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STUDY ON FLYASH CONCRETE USING SEM ANALYSIS

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ABSTRACT *Increasing the performance of concrete with the partial replacement of mineral admixture using flyash along with chemical admixtures eliminates these drawbacks besides enhancing durability characteristics. This paper reports the investigation carried out on concrete with partial replacement of cement by flyash. Concrete mixes, viz. Conventional concrete mixes with varying percentages of flyash (10, 20, 30 and 40%) as cement replacement material were investigated. The compressive strength, tensile strength of cubes and cylinders and flexural strength test were carried out on 4 concrete mixes at the ages of 28,45,60,90 and 180 days. The effect of fllyash as cement replacement material on mechanical properties were analyzed and compared with conventional cement concrete. This paper briefly presents the compressive strength, tensile strength of cubes and cylinders and flexural strength of all the concrete mixes investigated at the age of 28,45,60,90 and 180 days. The SEM analysis of the flyash concrete is studied in detailed.*

Keywords: Flyash, Compressive strength, Tensile strength, Flexural strength, Cement Replacement Material, SEM analysis.

INTRODUCTION

The production of each tone of Portland – cement clinker is accompanied by the release of approximately one tone of the greenhouse gas carbon dioxide (CO_2). Besides other raw materials, each tone of Portland cement requires approximately 1.5 tones of limestone, and considerable amounts of both fossil fuel and electrical energy .Therefore, the challenge before the power sector is how to utilize flyash before major environmental problems crop up. To find out the users for flyash, the Neyveli Lignite Corporation organized a workshop at Neyveli near here recently. In general the concrete made up of flyash which meets special performance requirements with regard to workability, strength and durability, that cannot always be obtained with techniques and materials adopted for producing conventional cement concrete. The cement content of conventional high strength concrete is generally high which often leads to higher shrinkage and grater emission on heat of hydration, besides increased cost. A partial replacement of cement by mineral admixture such as flyash in concrete mixes would help to overcome these problems and lead to improvement in the durability of concrete. This would also lead to additional benefits in terms of reduction in cost, energy savings, environmental pollution of dumping, promoting ecological balance and conservation of natural resources, etc, In order to evaluate the mechanical and durability related properties, an experimental investigation was carried out on M20 grade concrete with flyash as cement replacement material. This paper presents the mechanical properties of concrete and SEM analysis support this strength.

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MATERIALS AND METHODS

The flyash wastages increase year by year. Here is the information about the Gross electricity generation, Coal requirement (million tones) and Flyash generation (million tones) is shown in the Fig1.

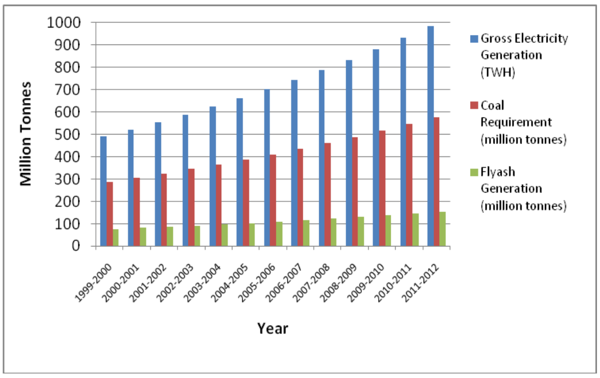

Fig.1 Flyash generation in (million tones)

Ordinary Portland cement 53 grade with the Properties given in Table 1was used throughout this experimental investigation. The cement satisfied the requirements of Indian standard Specification IS: 12269-1987. Flyash obtained from Neyveli Lignite Corporation Thermal Power Plant I is used in the experimental investigation. The physical and chemical analysis of lignite ashes were carried out at Neyveli Lignite Corporation Ltd. The results were compared to Indian standard specification IS: 3812-1981. The physical and chemical properties are shown in the Table 2 was used in this investigation. Table 2 shows some of the important physical and chemical properties of the flyash. Natural river Sand conforming to grading zone II of IS: 383-1970 with specific gravity 2.6 and fineness modulus 2.96 as fine aggregate. The coarse aggregate was a normal weight aggregate with a maximum size of 20mm.The workability ranges of concrete maintained 40 – 60 mm in terms of slump.

