STUDY ON COMPOSITE CONCRETE USING FLY ASH AND M-SAND AND FLY ASH AGGREGATES

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ABSTRACT
Scarcity of Natural River sand because of environmental condition need an alternative material. One such alternative is "Manufactured sand". The use of Sand in concrete is desirable because of benefits such as useful disposal of a byproduct, reduction of river sand consumption and increased strength. The use of fly ash in concrete is desirable because of benefits such as increased workability, reduction of cement consumption and decreased permeability. The use of fly ash leads to a reduction in early strength of concrete but there is an increase in long term strength. This paper investigates the strength of concrete mix at 28-day and 56-day age containing 0%, 25% & 50% of fine aggregate by Sand and 0%, 25% & 50% of cementations materials by fly ash. The concurrent use of the two byproducts will lead to an economic and environmental benefit. The present study attempts to investigate the influence of partial replacement of fly ash for cement and Sand for fine aggregate on the mechanical properties and compared with the conventional concrete.

Keywords— *manufactured sand, Fine aggregate, Fly Ash, Workability, Compressive strength.*

INTRODUCTION
Concrete is the most basic material which is been used in construction industry since very long time in various fields of construction such as in buildings, bridges, pavements, dams, marine, sanitary structures and many others. Concrete is durable in nature. It is plastic and pliable in nature in its fresh state. Concrete is a building matter mainly composed of water, FA and CA embedded in a harden matrix of material called cement, which fills up the voids among aggregates and adheres them strongly. Concrete is good in compression but weak in tension, therefore the reinforcements are provided so that the required strength can be achieved in the tension zone.

The most important component of a concrete is cement. The manufacture of cement causes various environmental and social consequences depending on considerations which are both harmful and are welcomed. Cement industries produce a huge amount of carbon dioxide. Various attempts have been made to reduce the carbon dioxide emission relating to concrete from both industrial and academicals sectors by substitution of conventional clinkers with industrial bi products such as fly ash. The use of industrial wastes gaining importance as additives, because they increase strength, decrease density and most importantly decrease environmental impacts.

During the coal combustion process huge amount of combustion residues are produced and require proper disposal. Fly ash and bottom ash are the major ingredients. Fly ash is reprocessed more as compared to

bottom ash, as it is used in concrete to enhance the strength.

The characteristics of fly ash and bottom ash differ completely even if the source is same. Fly ash a small particulate grey in color with diameter less than 300 microns is captured and removed from flue gas by electrostatic precipitators. Bottom ash is a residue at the bottom of the furnace and consists of large particles. Coal ashes are mainly composed of oxides of silica, aluminium, iron, calcium, magnesium and sulphur.

FLY ASH AGGREGATES

Generally the light weight aggregate concrete are shown to be having adequate strength and durability and they have been started adopting in many structures of importance. The main objective of using fly ash aggregate is to reduce the self-weight of concrete giving same strength compared to the natural aggregates. Aggregates of fly ash are generally produced by mixing FA with water and cement. The cement and FA of various proportions are tried with suitable water content to get the pelletized aggregates. The aggregate crushing and impact value were studied on these aggregates based on those test results the cement and fly ash proportion will be fixed to introduce it in concrete. These aggregates can be effectively used in the making of light weight concrete. The procedure of preparation of these types of aggregates is called pelletisation. Pelletization process in which a suitable proportion of cement and fly ash selected and will be added into a mixing drum to get pellets of fly ash aggregate maintaining a suitable W/C ratio.

Fig: Fly Ash Aggregates

LITERATURE REVIEW

N.P. Rajmani and P.S. Ambily , 2006 [1]: In this study the usage of mortar for the aggregate of light weight concrete was made with aggregate based fly ash was examined and it was found that the aggregate of fly ash is technically viable and also found out to be having relatively less weight in nature as compared with natural aggregates. The aggregates of fly ash can be made use in the manufacturing of blocks of cocnrete in masonry structures up to 20Mpa. However by using of less content aggregates of fly ash in concrete more than 40Mpa strength can be achieved.

