International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 02 | Feb -2017 www.irjet.net p-ISSN: 2395-0072

EXPERIMENTAL STUDY ON CONCRETE CONTAINING FLY ASH

Aayush Choure[1], Dr. Rajeev Chandak[2]

[1]M.E.-scholar, (structural engineering), department of civil engineering , Jabalpur engineering college Jabalpur India.

[2] Head of the department, department of civil engineering, Jabalpur engineering College Jabalpur India.

Abstract –

In India, currently a large amount of fly ash is generated mainly in thermal power plants with an imperative blow on environment and living organism. The use of fly ash in concrete can reduce the consumption of natural resources and also diminishes the effect of pollutant in environment. In recent studies, many researchers found that the use of additional cementitious materials likes fly ash in concrete is economical and reliable. This investigation is a part of experimental programme carried out to study the utilization of non-conventional building material (fly ash) for development of new materials and technology. It is aimed at materials which can fulfil the expectations of the construction industry in different areas. In this study, cement has been replaced by fly ash accordingly in the range of 0% ,5%10%,15%, 20% by weight of cement for M-30 mix with 0.43 water cement ratio. The most important mechanical property of concrete is compressive strength and it is evaluated on 150X150X150 mm cubes by The compressive strength is obtained for 28 day strength and results are analyses.

Key Words: class F fly ash, Ordinary Portland Cement(O.P.C.), Compressive strength

INTRODUCTION

In thermal power stations, mainly two types of ashes are produced from burning of coal. The lighter one goes up the chimney and collected either by mechanical or by electrostatic precipitator is known as fly ash. Portion of fly ash escapes along with hot gases through chimneys. The other fraction containing coarser materials are collected at the bottom of the furnace, is called bottom ash. Fly ash is fine and carried away with flue gases. It is separated from hot gases in Electrostatic precipitator. Fly ash is in two type class f and c, in class f fly ash normally produces by burring anthracite or bituminous coal, usually has less than 5% CaO. Class f fly ash has pozzolanic only and in class c fly ash normally produced by burning lignite or sub bituminous coal. Some class c fly ash may have CaO content in excess of 10%. In addition to pozzolanic properties, class c fly ash also possesses cementations properties. Over the past several decades, the use of fly ash in concrete has had a successful track record. The performance benefits fly ash provides to mechanical and durability properties of concrete have been well researched and documented in actual structures. Currently, fly ash is used in more than 50% of all ready mixed concrete placed in the India, yet many design professionals continue to remain overly restrictive when it comes to using fly ash in concrete.

A concrete mix with fly ash can provide environmental and economical benefits. Fly Ash concrete enhances the workability, compressive strength, flexural strength and also increases its pump ability, durability and concrete finishing. It also reduces corrosion, alkali silica reaction, sulphate reaction shrinkage as it decreases its permeability and bleeding in concrete. The disposal of fly ash is a serious environmental problem. A number of studies are going on in India as well as abroad to study the impact of use of these pozzolanic materials as cement replacements and the results are encouraging. Addition of fly ash to concrete has many advantages like high strength, durability and reduction in cement production. The optimum fly ash replacement percentage for obtaining maximum 28- day's strength of concrete ranged from 5% to 20%. Cement replacement up to 20% with fly ash leads to increase in compressive strength, for M30 grade of concrete. When pozzolanic materials are incorporated to concrete, the silica present in these materials react with the calcium hydroxide released during the hydration of cement and forms additional calcium silicate hydrate (C–S–H), which improve durability and the mechanical properties of concrete. In this paper suitability of fly ash has been discussed by replacing cement with fly ash at varying percentage and the strength parameters were compared with conventional concrete.

Literature Review

Some of the early researches have examined the use of fly ash (FA) in concrete.

Vittal (2001) stated that few embankments have already been constructed using pond ash in India. According to IRC, 2001 (a working body of Indian govt.) has proposed strategies to use fly ash in road embankments. Fly ash shows self-hardening behavior and can be utilized in construction over wide range. This property is due to the availability of free lime .The properties of it depends on various characteristics out of which some are characterization of coal, fineness of pulverization, furnace type and temperature of firing.

Chindaprasirt (2005) using fly ash in concrete increases the ultimate compressive strength of concrete. However, when high volume of fly ash replacement is used (50%), the compressive strength of concrete will decrease. Fly ash affects the strength of concrete due to a process known as the packing of fly ash particles. Physical features of fly ash such as sphericity, uniformity, and fineness of fly ash particles influence the effects of packing on concrete. Due to these physical properties, most of the voids or airspaces get filled with fly ash particles which increase the density of concrete. In addition to that, the pozzolanic reaction improves which results in increasing the compressive strength.