Table 1: Physical properties of cement

Physical properties	Present study value	Permissible range IS:12269-1987
Specific gravity	3.1	- -
Standard consistency	33%	-
Initial setting time	90 minutes	>30 minutes
Final setting time	300 minutes	<600 minutes

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Table 2: Physical and chemical properties of Neyveli flyash

Physical and chemical composition	Neyveli flyash	IS:3812-1981
Specific gravity(% of retained on 45/µm)	1.92	-
Fineness (By Blaine s) cm2/gm	4668	3200 min
Bulk density gm/cc	0.94	-
SiO_2	46.3%	35.0% min
Al_2O_3	22.1%	-
Fe_2O_3	3.1%	-
CaO	13.3%	-
MgO	3.11%	5.00 % max
Na_2O	0.9%	1.5%
K_2O	0.78%	-
TiO_2	0.78%	-
P_2O_5	0.44%	-
MnO	0.13%	-
BaO	1.18%	-
SO_3	0.80%	2.75%max
LOI(Loss on ignition)	0.65%	-
SiO2+Al2O3+Fe2O3	71.5%	70.00% min

Mix proportion

Four volumes flyash concrete mixes were made by replacing ordinary Portland cement with 10%, 20%, 30% and 40% of class F flyash by mass. These concrete mixes are named as CF1, CF2, CF3, and CF4 respectively. The concrete mix of the concrete was designed with a mix ratio of cement/sand/coarse aggregate of 1:1.66:3.61 by weight all the ingredients mixed in dry for few seconds in a titled drum type concrete mixer. Then the properties of concrete at fresh state were evaluated. The water – to- cementitious material ratio was varied from 0.48 to 0.39.

Preparation and casting of test specimens

Concrete cubes of 150 mm in size were cast from all the concrete mixes for compressive strength, 150 x 300 mm cylinders for tensile strength, 100x100x500mm prism for flexural strength. All the concrete specimens were prepared in accordance with Indian standard specifications IS: 516-1956. After 24 hours of casting the specimens were demoulded and put into water curing tank until the age of testing.

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RESULT AND DISCUSSIONS

Compressive strength of cubes

The compressive strength of concrete cubes made with Flyash was determined at the ages of 28,45,60,90 and 180 days results shown Figure 2 with conventional concrete. From the test results it is observed that the compressive strength increased by 1.92% to 21.1% at 10% and 20% replacement flyash. Similarly for 45, 60, 90, and 180 days compressive strength is increased. When flyash replaced in cement, the strength is significantly greater than that of the control mix. These observations indicate the beneficial pozzolanic reaction of flyash in concrete. At mixing ratios of 30% and 40% displayed a reduction in compressive strength than that of conventional concrete respectively. This inclination may be due to high ash content which increases the w/c ratio. The presence of silica in flyash reacts with free lime either from cement or from any other source forming higher order hydrated products leading to increased compressive strength.

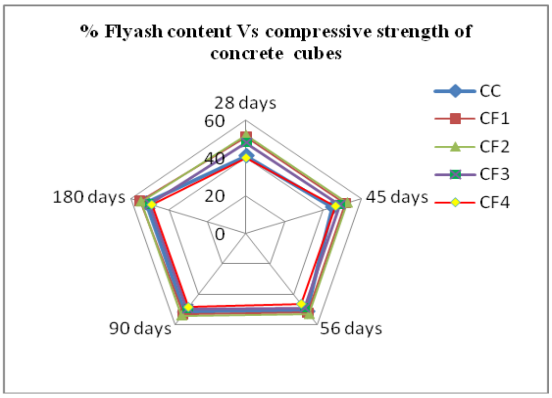

Figure 2 Compressive strength of cubes

Compressive strength of cylinder

The compressive strength of concrete cylinder made with flyash was determined at the ages of 28,45,60,90 and 180 days results shown Figure 3 with conventional concrete. From the test results it is observed that the compressive strength increased by 2.9% to 17.3% at 10% and 20% replacement flyash. Similarly for 45, 60, 90, and 180 day s compressive strength is increased. These observations indicate the beneficial pozzolanic reaction of Flyash in concrete. At mixing ratios of 30% and 40% at 45, 60, 90 and 180 days displayed a reduction in compressive strength compressive strength of conventional concrete respectively. This is due to high ash content and increases the w/c ratio. The presence of silica in flyash reacts with free lime either from cement or from any other source forming higher order hydrated products leading to increased compressive strength.