S. Shanmugasundaram, et al, 2010 [2]: In this study utilization of fly ash aggregates in concrete was made. The coarse and fine aggregates were fully replaced by aggregates of fly ash in the concrete for M20 mix. The aggregates made of fly ash were manufactured by blending the FA with water and cement. The proportions of FA and cement were 90:10, 87.5:12.5, 85:15,

82.5:17.5, 80:20 and 77.5:22.5 were tried with W/C ratio as 0.3. The concrete cubes, beams and cylinders were and tested with the above 6 proportions of fly ash cement. It was discovered that the flexural, compressive, and tensile strength was seem to be higher for the ratio 85:15 for 7 and 28 days compared with control concrete.

A. Sivakumar and P. Gomathi, 2012 [3]: This paper mainly focuses on usage of pelletized fly ash low weight aggregate in concrete. Fly ash is a material that can be mostly used as a cementations material, replacement for fine aggregates and also as a light weight aggregate. Fly ash aggregate manufactured by pillarization is an effective aggregate in concrete. The pillarization efficiency depends on pelletizer speed, pelletizer angle and the binder type added with fly ash. In recent times, the usage of artificial aggregates such as fly lash aggregates reduces construction costs compared with conventional aggregates. In future the fly ash aggregate can be compensated by the nature resources for the aggregate.

Rahul Bansal and et al, 2015 [4]: This report reveals the experimental studies on the "Effect on Compressive Strength with Replacement of Fly Ash Partially". International Journal on Emerging Technologies 6(1): 2015. In this paper the fly ash is partially replaced with cement at 10%, 20% and 30. For all the above proportions three cubes of M-20 grade of size 150X150X150 mm were tested on compression testing machine and compression strength of these cubes were noted at the age of 7 and 28 days. The result showed that the 10% fly ash replacement gives 20% and 50% increase in the compressive strength at the age of 7 and 28 days respectively. It was observed with replacement of 20% fly ash concrete compressive strength was increased by 7% and 11% as compared to normal concrete cubes. It was seen that with 30% of fly ash 23% and 25% increase in compressive strength at 7 and 28 days period of curing. It was also observed that with increase in age the compressive strength also increases for fly ash replaced concrete.

Shwetha P C and et al, 2015 [5]: This paper reveals the "Experimental Study on Replacement of Cement by Fly Ash Partially with Glass Fiber Reinforcement". IJERT Vol. 4 Issue 05, May-2015

In this study fly ash was used as a mineral ingredient in cement for M-40 grade concrete. Glass fibers are used as additional reinforcement of constant 0.17% by weight of cement.

Here fly ash has been partially replaced with cement at 5% to 30% in the interval of 5% for determining the mechanical properties at the age of 7, 28 and 56 days. The result showed that the workability increases for fly ash concrete mix and decreases for the fly ash and glass fiber combinational mix in the concrete. The compressive strength of fly ash concrete specimens was seemed to be higher than the corresponding conventional concrete at 28 and 56 days. 10% FA and 0.17% GF seemed to give good flexural strength compared to the control mix and fly ash concrete mixes. 15% FA and 0.17% GF combination seemed to give good tensile

strength compared to the control mix and fly ash concrete mixes.

Jayesh kumar pitroda and et al, 2012 [6] made an Experimental analysis on Partial Replacement of Cement with Fly Ash in Design Mix Concrete. Here in this paper the cement is fly ash replaced in various proportions from 0% to 40% at interval of 10% by wt. of cement for M-25 and M-40 mix. Concrete specimens were casted, tested and compared in terms of compression and tensile strength with the normal concrete. The tests were performed to find out the general properties for the test results for compressive strength until 28 days and tensile strength for 56 days are recorded. From the result it was seen that the compressive and tensile strength decreases with fly ash content increase in concrete.

