properties of cement
Types of cement used: Ordinary Portland Cement

Sl no	Property	values
1	Specific gravity	3.0
2	Normal consistency	28%
3	Initial setting	30min
4	Final setting	600min
5	Fineness	99.3%

2.3 PROPERTIES OF AGGREGATES

Well graded aggregates are controlled the maximum voids and minimizing the cement content and it leads to good concrete with high strength, economy, low shrinkage and greater durability.Fine aggregates generally consist of natural sand or crushed stone. Medium and fine sand are to be used in mortars. The properties of fine aggregate shall be in accordance with the requirements of IS: 383-197 The compressive strength, crushing value, etc. of the aggregate shall be in accordance with the requirements of IS: 383-1970

Table2.2 Visual characteristics of material

Sl. No.	Material	Visualisation	Shape
1	Natural river sand	Smooth surface	Angular and round edges
2	Coarse aggregate	Round surface	Irregular and Sharpe edges
3	Quarry rock dust	Round surface	Irregular and Sharpe edges

.

2.4 PROPERTIES OF FLYASH

Fly ash is a by-product from coal-fired electricity generating power plants. The coal used in these power plants is mainly composed of combustible elements such as carbon, hydrogen and oxygen (nitrogen and sulphur being minor elements), and non-combustible impurities (10% to 40%) usually present in the form of clay, shale, quartz, feldspar and limestone.

Table2.3Physical properties of fly ash

Sl. No.	Properties	Values
1	Specific gravity	3.2
2	Fineness of fly ash	3.3
3	Initial setting	30 minutes
4	Final setting	600 minutes

2.5 QUARRY DUST

The quarry dust can be defined as residue, tailing or other non-voluble waste material after extraction and processing of rocks to form fine particles less than 4.75 mm. usually, quarry rock dust is mostly used in highways as surface finishing materials and also used for manufacturing of hollow blocks.

Table 2.4 Physical properties of quarry dust are given below

Sl. No.	Properties	Values
1	Specific gravity	2.68
2	Bulk density(kg/m^3)	2.10
3	Fineness modulus	2.70
4	% of voids	21.5
5	Water absorption (%)	0.60

2.6 CHEMICAL PROPERTIES OF MATERIALS

The rocks which contain reactive constituents include traps, andesitic, hyalites, siliceous limestone and certain types of sand stones. The reactive constituents may be in the form of opals, cheers, chalcedony, volcanic glass and zeolites etc., the reaction starts with attacks on the reactive siliceous minerals in the aggregate by the alkaline hydroxide derived from the alkalis cement. As a result, the alkalis silicate gels of unlimited swelling type are formed. Which results is disruption of concrete with the spreading of pattern cracks and eventual failure of concrete structures. The lime stones and dolomites containing chart nodules would be high reactive and stone contain silica minerals like chalcedony, crypto to microcrystalline quartz and opal are formed to be reactive. Geographically India has very extensive deposits of volcanic rocks. Some type of aggregates which contain reactive silica in particular proposition and particular fineness are found to exhibit tendencies for alkali aggregate reaction. It is possible to reduce its tendency by alerting either the proposition of reactive silica or its fineness.

Table 2.5 Percentage in chemical composition of materials

Sl. No.	Property	Natural fine	Quarry rock	Coarse aggregate	Cement	Fly ash
1	Silica (SiO_2)	90 – 95	62.48 -65.5	65.48-65.5	22.0%	10.8-39.6%
2	Iron (Fe_2O_3)	2.682-8.25	5.78-6.54	5.78-6.54	3.0%	0.6-2.5%
3	Titanium(TiO_2)	--	1.10-1.31	1.10-1.31	--	--
4	Aluminium(Al_2O_3)	0.005-0.010	16.12-19.10	16.12-19.10	6.0%	1.1-2.7%
5	Calcium (CaO)	--	4.10-4.92	4.10-4.92	63.0%	14.1-41.3%
6	Magnesium(MgO)	0.02	2-2.78	2-2.78	2.50%	3.1-9.2%
7	Sodium(Na_2O)	0	0-0.78	0-0.78	--	1.0-15.45%
8	Potassium(K_2O)	0	3.10-3.78	3.10-3.78	--	--
9	Sulphur trioxide(SO_3)	--	--	--	1.75%	11.2-20.0%

2.7 GRADING OF AGGREGATE

The particle size distribution of an aggregate as determined by sieve analysis is termed as grading of aggregate. The grading of an aggregate is expressed in terms of percentage by weight retained or passing percentage through a series of sieves taken in order of 4.75 mm, 2.00 mm, 1.00 mm, 0.600 mm, 0.425 mm, 0.300 mm and 0.150 mm, pan for fine aggregate. (As per IS 2386-Part 111-1963)

Table 2.6 Grading of aggregate comparison of fine aggregate to standard

Sl. No.	IS Sieve designation	Grading limits Zone- II	Grading limits of fine aggregate
1	10 mm	100	100
2	4.75mm	90 – 100	99.6
3	2.36 mm	75 – 100	96.2
4	1.18 mm	60 – 90	77.2
5	0.600 µ	35 – 59	65.8
6	0.300 µ	8 – 30	31.6
7	0.150 µ	0 – 10	2

2.8 FINENESS MODULUS

By the particle size distribution of an aggregate to calculate the fineness modulus value. The fineness modulus value gives an idea of the mean size of the particles present in the aggregates. The object of finding the fineness value is to grade the aggregate for the most economical mix for the required strength and workability with minimum quantity of cement. If the tested aggregate gives higher fineness modulus means the mix will be harsh and of gives a lower fineness modulus, it gives an economic mix. For workability, a coarse aggregate requires less W/C ratio. The fineness modulus was determined as per IS 386- Part: III – 1963

Fineness modulus of natural river sand : 2.63

Fineness modulus of quarry dust : 2.70

Fineness modulus of coarse aggregate : 2.65

2.9 SPECIFIC GRAVITY

It is defined as the ratio of the mass of void in a given volume of sample to the mass of an equal volume of water at the same temperature. The specific gravity is required for the calculation of the yield of concrete or the required quantity of aggregate for the given volume of concrete. The specific gravity of the materials was determined as per IS 2386- Part: III – 1963. 17