Hussein *et al*. (2013) in his study replaced OPC with 5 to 50% fly ash and observed that 10% fly ash showed the highest compressive strength at all ages, use of 15%-30% fly ash significantly increased the compressive strength at 90 and 180 days.

Mukherjee *et al*. (2013) reported that the zero slump concrete showed higher compressive strength compared to workable concrete with super plasticizer up to 60% replacement with fly ash. The strength gain with time is higher compared to the OPC concrete at all replacement level of cement by fly ash and the optimum strength gain was noted at 70% replacement at 28 days.

EXPERIMENTAL PROGRAM:-

Materials Used: The various material used in the preparation of concrete are cement, sand, cement coarse aggregates, fly ash(F.A.) and water.

Fly Ash: Class F Fly ash is normally produced from burning anthracite or bituminous coal that meets the applicable requirements. This class f fly ash has pozzolanic properties and will have a minimum silica dioxide plus aluminum oxide plus iron oxide. The physical and chemical properties are listed in table 1 and table 2 respectively.

Table 1 . Typical physical properties of fly ash.

Property	Value
Mean grain size (μm)	20
Specific surface (cm^2/g)	2680–4000
Specific gravity	2.1–2.4
Colour	Dark Gray

Table 2. Typical chemical composition of fly ash.

Compound	Percentage composition
Calcium oxide (CaO)	4.74
Silicon oxides (SiO_2)	46.80
Aluminum oxide (Al_2O_3)	23.89
Iron oxide (Fe_2O_3)	15.77
Magnesium oxide (MgO)	0.9
Sulfur oxide (SO_3)	1.18
Sodium oxide (Na_2O)	0.62
Potassium oxide (K_2O)	0.11
Loss on ignition (LOI)	2.36

Cement: Ordinary Portland Cement "Birla gold" (43 Grades). Which is available in market is used.

Fine Aggregate: The natural river sand available in local market which passes through 4.75mm sieve with specific gravity of 2.62. Conforming to Zone II.

Coarse Aggregate: Crushed granite conforming to IS 383 - 1987 is used in this study. Coarse aggregate passing through 20mm and retained on 16 mm sieve and specific gravity 2.82 was used.

Water: Water is an important ingredient of concrete as it actively participated in chemical reaction with cement, clean portable water which is available in our college campus is used.

Mix Proportion: The mixture proportion for the controlled concrete of M30 grade was arrived from the trial mix as per IS:10262-2009.

Table 3. Mix proportions

S.No.	% Replace by fly ash	Cement (Kg/m³)	Fly ash (Kg/m³)	Fine aggregate (Kg/m³)	Coarse aggregate (Kg/m³)	Water Kg/m³	w/c ratio
1.	0	423.25	0	656	1222	182	0.43
2.	5	402.08	21.17	656	1222	182	0.43
3.	10	308.92	42.32	656	1222	182	0.43
4.	15	359.76	63.48	656	1222	182	0.43
5.	20	338.60	84.65	656	1222	182	0.43

Methodology

Replacement levels of OPC by FA of 0,5, 10, 15 and 20 % were chosen for this research work. Batching was carried out by weighing as per calculated amount of each concrete constituent according to the mix ratio of 1:1.54:2.88 and M-30 grade of concrete was adopted. The constituents were then mixed thoroughly until a uniform mix was obtained. Water was then added and the mix was repeated. The fresh concrete mix was then placed in a mold of size 150 mm, compacted, and left for 24 h before testing Compressive specimens were tested at the ages of 7 and 28 days.

RESULT AND DISCUSSION

Compressive Strength:-The results of compressive strength were presented in Table 4. The test was carried out obtain compressive strength of concrete at the age of 7 and 28 days. The cubes were tested using Compression Testing Machine (CTM) of capacity 2000KN available in structures lab. From Fig1 the compressive strength is up to 33.34 N/mm² and 44.01 N/mm² at 7 and 28 days. The maximum compressive strength is observed at 20% replacement of fly ash. There is a significant improvement in the compressive strength of concrete because of the high pozzolanic nature of the fly ash and its void filling ability.

Table 4. Compressive strength test result of FA concrete at different ages.