Aman Jatale and et al, 2013 [7]: In this paper they have analyzed the "Effects on Compressive Strength When Cement Is Replaced by Fly Ash". Here they have partially replaced with 20%, 40% and 60% by weight of cement. The effect of fly ash on workability, compressive strength, elastic modulus were studied and concrete grades of M15, M20, M25 with different fly ash proportions were studied, the result showed that the use of fly ash improves with workability of concrete which reduces the use of admixture dosage in concrete. The elastic modulus of concrete using fly ash also decreases with the increase in % age of fly ash for a taken W/C ratio. The compressive strength of the concrete decreases with increase in fly ash content. The Rate of development of strength in concrete at distinct stages is compared to the W/C ratio and fly ash %ages in the concrete mix.

T. Subramani and K.S. Ramesh, 2015 [8]: Made an "Experimental Investigation on Partial Replacement of Fly Ash and Complete Replacement Of Natural FA With M-Sand". The fly ash is partially replaced with 25%, 30% and 35% by cement in concrete. The Cubes, Cylinders and beams were casted, cured and tested after 7, 14 and 28 days of water curing. The result showed that the compressive, flexural and tensile strength increases with gradual increase in fly ash content for 7, 14 days compared to control concrete. For 28 days the compressive, flexure and split tensile strength increases and reaches maximum at 30% fly ash content compared to control concrete.

Rafat Siddique, 2003 [9]: Studied the "Effect of fine aggregate replacement with Class F fly ash on the general properties of concrete". Cement and Concrete Research 33, 2003. In this study the fine aggregates was replaced from 10% to 50% of class F fly ash by the weight of cement. Compressive, tensile, flexure strength and modulus of elasticity were found out at 7, 14, 28, 56, 91, and 365 days of curing. M-20 concrete mix proportion was adopted and the melamine based super plasticizer was used for all mix proportions. The result showed that compressive, tensile, flexural strength and Elastic Modulus of natural FA replaced with fly ash concrete specimens were found to be more than the normal concrete specimens at all ages and the strength increases with increase in ages. The maximum compressive, Split and

flexure strength seem to occur at 50% fly ash content at different ages.

METHODOLOGY

- The materials like Cement, Fly Ash, M-Sand, Natural Coarse Aggregate, Fly Ash Aggregates and grade of concrete are selected and their characteristics has been thoroughly analyzed.
- Using these materials, Design mix is done with required w/c ratio for M25 concrete grade.
- Optimum value for fly ash by partial replacement for cement will be determined.
- Selection of best proportion of fly ash aggregate is done with various different proportions of cement and fly ash (80:20, 70:30, 60:40) by comparing the impact and crushing value with natural coarse aggregates.
- The best proportion of fly ash aggregate is selected and partially replaced with natural coarse aggregate for different proportions.
- The cubes, beams and cylinders are casted and tested for different mix proportions.

Finally with obtained results conclusions are given.

Table Crushing Value for (60:40) Ratio

S.No.	Description	Values (g)
1	Total wt. of aggregate filled the Cylindrical measure **[W_1]**	1906 g
2	Weight of aggregate passed through IS 2.36mm sieve after test **[W_2]**	547 g
3	Weight of aggregate retained on IS 2.36mm after test **[W_3]**	1273 g
4	Aggregate crushing value = $(\boldsymbol{W2 \div W1}) \times \mathbf{100}$	**28.70**

RESULT:

Fly ash aggregate crushing value= **28.70%**

Table Impact Value and Crushing Value of Different Proportion of FAA

Ratio	80:20	70:30	60:40	Natural Aggregates
Impact Value (%)	26.22	23.55	20.37	20.91
Crushing Value (%)	37.65	30.65	28.70	31.5
Specific Gravity	1.74	1.65	1.62	2.64