Specific gravity of natural river sand : 2.60
Specific gravity of quarry rock dust : 2.68
Specific gravity of coarse aggregate : 2.83

Table 2.7 Determination of specific gravity

Sl. No.	Particulars	River sand	Quarry dust	Coarse aggregate
1	Weight of an empty container **(W_1)(gms)**	676.60	676.60	676.60
2	Weight of container + sand **(W_2)(gms)**	1509.10	1605	1609.50
3	Weight of container + sand + water **(W_3)(gms)**	2563	2685	2592
4	Weight of the container in water **(W_4)(gms)**	1411	1411	1411
5	**Specific gravity= $(W_1-W_2)/\{(W_2-W_1)-(W_3-W_4)\}$**	2.55	2.68	2.65

2.10 BULK DENSITY

The mass of the material in a given volume and it is expressed in kg/m3. Bulk density was determined as per IS 2386-Part: III – 1963.

Table 2.8 Bulk density of aggregate

Property	**Natural river sand**		**Quarry dust**		**Coarse aggregate**	
	Loose State	Compacted State	Loose State	Compacted State	Loose State	Compacted state
Bulk density(kg/m^3)	1.825	2.095	1.97	2.215	1.655	1.955

2.11 CRUSHING STRENGTH OF COARSE AGGREGATE

It is defined as the percentage by weight of the crushed material obtained when the test aggregate are specified load under standardized condition is a numerical index of the strength of the aggregate used in road constructions. Crushing strength of coarse aggregate was determined as per IS 2386-part: IV-1963.

Table 2.9 Crushing strength of coarse aggregate

Sl. No.	Weight of the container (W_1)(gms)	1800	1800	1800
1	Weight of the container + sample (W_2)(gms)	2450	2509	2503
2	Weight of the sample passed in 2.36mm IS sieve (W_3)(gms)	90	98	97
3	Aggregate impact value $\{(W_3/(W_2-W_1))/100\}$ (%)	13.80	13.82	13.79

2.12 IMPACT STRENGTH OF COARSE AGGREGATE

Toughness is usually considered as the resistance of the material to failure by impact loading. The impact value of an aggregate may be used as an alternative to its crushing value. The aggregate impact value is a measure of resistance to sudden impact or shock, which may differ from its resistance of gradually applied compressive load. Impact strength of coarse aggregate as per IS2386-part: IV-1963.

Table 2.10 Impact strength of coarse aggregate

Sl. No.	Weight of container (W_1)(gms)	10320	10320	10320
1	Weight of container + sample (W_2)(gms)	13800	13850	13810
2	Weight of the sample passed in 2.36mm IS sieve (W_3)(gms)	540	550	542
3	Aggregate impact value $\{(W_3/(W_2-W_1))/100\}$ (%)	15.55	15.58	15.53

2.13 WATER ABSORPTION

Percentage of water absorbed by an air dried aggregate, when it is immersed in water for 24 hours is termed as "absorption of aggregate" (air dry basis) the Knowledge of the absorption of an 20 aggregate is important for concrete mix design.Water absorption was determined as per IS 2368 - Part III – 1963.

Table 2.11 Percentage of absorption of aggregates

Sl. No.	Property	Natural river Sand	Quarry dust	Coarse aggregate
1	% of Absorption	0 .94	0.60	0.54

2.14 PROPERTIES OF WATER

Water is an important ingredient of concrete as it actively participates inthe chemical reactions with cement. The strength of cement concrete comes mainly from the binding action of the hydration of cement get the requirement of water should be reduced to the required chemical reaction of un-hydrated cement as the excess water would end up in only formation undesirable voids in the hardened cement paste in the hardened cement paste in concrete.

Table 2.12 Percentages of particles present in water

Sl. No.	Particles	Standard values
1	P_H	6.5-8
2	Organic	0.02
3	Inorganic	0.30
4	Sulphates	0.05
5	Alkali chlorides	0.10

2.15 SLUMP TEST ON CONCRETE

The object of the test is to find out the workability of freshly mixed cement concrete. Workability is the capability of being worked without extra labour and loss in strength. The strength of cement concrete entirely depends upon the correct percentage of water and slump. Slump is the fall in vertical height of a freshly prepared concrete with respect to its standard moulded height.

Table 2.13 Slump values for various water-cement ratios

Sl. No	Mix proportion	Weight of cement (gm)	Water cement ratio	Volume of water added (ml)	Slump value (mm)	Comment
1	1:1.35:3.20	2654	0.45	1194	300-275=25	Road work-mass concrete
2	1:1.35:3.20	2654	0.50	1327	300-230=70	Rc column
3	1:1.35:3.20	2654	0.55	1460	300-168=112	Rc column

2.16 MIX DESIGN

It is defined as the process of selecting suitable ingredients of concrete and determining of concrete and determining their relative propositions with the object of producing concrete of certain minimum strength and durability as economically as possible. The purpose of designing as can be seen from the definition of two folds. The first objective is to achieve the stipulate minimum strength and durability. The second objective is to make the concrete in the most economical manner. Cost wise all concrete depends preliminary on two factors, namely cost of material and labour. concrete mix design done as per IS: 10262 – 1982

Mix design procedure

The following basic data are required of a concrete mix as per IS: 10262 – 1982

i. Characteristics compressive strength of concrete.
ii. Degree of workability desired
iii. Maximum water cement ratio of coarse aggregate
iv. Type and maximum size of coarse aggregate
v. Standard deviation – based on concrete control
vi. Statistical constant – accepted
vii. Grade of cement used 26

Target mean strength is determined as F ck = f ck + t x s

The water/cement ratio for the target mean strength is obtained from fig.2 of IS: 10262 – 1982 and is limited as per table 3 of IS: 456 – 2000 The air content is estimated as per table – 3 of IS: 10262 – 1982 Appropriate sand and water content per m3 of concrete are selected as per table 4 of 5 (depends on grade of concrete) from IS: 456 – 2000 Adjustments in sand percentage and water content are as per table 6 if the condition given for table 4 or 5 differs in IS: 456 – 2000 Collected water quantity is computed and hence from w/c ratio The quantity of fine aggregate and coarse aggregate per unit volume of concrete can be calculated from the following equations.

