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GEO-Polymer Concrete by using Fly Ash

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Abstract:
Through research efforts, the Fly ash by-product materials have potential to be utilized as construction material to replace conventional Ordinary Portland Cement. Recycling the Fly ash by-product materials is the act of processing the waste material to creating an alternative product. The use of Fly ash as a pozzolanic material as a partial cement replacement for producing cement will reduce the environmental pollution problems created by excessive production of cement as well as the requirement for disposing the ash. In the present investigation, Fly ash concrete is mix according to 10%, 20%, 30% by weight of cement replaced with Fly ash. The present study designed to determine the effectiveness of Fly ash and discovered its potential as a cement replacement in concrete.

Keywords: Geo-polymer concrete, Fly ash.

I. INTRODUCTION

Concrete is the most widely consumed material in the world, after water. Now days, most of the construction for buildings and infrastructures in Malaysia are using concrete as construction material. It is a construction material composed of cement as well as other cementations materials such as Fly ash and slag cement, aggregate water, and chemical admixtures. Concrete solidifies and hardens after mixing with water and placement due to a chemical process known as hydration. The water reacts with the cement, which bonds the other components together, eventually creating a stone-like material. As it gives benefit to the construction field, it's also give environmental problem. The cement industry is one of the primary producers of carbon dioxide (CO_2), cement kiln CO_2. is released from calcinations of limestone *(±50%)* and from the combustion of fuels *(±50%)*, and cement production accounts for approximately *5%* of the global CO_2, emissions (Guimares&Pade, 2006). According to Environment Institute Association (2006) noted that more than60% of the CO_2 emissions from industrial sources originate from cement manufacturing. Four basic materials are required to make cement: namely calcium, silicon, aluminium, and iron. Substrates of these materials are ground into a powder and heated in a kiln. While in the kiln, limestone (the predominant source of calcium) is broken down into carbon dioxide and lime. The carbon dioxide is driven off into the atmosphere. The production of the cement is necessary to keep the development of a country, but the environmental problems also should be taken into consideration. The alternative way to let the engineering field giving its benefit for the good of all mankind is to reduce the excessive use of cement in one construction. The proper mixes and proportion of cement may be important to obtained the standard quality of concrete, the engineer have to come out a concrete with less used of cement in mixes and replace it with another material without having the decrease of the concrete quality. Gutty and Smith *(1975)* stated that waste materials can make a small but useful contribution to supplies of aggregates and cement. The potential for greater use of specific wastes is examined. Attention is focused on problems of specification and acceptance of waste materials, products derived from wastes, and from other unused materials. In view of problems in excessive cement used which polluting nature, the waste material can be used to replace a small proportion of cement to reduce the rate of environmental problem. However there are not many waste materials suitable to replace the proportion. The study by Hues and Al-Mi (1991) stated that mix design facilitates the economical use of available materials to provide a concrete with certain a desirable characteristics. Mix design for Fly ash concrete should therefore be no exception. The relevant properties of economically available Fly ash should be assessed together with those for the aggregates and cement and a suitable concrete designed for the required criteria for quality (e.g. strength) and for workability (e.g.Vebe time). The study shows that the Fly ash can be taken as consideration to used in the construction material as its benefit to the environment which controlling the produce of wastage that increase by year and preserving the air purity by pollution through the emission of carbon dioxide into the air by the process of making cement in industrial. It is said that the design of modified concrete can solve environmental problems.

Furthermore, with Fly ash utilization, especially in concrete, has significant environmental benefits including:

1) Increasing the life of concrete roads and structures by improving concrete durability,
2) Net reduction in energy use and greenhouse gas and other adverse air emissions when fly ash is used to replace or displace manufactured cement,
3) Reduction in amount of fly ash combustion products that must be disposed in landfills

Concrete is used as a construction material in hostile environments in structures such as seafloor tunnels, offshore piers and platforms, highway bridges, sewage pipes, and containment structures for solid and liquid wastes containing toxic chemicals and .radioactive elements. Numerous publications reporting improved rheology and cohesiveness, lower heat of hydration, lower permeability and higher resistance

to chemical attack resulting from the use of different mineral admixtures have emerged over the years. The requirements for acceptable durability performance in such conditions go beyond those achievable with ordinary cements.
As a result, the blending of ordinary Portland cement (OPC) with pozzolanic materials has become an increasingly accepted practice in such structures. The used of pozzolanic material like Fly ash also can improve the quality of concrete through its composition of chemical (Khan et al., 2000)