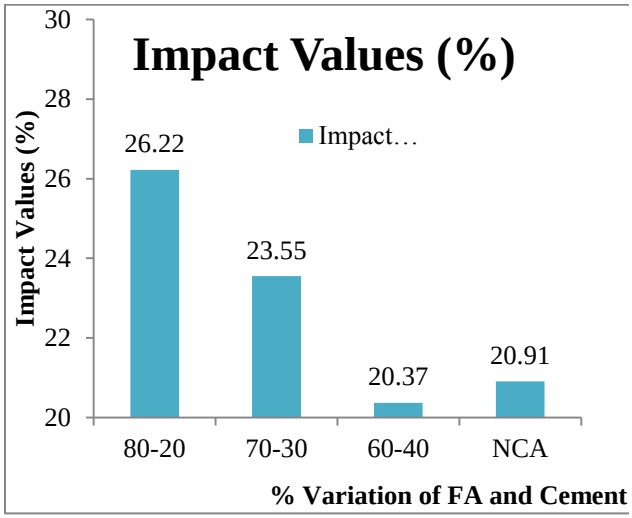

Fig Impact Value of Different Proportion of FAA

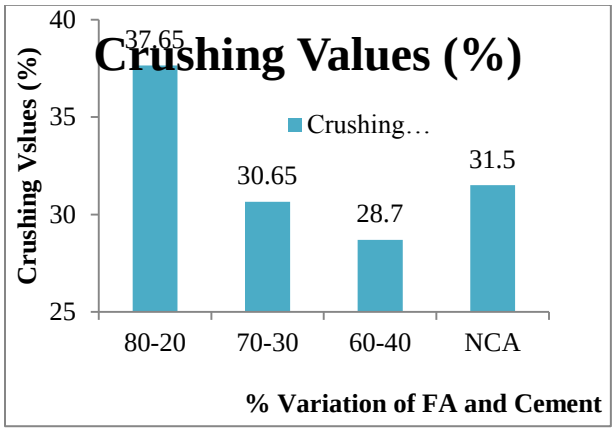

Fig Crushing Value of Different Proportion of FAA

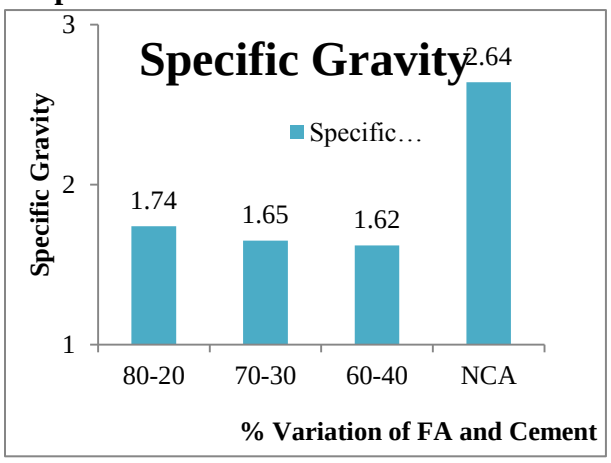

Fig Specific Gravity of Different Proportion of FAA

The FAA's were first produced adopting proportions 80:20, 70:30, and 60:40. And were cured for 28 days, after the curing is done the basic tests such as aggregate crushing, impact and specific gravity were conducted, based on the test results 70:30 proportioned FA and cement seemed to give better results and by considering the economy factors too it was considered suitable and was adopted in production of FAA.

FLEXURAL STRENGTH TEST

Table: Flexurall Strength of M25 Concrete Grade with 20% Fly Ash as Cement Replacement and using Fly Ash Aggregate for 28 and 56 Days in N/mm^2

Sl. No.	% Variation in FAA	Flexural strength in N/mm^2	
		28 days	56 days
1	CC	3.86	4.07
2	0% FAA	3.80	3.95
3	10% FAA	4.05	4.33
4	20% FAA	4.43	4.50
5	30% FAA	4.51	4.66
6	40% FAA	3.98	4.26
7	50% FAA	3.90	4.14