V = (W+(C/SC) + ((1/P) x))) x (1/1000)

Ca= (((1-P) x f a x (S ca /S fa))

The mix propositions by weight are computed by keeping the cement as one unit.

Mix design calculation

Design stipulations

Grade of concrete – M30

Degree of control – Good

Type of exposure – Mild

Grading of sand – zone – II

Water cement ratio – 0.50 27

Test Data

Cement material

Type of cement : OPC 53 Grade

Specific gravity of cement : 3.0

Fineness of cement : 99.3%

Fine aggregate

Specific gravity : 2.60

Fineness modulus : 2.63

Bulk density of fine aggregate : 1.42 kg/m3

Coarse aggregate

Specific gravity : 2.65

Fineness modulus : 2.65

Bulk density of coarse aggregate : 1.63 kg/m3

Calculation

i. Target mean strength of concrete F ck = f ck + t x s = 30 + (1.65 x 5) = 38.25 MPa

ii. W/C ratio from graph is 0.50

iii. Sand belongs to zone – II (corrections adopted)

iv. Required sand content (%) = 35

v. Required water content = 186 + 5.58 = 191.6/m3

vi. Required cement content = 191.6/0.5 = 383kg/m3

vii. Required fine aggregate = 516 kg/m3

viii. Required coarse aggregate = 226 kg/m3

Table 2.14 Mix proportion of concrete for M30 grade

Sl. No.	Water	Cement (Kg)	Fine aggregate (Kg)	Coarse aggregate (Kg)
1	191.6	383.00	516	1226
2	0.5	1	1.35	3.20

Mix proportions

M30 grade mix is 1:1.35:3.20 for normal concrete

For both replacement of fly ash and quarry dust

M30 grade mix is 0.80:1.08:3.20 for 20% partial replacement of concrete

M30 grade mix is 0.70:0.95:3.20 for 30 % partial replacement of concrete

M30 grade mix is 0.60:0.81:3.20 for 40% partial replacement of concrete

M30 grade mix is 0.50:0.68:3.20 for 50% partial replacement of concrete

M30 grade mix is 0.40:0.54:3.20 for 60% partial replacement of concrete

For replacement of fly ash
M30 grade mix is 0.80:1.35:3.20 for 20% partial replacement of concrete
M30 grade mix is 0.70:1.35:3.20 for 30 % partial replacement of concrete
M30 grade mix is 0.60:1.35:3.20 for 40% partial replacement of concrete
M30 grade mix is 0.50:1.35:3.20 for 50% partial replacement of concrete
M30 grade mix is 0.40:1.35:3.20 for 60% partial replacement of concrete
For replacement of quarry dust
M30 grade mix is 1:1.08:3.20 for 20% partial replacement of concrete
M30 grade mix is 1:0.95:3.20 for 30 % partial replacement of concrete
M30 grade mix is 1:0.81:3.20 for 40% partial replacement of concrete
M30 grade mix is 1:0.68:3.20 for 50% partial replacement of concrete
M30 grade mix is 1:0.54:3.20 for 60% partial replacement of concrete

2.17 EXPERIMENTAL WORK ON CONCRETE

Casting and curing of specimens For ordinary concrete, fine aggregate and cement were weighted and mixed thoroughly: the coarse aggregate was then added and mixed with the above. The required amount of water was added and mixed thoroughly to get uniform concrete mass. And compacting the concrete in the mould by hand compaction as per IS procedures.For preparing the specimens for determine the compressive strength, of standard size were used. The fresh concrete was filled in the mould. Care should be taken to see that the concrete was compacted perfectly. All the moulds were De-moulded after 24 hours of casting and cured. They were tested on 7, 14 and 28 days, as per IS 456-2000. Specimen and testing details Cube of size 150 mm x 150 mm x 150 mm were casted for the determination of compressive strength of fly ash, quarry dust concrete specimen. Compressive strength of cubes The compressive strength of concrete is one of the most important and useful properties of concrete. In most structural applications concrete is used primarily to resist compressive stress. In those cases were strength in tension or in shear is of primarily important, the compressive strength is frequently used as a measure of these properties. Compressive strength is also used as a qualitative measure for other properties of hardened concrete. In practical the compressive strength increases as the specimen size decreases. At least three cubes of 150 mm x 150 mm x 150 mm were casted for each age, usual 7, 14 & 28 days. The specimens were cured for one day outside and in water for the rest of the days. Specimens were tested in saturated condition. Cubes were placed such a manner in testing machine that they line of loading is perpendicular to direction was cast. Constant load of 140 kg/cm2/min is applied till failure. Compressive stress = ultimate load/bearing area.

3. RESULTS, DISCUSSION AND CONCLUSIONS

3.1 INTRODUCTION

In the present investigation, compression test strengths were carried out on conventional concrete and fly ash, quarry dust concrete of M30 grades.

3.2 RESULTS

Compressive strength test of conventional concrete and fly ash and quarry dust for 7, 14 and 28 days are shown in tables and in bar charts. Compressive strength tests of conventional concrete as well as replacement of cement by fly ash, replacement of sand by quarry dust and replacement of cement and sand by fly ash and quarry dust respectively were conducted and the test results are presented in Tables 3.1 to 3.10 and in bar charts in figures3.1 to 3.10.