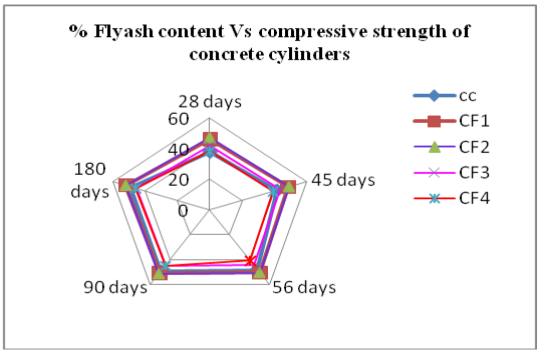

Figure 3 Compressive strength of Cylinders

Tensile strength of cubes

The tensile strength of concrete cubes made with flyash was determined at the ages of 28,45,60,90 and 180 days results shown Figure 4 with conventional concrete. From the test results it is observed that the tensile strength increased by 0.9% to 14.6% at 10% and 20% replacement flyash. Similarly for 45, 60, 90, and 180 day s tensile strength is increased. When flyash replaced in cement, the strength is significantly greater than that of the control mix. These observations indicate the beneficial pozzolanic reaction of Flyash in concrete. At mixing ratios of 30% and 40% at 45, 60, 90 and 180 days displayed a reduction in tensile strength than that of conventional concrete respectively. This inclination may be due to the increase in the ash with absorps more water. The presence of silica in flyash reacts with free lime either from cement hydrated products leading to increased tensile strength.

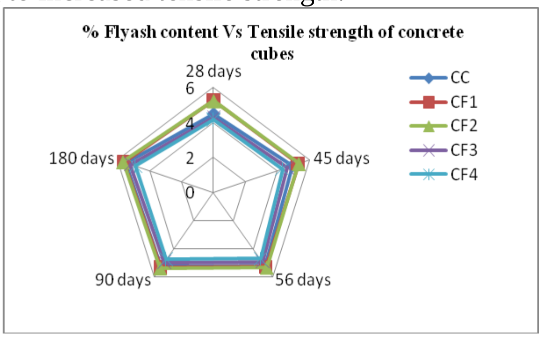

Figure 4 Tensile strength of Cubes

Tensile strength of cylinder

The tensile strength of concrete cylinder made with flyash was determined at the ages of 28,45,60,90 and 180 days results shown Figure 5 with conventional concrete. From the test results it is observed that the tensile strength increased by 0.9% to 3% at 10%, 20% and 30% replacement flyash. Similarly for 45, 60, 90, and 180 day s tensile strength is increased. These observations indicate the beneficial pozzolanic reaction of Flyash in concrete. At mixing ratios of 30% and 40% at 45, 60, 90 and 180 days displayed a reduction in tensile strength than that of conventional concrete respectively. This is due to high ash content by which the w/c ratio

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increases. The presence of silica in flyash reacts with free lime either from cement or from any other source forming higher order hydrated products leading to increased tensile strength.

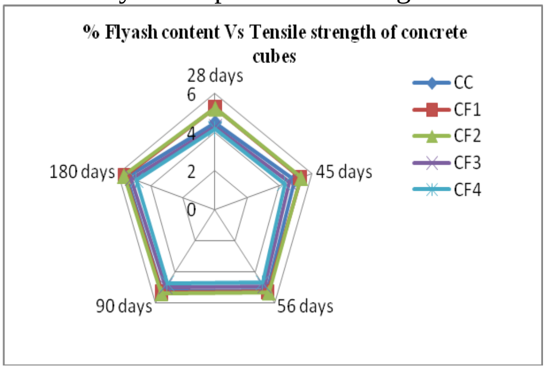

Figure 5 Tensile strength of Cylinder

Flexural strength of Beam

The flexural strength of concrete made with flyash was determined at the ages of 28,45,60,90 and 180 days results shown Figure 6 with conventional concrete. From the test results it is observed that the flexural strength increased by 1.1% to 6.0% at 10% and 20% replacement flyash. Similarly for 45, 60, 90, and 180 day s tensile strength is increased. When flyash replaces cement, the strength is significantly greater than that of the control mix. These observations indicate the beneficial pozzolanic reaction of flyash in concrete. At mixing ratios of 30% and 40% at 45,60,90 and 180 days displayed a reduction in flexural strength than that of conventional concrete respectively. This is due to increase in ash increase the w/c ratio. The presence of silica in flyash reacts with free lime either from cement or from any other source forming higher order hydrated products leading to increased Flexural strength.