Test on Materials
Tests on Cement

- Fineness of cement
- Initial and Final setting time
- Soundness test

Tests on fine aggregate:

- Specific gravity test
- Fineness modulus

Tests on coarse aggregates:

- Specific gravity test
- Crushing test
- Impact test
- Abrasion test
- Shape tests (Flakiness and Elongation)

Tests on fresh concrete:

- Slump cone test
- Compaction factor test

Tests on hardened concrete:
Compressive strength

Concrete mix design
The bureau of Indian standards, recommended a set of procedure for design of concrete mix mainly based on the work done in national laboratories. The mix design procedures are covered in IS: 10262-82. Their methods can be applied for both medium and high strength concrete. The following mixes are designed based on Indian standard recommended method of concrete mix design IS: 10262-82.

Mix design calculations (is: 10262-2009, sp 23)

1. Stipulations for proportioning [as per is 10262-2009, is 456-2000, & sp23]
A) Grade of concrete : M -20

B) Type of cement : Ordinary Portland cement-53 Grade -IS: 8112

C) Maximum nominal size of aggregate : 20 mm

D) Minimum cement content : 250 kg/m3

E) Maximum water cement ratio : 0.60

F) Workability : 70-120mm (slump)

H) Method of concrete placing : Mild

I) Degree of supervision : Good

J) Type of aggregate : Crushed angular aggregate

K) Maximum cement content : 400 kg/m^3

2. Test data for materials
A) Cement use : OPC-53 Grade conforming to IS: 8112

B) Specific gravity of cement : 3.07

C) Chemical admixture : 0

i) Specific gravity of admixture : 0

D) Specific gravity of coarse aggregate : 2.65

E) Specific gravity of fine aggregate : 2.62

F) Water absorption of CA & FA

i) Water absorption of CA : 0.31%

ii) Water absorption of FA : 0.46%

G) Free surface moisture

i) Coarse aggregate : Nil

H) Sieve Analysis:

TABLE. 1. COARSE AGGREGATE

IS Sieve (mm)	Analysis of Coarse aggregate Fraction		Percentage of Different Fractions			Conforming to Table 2 of IS 383
	20mm	10mm	20mm	10 mm	Combined	
			70%	30%	100%	
40	100	100	70.00	30.00	100.00	100
20	100	100	70.00	30.00	100.00	95-100
10	30.40	92.00	21.28	27.60	48.88	25-55
4.75	2.56	0.70	1.79	0.21	2.00	0-10

TABLE.2. FINE AGGREGATE

IS Sieve in mm	% Passing	Conforming to grading Zone II Table 4 of IS 383
10	100.00	100.0
4.75	98.80	90-100
2.36	91.40	75-100
1.18	71.80	55-90
0.60	44.00	35-59
0.30	20.20	8-30
0.15	2.00	0-10

3. Target strength for mix proportions
f' ck = fck +1.65S

f' ck = Target average compressive strength at 28 days

fck = Characteristic compressive strength at 28 days

S = Standard deviation

Standard deviation S = 4.00 N/mm² (from code IS 456-2000 for M_{20} grade of concrete)

As per IS-10262, The Target mean strength is

f' ck = 20 +(1.65 x 4) = 26.6 N/mm²

4. Selection of water cement ratio
From IS-456,

Maximum water-cement ratio =0.60

Based on trails, adopt water cement ratio as =0.51

0.51=0.60, Hence ok.

5. Selection of water content
From Table 32,(IS 456-2000)

Maximum water content =185 litres (for 30 to 50 mm slump) for 20mm aggregate.

6. Calculation of cement content
Water cement ratio = 0.51

Cement content = 200/0.51 = 392.16 kg/m³ say 392 kg/m³

From Table-23 of SP 23,

Minimum cement content for Moderate Exposure condition =250 kg

392 kg/m³ > 250 kg/m³, Hence ok.