Table 3.1 Compressive strength of M30 concrete

Sl. No.	No. of curing days	Number of specimen	Initial crack load(kN)	Ultimate load(kN)	Ultimate compressive strength(N/mm^2)
1	7	3	326.155	596.250	26.50
2	14	3	556.621	733.500	32.60
3	28	3	599.264	877.500	39.00

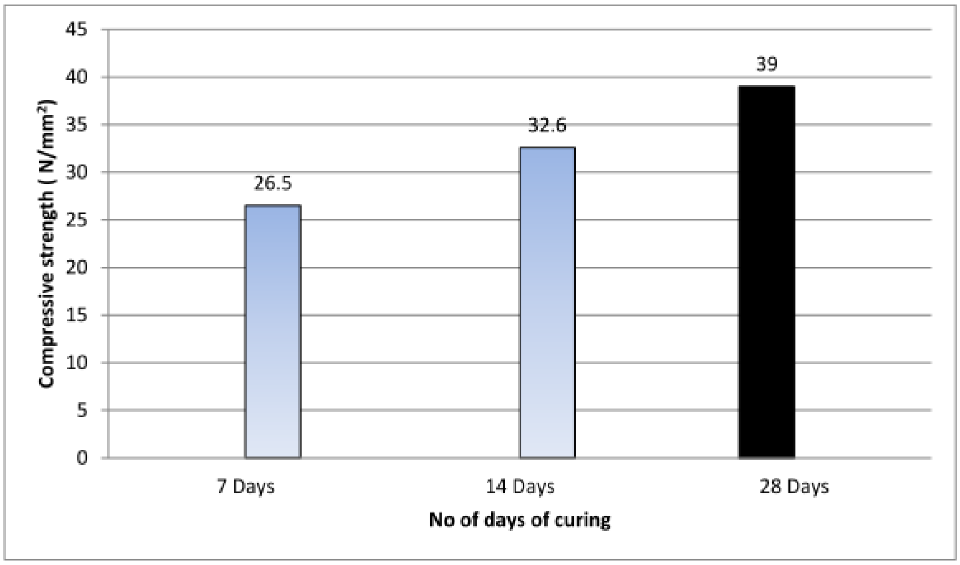

Fig 3.1 Compressive strength of M30 concrete

Table 3.2 Compressive strength of partial replacement of fly ash cubeAs at 7days

Sl. No.	Partial replacement in%	Number of specimen	Initial crack load (kN)	Ultimate load(kN)	Ultimate compressive strength (N/mm^2)
1	20	3	392.864	573.620	25.49
2	30	3	445.523	591.525	26.29
3	40	3	457.265	600.425	26.68
4	50	3	450.253	577.350	25.66
5	60	3	325.160	545.430	24.24

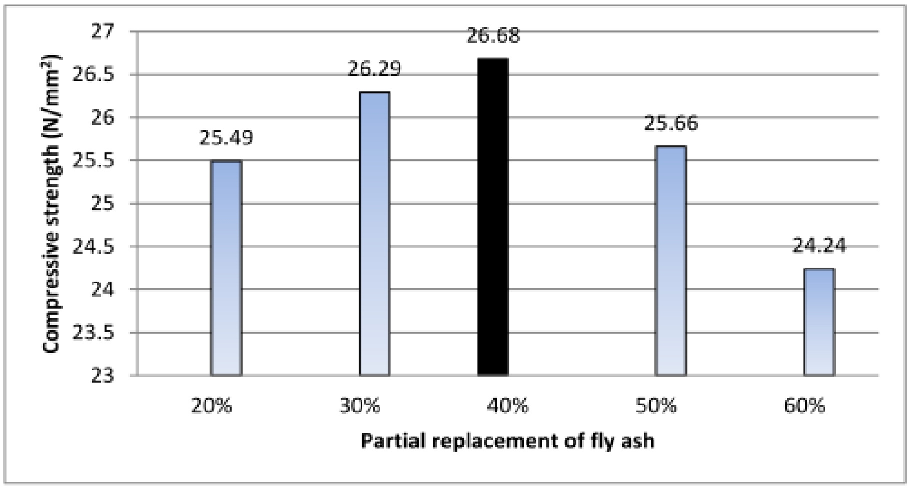

Fig 3.2 Compressive strength of partial replacement of fly ash cubes at 7 days

Table 3.3 Compressive strength of partial replacement of fly ash cubes at 14 days

Sl. No.	Partial replacement In%	Number of specimen	Initial crack load (kN)	Ultimate load (kN)	Ultimate compressive strength (N/mm^2)
1	20	3	465.325	640.920	28.48
2	30	3	478.26	657.450	29.22
3	40	3	483.658	710.460	31.58
4	50	3	450.355	680.850	30.26
5	60	3	436.732	623.450	27.71

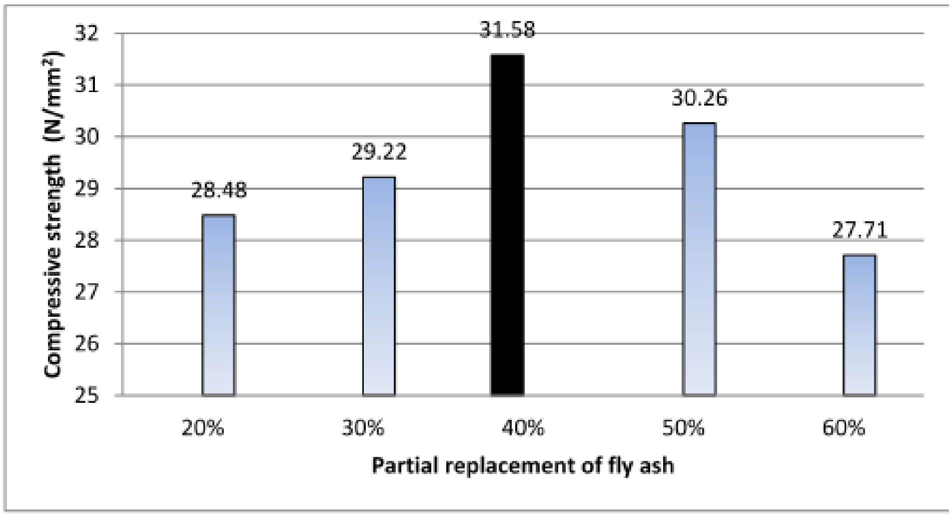

Fig3.3 Compressive strength of partial replacement of fly ash cubes at 14 days

Table 3.4 Compressive strength of partial replacement of fly ash cubes at 28 days

Sl. No.	Partial replacement in %	Number of specimen	Initial crack load (kN)	Ultimate load(kN)	Ultimate compressive strength (N/mm^2)
1	20	3	540.120	795.750	35.37
2	30	3	580.260	816.352	36.28
3	40	3	610.256	836.150	37.16
4	50	3	590.212	801.250	35.61
5	60	3	482.650	768.324	34.15