S.NO.	Name of cube sample	Fly Ash (%)	Average Ultimate Compressive strength(N/mm²)	
			(7 days)	(28 days)
1.	F0	0	26.81	40.74
2.	F5	5	28.89	41.63
3.	F10	10	30.65	42.37
4.	F15	15	31.85	43.25
5.	F20	20	33.34	44.01

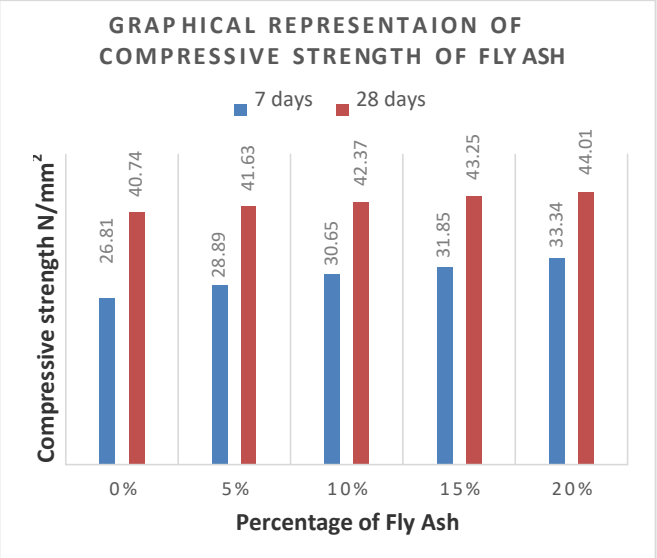

Figure 1 Relationship between compressive strength and different percentage of FA. at age of 7 and 28-days

CONCLUSION

In this study series of the experiments have been conducted on concrete with the addition of fly ash as partial replacement of OPC. In the fly ash was used as partial replacement of OPC in different percentage that is 0%, 5%, 10%, 15% and 20% of the dry weight of the cement. the experiments were conducted on M-30 grade of concrete as per relevant IS-code practice based on the test results obtained from this study the following conclusion can be drawn.

1. Having fly ash in a concrete mix as a replacement of cement, increases its compressive strength due to the pozzolanic activity of the ash.
2. The compressive strength of a fly ash concrete keeps increasing over a long time because the fly ash retards the hydration process of cement, whereas ordinary concrete reaches its maximum compressive strength after around 28 days.
3. 20% FA as replacement of cement has achieved the maximum compressive strength.
4. From the compressive strength test results, it is found that the higher strength is observed for the conventional concrete.
5. Finally the compressive strength increases with the increments of fly ash due to the pozzolanic reactivity of the ash and the fineness of the particles which improved the microstructure of the hardened concrete due to packing and filling effect. 20% FA is considered to be the best ratio of cement replacement in a concrete mix.

REFERENCE

[1]Weerachart Tangchirapat1; Chaiyanunt Rattanashotinunt2; Rak Buranasing3; and Chai Jaturapitakkul Influence of Fly Ash on Slump Loss and Strength of Concrete Fully Incorporating Recycled Concrete Aggregates Journal of Materials in civil Engineering © Asce / February 2013

[2]ACI Committee 211 (1993), Guide for Selecting Proportions for High Strength Concrete with Portland Cement and Fly ash, ACI Materials Journal, Vol.90, No.3, pp. 272-283.

[3] Bharat Kumar, B. H., Narayanan, R., Raghu Prasad, B. K., Ramachandra murthy, D. S. (2001), Mix proportioning of high performance concrete‖, Cement & Concrete Composites, Vol.23, pp. 71 – 80.

[4] Gopalan, M. K., Haque, M. N. (1986), —Strength development of fly ash concretes‖, Engineering Materials and Structures, Vol.19, No.1, pp. 33-37.

[5] Mehta, P. K. (1985), —Influence of Fly Ash Characteristics on the Strength of Portland Fly Ash Mixtures‖, Vol.15, pp.669 – 674.

[6] Xu, A., Sarkar, S.L. (1993), —Hydration and Properties of Fly ash Concrete‖, in S.N.Ghosh edited Mineral Admixtures in Cement and Concrete, Progress in Cement and Concrete series, Akademia Books International, New Delhi, India, pp. 174 – 225.

[7] Slanicka, S. (1991), —The Influence of Fly Ash Fineness on the Strength of Concrete‖, Cement and Concrete Research, Vol.21, pp. 285 – 296.