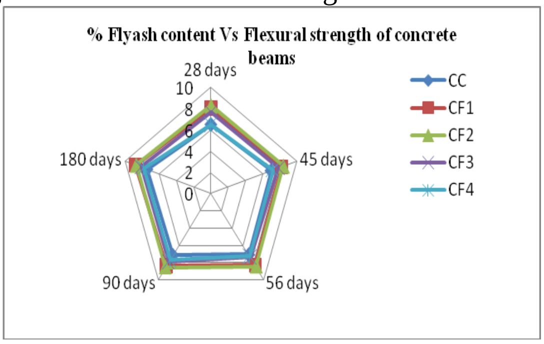

Figure 6 Flexural strength Vs curing days

The data presented in this paper show that there is great potential for the utilization of Flyash in concrete as cement replacement material. It is considered that latter form would provide much greater opportunities for value adding and cost recovery as it could be used as a replacement for non available of cement. The use of flyash in concrete would prevent expansive ASR in the presence of sand. The presence of silica in flyash reacts with free lime either from cement or from any other source forming higher order hydrated products leading to increased strength. Strength gain of flyash concrete is satisfactory. It has been concluded that 20% flyash could be

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incorporated as cement replacement without any long-term detrimental effects. Up to 40% of flyash could also be replaced in concrete of 40-MPa strength grade with acceptable strength.

SEM and EDS of conventional concrete

The collected samples were carbon coated and analysed using a scanning electron microscope (SEM) in the back scattered electron mode with an accelerating voltage of 20Kev. The back scattered Intensity was set to the same parameter for each sample. The SEM analysis of conventional concrete, 10% and 20% replacement of Flyash concrete is shown in the Fig.7, Fig.9, Fig.11 and its EDS is shown in the Fig.8 , Fig.10 , Fig.12.

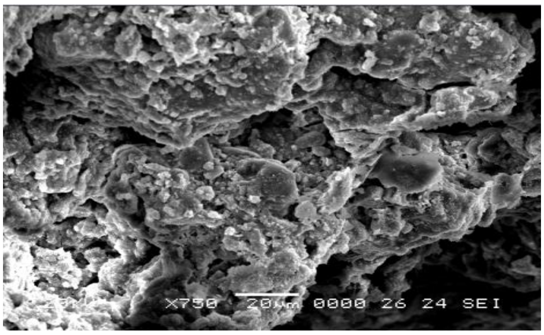

Figure 7 SEM of Conventional concrete

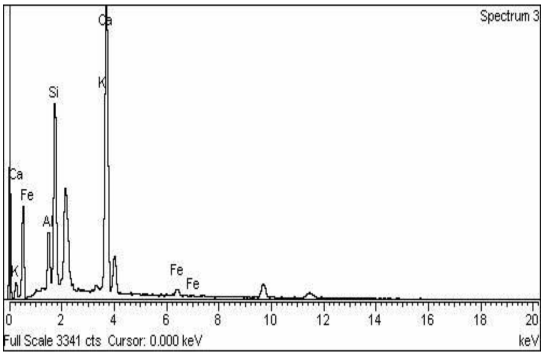

Figure 8 EDS of Conventional concrete

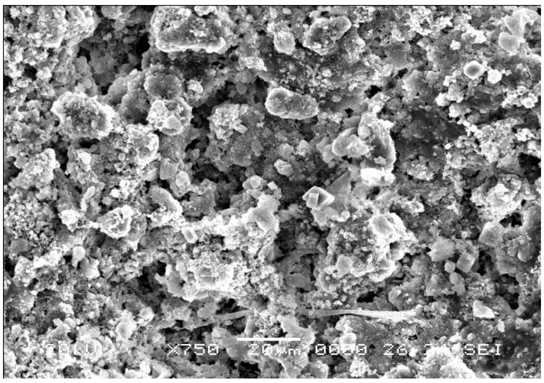

Figure 9 SEM of (C+10% Flyash) Concrete

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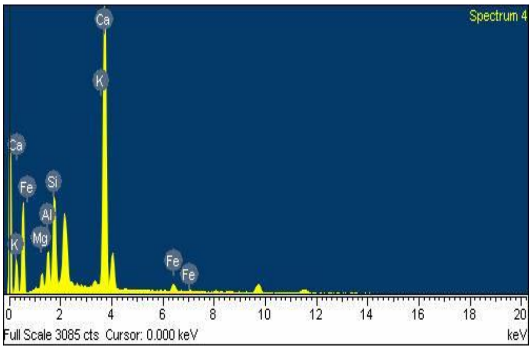