International Journal of Latest Research in Engineering and Technology (IJLRET)
ISSN: 2454-5031
www.ijlret.com || Volume 02 - Issue 08 || August 2016 || PP. 15-33

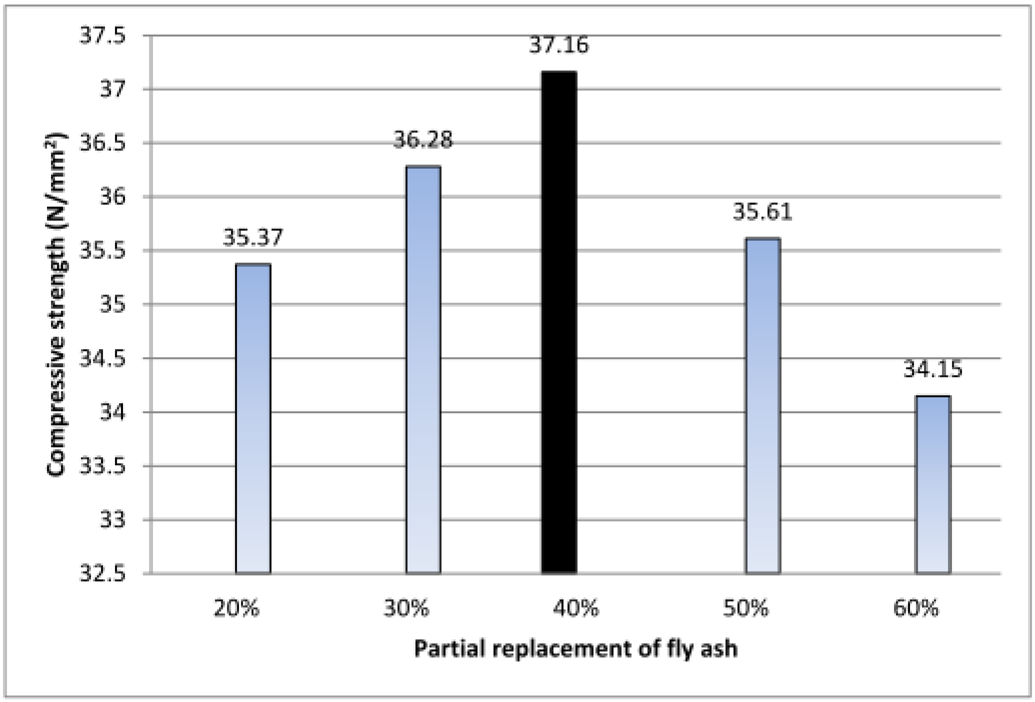

Fig3.4 Compressive strength of partial replacement of fly ash cubes at 28 days

Table 3.5 Compressive strength of partial replacement of quarry dust cubes at 7 days

Sl. No.	Partial replacement in%	Number of specimen	Initial crack load (kN)	Ultimate load (kN)	Ultimate compressive strength (N/mm^2)
1	20	3	264.462	540.000	24.00
2	30	3	276.542	548.100	24.36
3	40	3	290.165	565.650	25.14
4	50	3	253.125	530.100	23.56
5	60	3	225.166	524.925	23.33

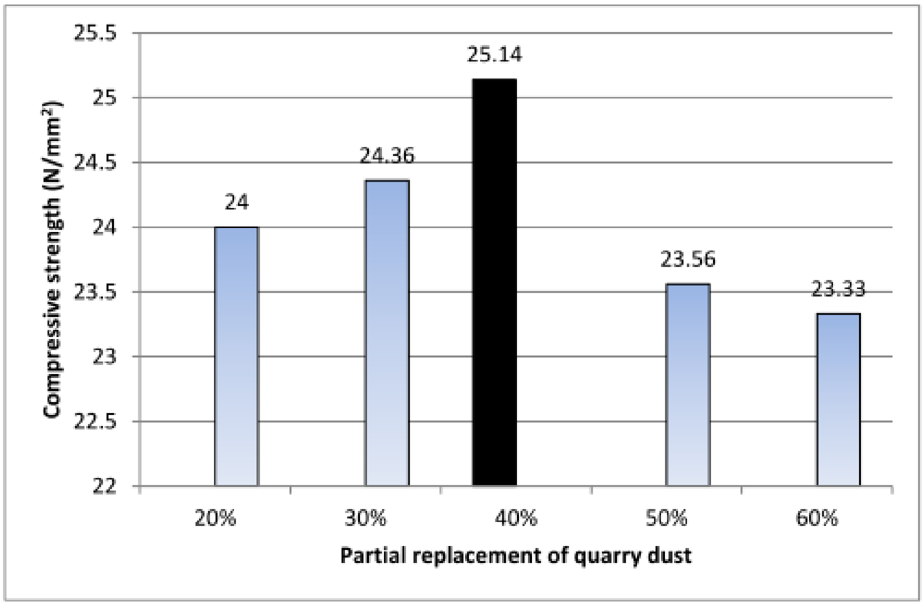

Fig3.5 Compressive strength of partial replacement of quarry dust at 7 days

Table 3.6 Compressive strength of partial replacement of quarry dust cubes at 14 days

Sl. No.	Partial replacement in %	Number of specimen	Initial crack load(kN)	Ultimate load(kN)	Ultimate compressive Strength (N/mm^2)
1	20	3	250.135	602.437	26.77
2	30	3	268.615	614.925	27.33
3	40	3	300.526	661.275	29.39
4	50	3	250.345	569.025	25.29
5	60	3	240.269	593.775	26.39