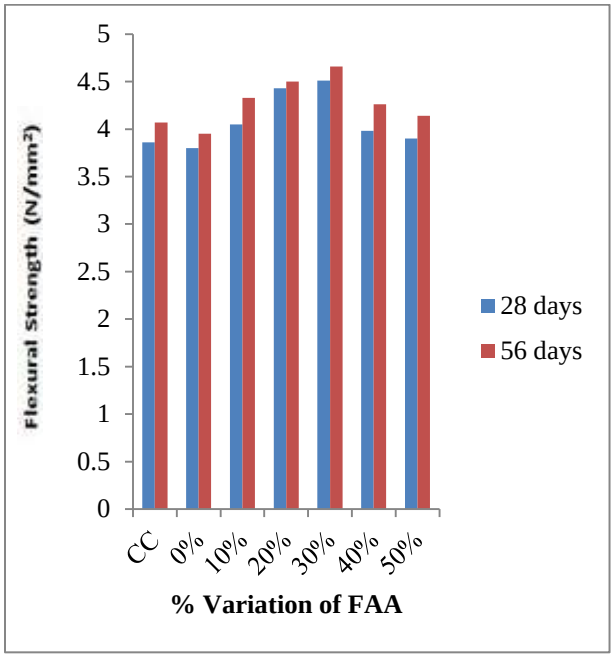

Fig: % Variation of FAA with Respect to NCA for 28 & 56 Days in N/mm^2

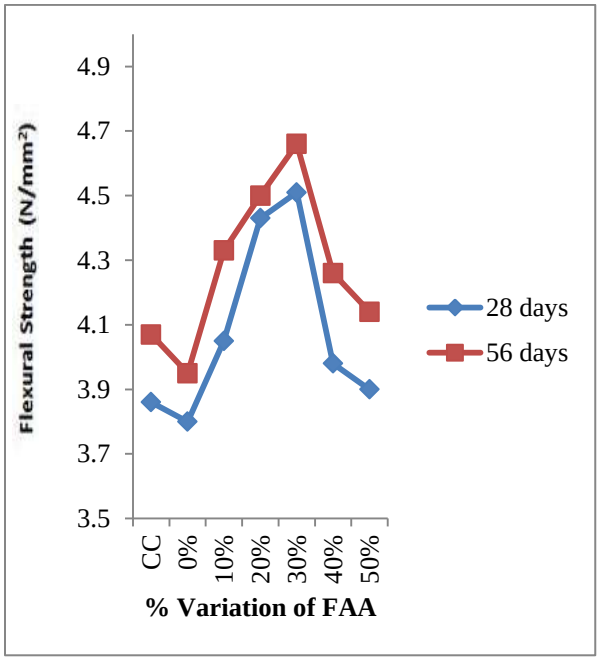

Fig: % Variation of FAA with Respect to NCA for 28 & 56 Days in N/mm^2

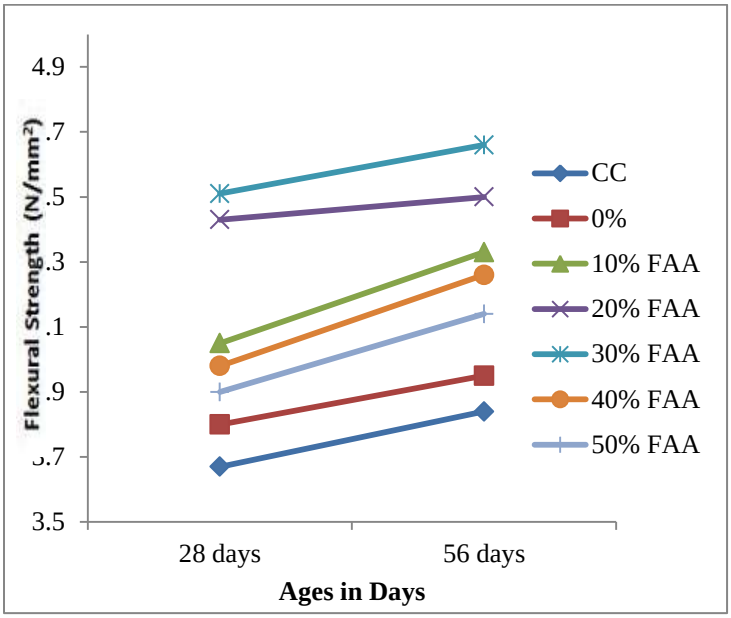

Fig: % Variation of FAA with Respect to NCA for 28 & 56 Days in N/mm^2

Discussion on Flexural Strength Test

The variation of flexure strength v/s percentage of light weight FAA as a replacement to natural aggregates for 28 & 56 days of curing are as shown in above figures. The flexural strength value was found to increase with addition of aggregates of fly ash until an optimum of 30% replacement with natural coarse aggregates and decreasing gradually.