Figure 10 EDS of (C+10% Flyash) concrete

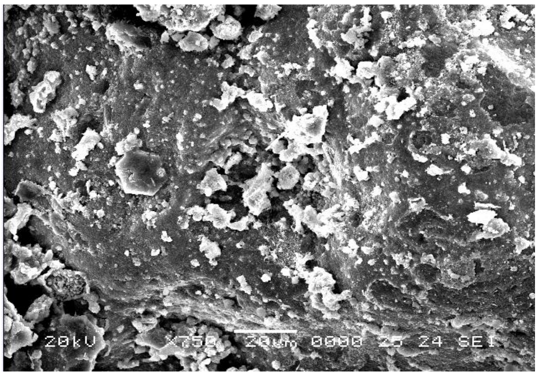

Figure 11 SEM of (C+20% Flyash) concrete

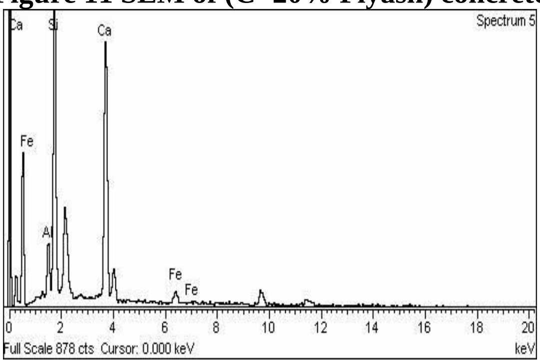

Figure 12 EDS of (C+20%Flyash) concrete

CONCLUSION

The data presented in this paper show that there is great potential for utilization of flyash in concrete in several forms. It is considered that the latter form would provide much greater opportunities for value adding, cost recovery and reduce the environmental pollution near neyvelli were the flyash are carried for dumping. It has been concluded that 20% neyvelli flyash could be incorporated as cement replacement in concrete. Since the concrete specimens containing 10% and 20% flyash were examined by scanning electron microscopy (SEM) represent dense microstructure which increases the strength in concrete.

REFERENCES

1.Mehta, P.K, "Reducing the environmental impact of concrete", Concrete International, Vol.23, pp.61-66 October **(2001).**

2.Gopalakrishnan .S, Rajamne, N.P., Neelamegam, Peter.J.A, and Dattateya, J.K. "Effect of partial replacement of cement with flyash on the strength and durability of HPC", Indian Concrete Journal, vol.75, No.5, pp. 335-341, May **(2001).**

3.Papayianni J. Concrete with high – calcium Flyash. In: Supp., papers of 4th international conference on the "Use of Flyash, Silica fume, slag and natural pozzolans in concrete", Istanbul. pp. 261-84 ACI: **(1992).**

4.Li D, Chen Y, Shen J, Wu X, "The influence of alkalinity on activation and microstructure of flyash. Cem Concr Res., **(1989)**

5.Marsh B.K, Day R.I, "Pozzolanic and cementitious reactions of flyash in blended cement pastes. Cem Concr Res **(1988)**

6.Diamond S. Minimal pozzolanic reaction in one year old flyash paste. An SEM evaluation. In: Proceedings of the 11th ICCM, New Oricans, **(1989)**

7.IS 12269 Specification for 53 grade ordinary Portland cement, Bureau of Indian standards, New Delhi**.(1987)**

8.IS 383 Specification for coarse and fine aggregates from natural sources for concrete , Bureau of Indian Standards, New Delhi**.(1970)**

9.IS 2386 (Part I-VIII), Methods of test for aggregate for concrete, Bureau of Indian standards, New Delhi**.(1963)**

10.IS 7320 Specification for concrete slump test apparatus, Bureau of Indian standards, New Delhi**.(1974)**

BIOGRAPHY

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