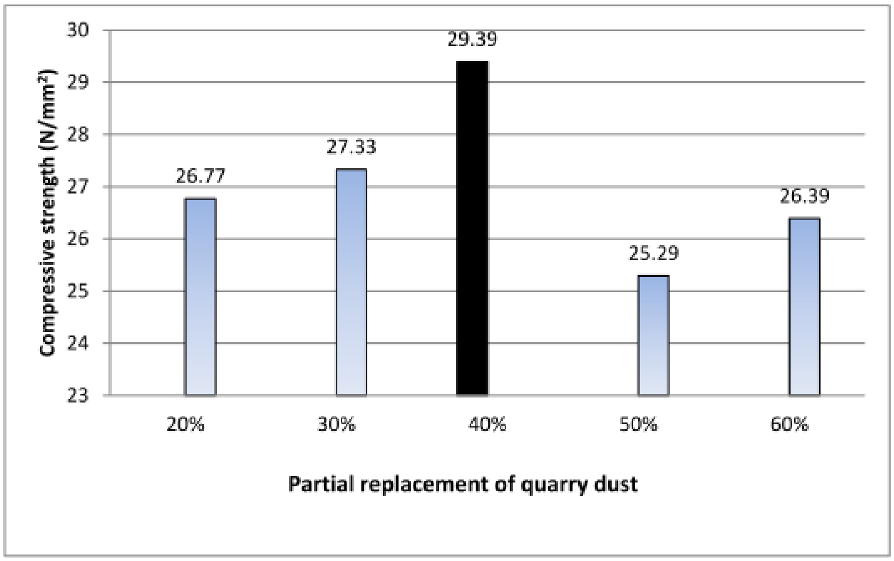

Fig3.6 Compressive strength of partial replacement of quarry dust at 14 days

Table 3.7 Compressive strength of partial replacement of quarry dust cubes at 28 days

Sl. No.	Partial replacement in %	Number of specimen	Initial crack load (kN)	Ultimate load (kN)	Ultimate Compressive Strength (N/mm^2)
1	20	3	468.152	725.850	32.26
2	30	3	489.254	740.025	32.89
3	40	3	509.364	762.750	33.90
4	50	3	468.165	732.600	32.56
5	60	3	450.123	713.925	31.73

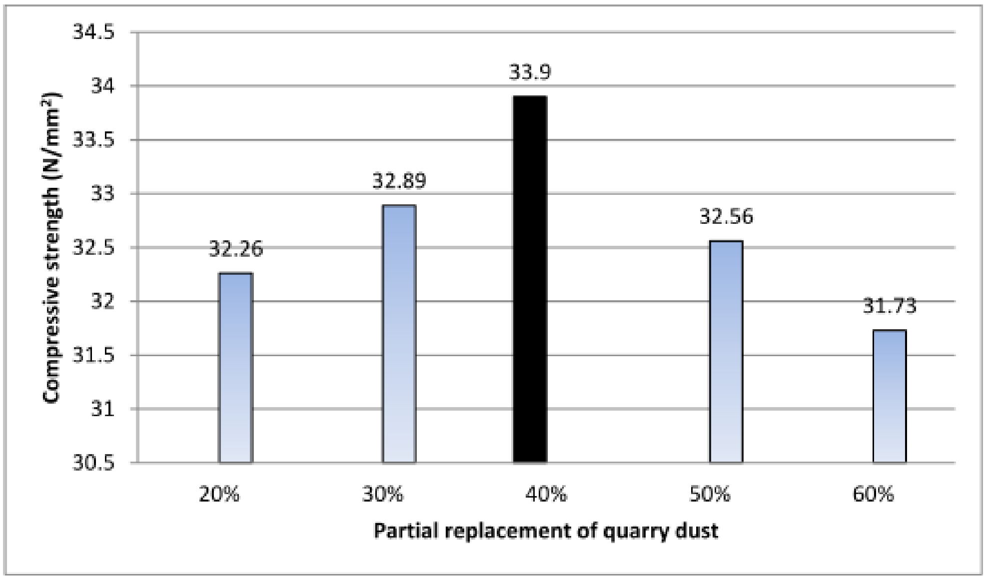

Figure 3.7 Compressive strength of partial replacement of quarry dust at 28 days

Table 3.8 Compressive strength of partial replacement of fly ash and quarry dust Cubes at 7 days

Sl. No.	Partial replacement in %	Number of specimen	Initial crack load (kN)	Ultimate load(kN)	Ultimate compressive strength (N/mm^2)
1	20	3	452.250	601.425	26.73
2	30	3	465.265	607.500	27.26
3	40	3	480.264	667.800	29.68
4	50	3	445.225	592.875	26.35
5	60	3	391.850	572.625	25.45

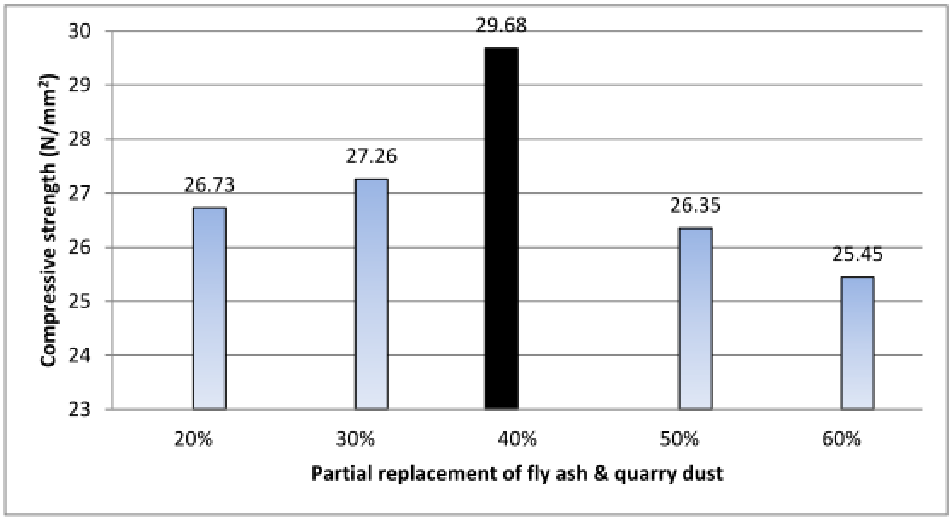

Figure 3.8 Compressive strength of partial replacement of fly ash and quarry dust Cubes at 7 days

Table 3.9 Compressive strength of partial replacement of fly ash and quarry dust cubes at 14 days