7. Proportion of volume of coarse aggregate & fine aggregate content
From Table-3, Volume of coarse aggregate corresponding to 20mm size aggregate & fine aggregate(Zone-II) for water cement ratio of 0.51=0.66

∴ Volume of coarse aggregate = 0.66%

∴ Volume of fine aggregate = 1 -0.66 =0.34%

8. Mix calculations
The Mix calculations per unit volume of concrete shall be as follows:

a) Volume of concrete(a) = 0.98 m^3

b) Volume of cement(b) = (mass of cement/sp gr of cement) x (1/1000)
= (392/3.07) x (1/1000) =0.128 m³

c) Volume of water(c) = (mass of water /sp gr of water) x (1/1000)
= (200/1) x (1/1000) =0.20 m³

e) Volume of all in aggregate (e)
= {a-(b+c+d)}
= {0.98-(0.128+ 0.20+0) = 0.652 m³

f) Mass of coarse aggregate
= e x volume of CA x sp gr of CA x 1000
= 0.652 x 0.66 x 2.650 x 1000 = 1140 kg.

g) Mass of fine aggregate
= e x volume of FA x sp gr of FA x 1000
= 0.652 x 0.34 x 2.620 x 1000 =580 kg.

TABLE.3. MIX PROPORTION

Cement	Water	Fine Aggregate	Coarse Aggregate	W/C ratio
392 Kg	200 Lit	580 Kg	1140 Kg	0.51

II. RESULTS

TABLE.4. COMPRESSIVE STRENGTH VALUES FOR REPLACEMENT OF CEMENT BY FLY ASH:

S.No	Total replacement by Fly ash	Compressive strength(Mpa)			
		7 days	14 days	21 days	28 Days
1	100% of cement	19.25	21.48	22.14	22.36
2	10% of fly ash+ 90% of cement	18.88	19.78	20.59	21.55
3	20% of fly ash+ 80% of cement	18.33	19.52	20.07	21.11
4	30%of fly ash+70% of cement	18	19.22	19.55	20

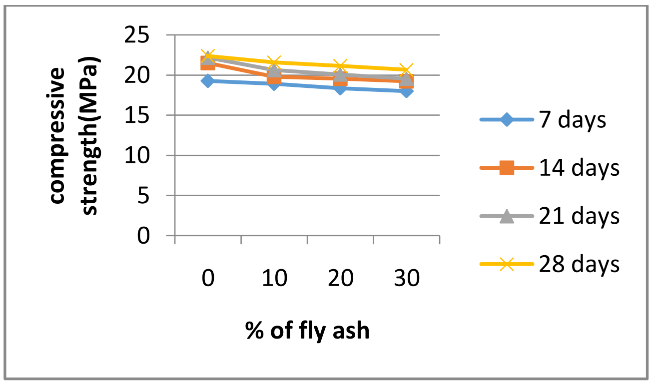

Figure.1. representation of testing compressive strength for 7,14,21,28 days:

III. CONCLUSIONS:

- From the study it is concluded that Fly ash can be used as replacement material for cement (i.e 20% of FA)gives a approximate strength compare to the control mix
- Test showed that is industrial waste is capable of improving hardened concrete performance enhancing fresh concrete behavior and can be used in plain concrete.
- More than 12 million tons of fly ash are used in concrete products each year. The use of fly ash, a recovered resource, reduces the depletion of natural resources. It also reduces the energy intensive manufacturing of Portland cement.
- This reduction in energy leads to less emissions of greenhouse gases. The use of a ton of fly ash to replace a ton of cement saves enough electricity to power an average American home for 24 days. It also reduces carbon dioxide emissions equal to two months use of an automobile.
- Fly ash use in concrete qualifies for credit under the U.S. Green Building Council's popular LEED rating system for sustainable construction.

IV. REFERENCES:

[1]. Afolayan, J.O. and Alhassan, A.Y. (2010) "Durability of Concrete Containing Pulverized Fuel Ash in Aggressive Environment". Journals of Engineering and Applied Science. Vol. 2

[2]. Neville, A.M., and Brook, J.J. (1990), "Concrete Technology", Longman Ltd., Singapore.

[3]. Scheffe, H. (1958), "Experiments with Mixtures", Journal of the Royal Statistical Society. Ser. B., 20, 344 – 360.

[4]. Neville, A.M., (1996), "Properties of Concrete", Longman Ltd., England.