DRY DENSITY TEST

The density of normal concrete and concrete with replacement fly ash aggregates at various percentages, keeping 20% replacement of FA with cement as constant is tabulated below.

Table : Dry Density of Concrete with 20% Fly Ash as Cement Replacement and using Fly Ash Aggregate for 28 days in kN/m^3

S. No.	% Variation of FAA	Density in kN/m^3
1	CC	24.75
2	0% FAA	24.45
3	10% FAA	24.21
4	20% FAA	23.60
5	30% FAA	22.70
6	40% FAA	21.96
7	50% FAA	21.13

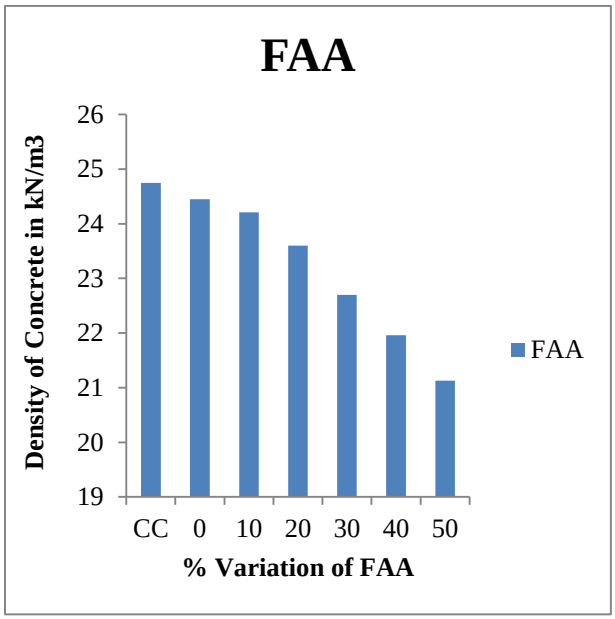

Fig: Density of FAA Concrete at 28 Days

Discussion on Density of Concrete

Density of FAA concrete is lowered as the percentage of aggregates of fly ash increased from 0% to 50% when compared to conventional concrete, this is because the specific gravity of both fly ash and aggregates of fly ash are less than cement and Natural coarse aggregate respectively.

CONCLUSIONS

On the basis of the experimental investigations made and analysis of the results, following are the conclusions which are made.

1. From the experimental study it has been seen that the preparation of structural light weight aggregate concrete from Pelletized aggregates of fly ash is possible.
2. The pelletized aggregate of fly ash are seem to be lighter and porous in nature, has a bulk density less than that of plain concrete and that is why it is called light weight aggregate.
3. The aggregates of fly ash are seem to be spherical in shape which affects the workability of concrete with water content variations when made comparisons with normal concrete.
4. The various proportions of fly ash and cement i.e. 80:20, 70:30, 60:40 which were adopted in the preparation of FAA, The 70:30 proportion was seemed to give better strength & was considered economical too.
5. Before the preparation of fly ash aggregate concrete, the optimum value for fly ash as a partial replacement was found out by conducting compression test result. It was observed that the 20% of fly ash as a substitute to cement seemed to give maximum strength and so it was adopted in the production of FAA concrete.
6. From experimental study on FAA concrete it is concluded that the compressive, tensile and flexural strength are seemed to be increased continuously at some optimum value of 30% and then seem to decrease with further addition of FAA content. But it was also observed that all the proportions

from 10% to 50% of FAA here in this thesis work are seemed to give more strength as compared to CC and hence higher proportion of FAA can be adopted further.

7. The density of FAA concrete is decreased with % replacement of fly ash and Fly ash aggregate this is mainly due to low specific gravity of FAA and FA. And the density was seemed to be reducing by 8% for 30% FAA optimum value as compared to the conventional concrete.

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