Sl. No.	Partial replacement in %	Number of specimen	Initial crack load (kN)	Ultimate load(kN)	Ultimate compressive strength (N/mm^2)
1	20	3	523.254	774.675	34.43
2	30	3	559.213	793.350	35.26
3	40	3	609.652	822.600	36.56
4	50	3	549.264	771.525	34.29
5	60	3	483.658	735.750	32.70

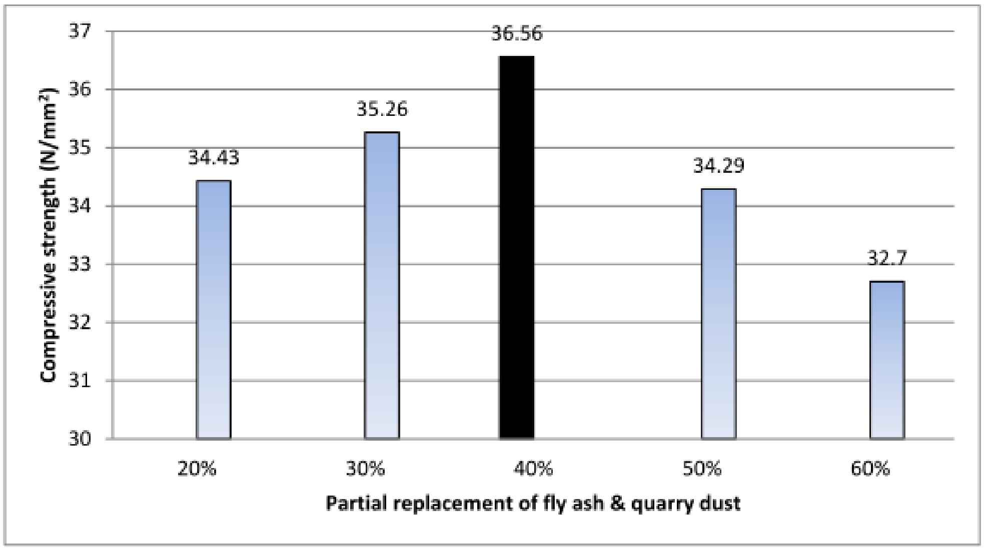

Fig3.9 Compressive strength of partial replacement of fly ash and quarry dust cubes at 14 days

Table 3.10 Compressive strength of partial replacement of fly ash and quarry dust cubes at 28 days

Sl. No.	Partial replacement in %	Number of specimen	Initial crack load(kN)	Ultimate load(kN)	Ultimate compressive strength (N/mm^2)
1	20	3	680.655	951.750	42.30
2	30	3	685.262	968.175	43.03
3	40	3	696.254	981.450	43.62
4	50	3	675.652	963.000	42.80
5	60	3	653.155	941.400	41.84

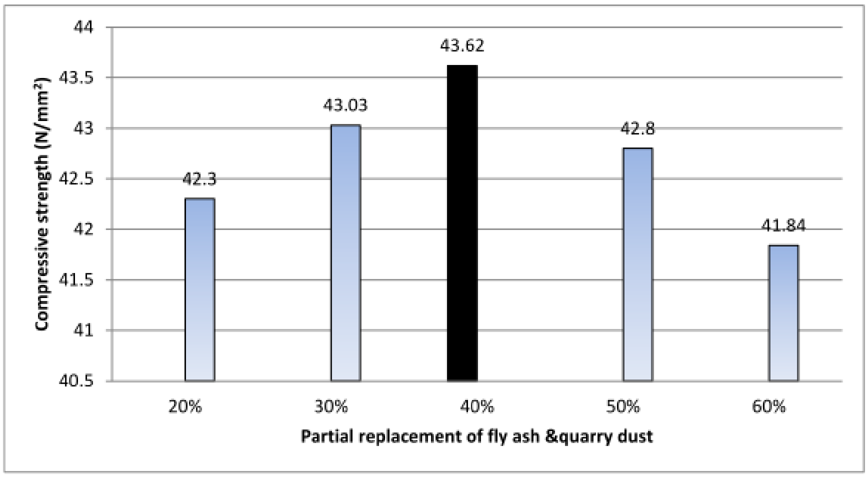

Fig3.10 Compressive strength of partial replacement of fly ash and and quarry dust cubes at 28 days

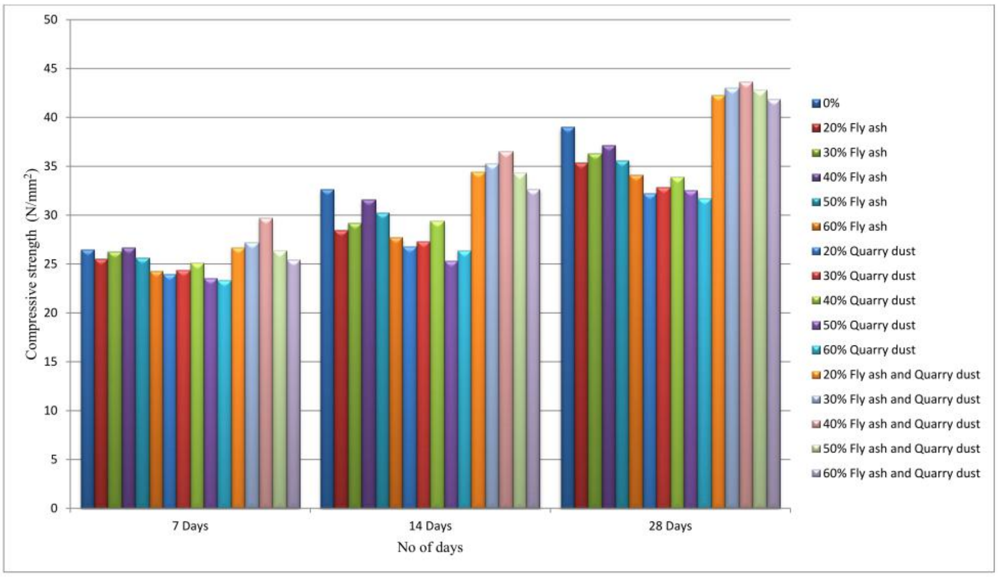

Fig 3.11 Comparison of results

3.3 DISCUSSION

As per IS 456-2000, the compressive strength of M30 concrete at 28 days is 30.00 N/mm2.Comparing this value with that of those presented in Table 3.1 and in Figure 3.1 it can be seen that the 28 days strength is 39.00N/mm2.It can be concluded that M30 mix design is acceptable. Comparing the various percentages on partial replacement of cement by fly ash by 20%, 30%, 40%, 50% and 60% as presented in Table 3.4 and in Figure 3.4 with the values presented in Table 3.1 and Figure 3.1, it can be concluded that 40% replacement of fly ash produces higher compressive strength to other replacement at 28 days. Therefore, it can be concluded that 40% replacement of cement by fly ash is encouraging and acceptable. Comparing the various percentages on partial replacement of fine aggregate by quarry dust by 20%, 30%, 40%, 50% and 60% as presented in Table 3.7 and in Figure3.7 with the values presented in Table 3.1 and Figure3.1, it can be concluded that 40% replacement of quarry dust produces higher compressive strength to other replacement at 28 days. Therefore, it can be concluded that 40% replacement of fine aggregate by quarry dust is also encouraging and acceptable.Comparing the various percentages on partial replacement of cement and fine aggregate by fly ash and quarry dust by 20%, 30%, 40%, 50% and 60% as presented in Table 3.10 and in Figure3.10 with the values presented in Table 3.1 and Figure 3.1, it can also be concluded that 40% replacement of fly ash and quarry dust produces higher compressive strength to other replacement at 28 days. Therefore, it can be concluded that 40% replacement of cement and fine aggregate by fly ash and quarry dust is further encouraging and acceptable.

3.4 ECONOMIC FEASIBILITY

Cost analysis is carried out for the optimum proportion of percentage of fly ash and quarry dust in concrete. . The cost is compared to the conventional concrete.

3.5 COST OF MATERIALS

Cement = Rs. 310/bag
Sand = Rs.1000/m3
Quarry dust = Rs.110/m3
Fly ash = Rs.0.12/kg
Coarse aggregate = Rs.600/m3

Table 3.11 Cost of material of conventional concrete

Description	Quantity	Cost	Cost of material
Cement	223.00 kg	6.20/kg	1382.60
Fly ash	-	-	-
Sand	300.00 /m^3	1000/m^3	350.00
Quarry dust	-	-	-
Coarse Aggregate	712.00/ m^3	600/m^3	552.24
Total cost			2254.84

Table 3.12 Cost of material of fly ash 40% partially replaced concrete

Description	Quantity	Cost	Cost of material
Cement	134.00 kg	6.20/kg	830.80
Fly ash	89.00 kg	0.12/kg	10.70
Sand	180.63/ m^3	1000/m^3	350.00
Quarry dust	-	-	-
Coarse Aggregate	712.00/ m^3	600/ m^3	522.24
Total cost			1713.74

Table 3.13 Cost of material of quarry dust 40% partially replaced concrete

Description	Quantity	Cost	Cost of material
Cement	223.00 kg	6.20/kg	1382.60
Fly ash	-	-	-
Sand	180.00/ m^3	1000/m^3	219.00
Quarry dust	120.00/ m^3	110/ m^3	16.06
Coarse Aggregate	712.00/ m^3	600/ m^3	522.24
Total cost			2139.90

Table 3.14 Cost of material of 40% partially replaced concrete

Description	Quantity	Cost	Cost of material
Cement	134.00 kg	6.20/kg	831.00
Fly ash	89.00 kg	0.12/kg	11.00
Sand	180.63/ m^3	1000/m^3	220.00
Quarry dust	119.37/ m^3	110/ m^3	14.63
Coarse Aggregate	712.00/ m^3	600/ m^3	522.24
Total cost			1598.87

The compared value of cost shows decrement in total cost of per cubic meter concrete. The above table shows cost values of 0% and 40% replacement and the difference in cost from normal concrete to partially replaced concrete was 30%

4 CONCLUSION

The following are the conclusions:

i. The Study clearly indicates that 40% replacement of cement and fine aggregate by fly ash and quarry dust is encouraging and the compressive strength is higher than the standard concrete. Therefore, 40% replacement is recommended which may prove to be economical.

ii. The above 40% replacement brings in a savings of 30% of the total cost in m3of concrete.

REFERENCES

[1]. Thomas MDA, Marine performance of PFA concrete, magazine of concrete research, 1991; 43(151), PP. 71-185.
[2]. Butler, WB. Super fine fly ash in high strength concrete. Concrete 2000, Eds. RK Dhir and MR Jones, 1993, PP. 1825-1831
[3]. Shah SP and Ahmed SH. High Performance Concrete. New York: McGraw-Hill , 1994
[4]. Cornelissen HAW., Hellewarrd R E and Visssens, JLJ. Processed fly ash for performance concrete, CANMET/ACI Conference, Wisconsin, USA, 1995, PP 67-81
[5]. Erdogdu K and Turker P., Effect of fly ash particle size on compressive strength of Portland cement fly ash, cement concrete research 1998, 28 : 1217 – 22
[6]. Mullick, AK., use of fly ash in structural concrete: Part II – How much?, The Indian concrete journal, June 2005, PP. 10-14

[7]. Rangan B. Vijaya, mix design and production of fly ash based geopolymer concrete, The Indian concrete Journal, May 2008, Vol.82, NO.5, PP. 7-14
[8]. Indian standard code of practice for specification for 53 grade of ordinary Portland cement, IS: 12269 – 1987 (Reaffirmed 2004). Bureau of Indian standards, New Delhi.
[9]. Indian Standard code of practice for specification for coarse and fine aggregate from natural sources for concrete, IS: 383 – 1970 (Reaffirmed 2002). Bureau of Is, New Delhi.
[10]. Indian Standard code of practice for recommended guidelines for concrete mix design, IS: 10262 – 1982 (Reaffirmed 2004). Bureau of IS, New Delhi.
[11]. Indian Standard code of practice for hand book on concrete mixes, SP : 23 – 1982, Bureau of Indian Standard, New Delhi. 49