International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 12, December-2016

A Study on Mechanical and Durability Properties of Concrete with Partial Replacement of Cement with Fly Ash and Fine Aggregate with Waste Glass

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***Abstract* - Concrete plays a vital role as a construction material in the world. In the present scenario, waste materials from various industries and admixtures are added to the mix. The objective of Present work is to find out the effectiveness of the Fly ash and glass aggregate based concrete. In this investigation it was proposed that the partial replacement of ordinary Portland cement by fly ash and fine aggregate by glass in concrete at variable temperatures and environments.**

In this investigation, cement is replaced by 10 percent of fly ash and fine aggregate by waste glass at 20 percent replacement.

The tests were carried out to evaluate the mechanical and durability properties like compressive strength and split tensile strength at 7days, 28days, 56days and 90days. The experimental investigation on strength of concrete and optimum percentage. This investigation is focused on the partial replacement of ordinary Portland cement by fly ash and fine aggregate by waste glass in concrete at variable temperatures and cures in HCL solution. The utilization of the industrial waste has been the focus of waste reduction research for economical, environmental reasons of the partial replacement by replacing cement via 5%, 10%, 15%, and 20% of fly ash shows that the compressive strength increased up to 10% addition of fly ash and further increase in fly ash reduces the strengths gradually. Keeping these results in view further investigation is carried in which cement is replaced by fly ash upto10% and fine aggregate by waste glass up to 20% and up to 0.75% of HCL solution experimental investigation is carried on finding compressive strength and tensile strength.

Key words : Compressive strength, Optimum percentage, Pozzolana, Tensile strength ..

INTRODUCTION

Concrete can be regarded as a composite material. For reducing the cost of concrete, greater use of pozzolanic materials like fly ash, blast furnace slag and waste glass was suggested. The use of these materials as the substitute material in concrete would reduce the disposal problem now faced by thermal power plants and industrial plants and at the same time achieving the required strength of concrete.

Fresh concrete or plastic concrete is a freshly mixed material which can be moulded into any shape. The relative quantities of cement aggregates and water mixed together control the properties of concrete in the wet state as well as in the hardened state.

As modern engineering practices become more demanding, there is a corresponding need for special types of materials with novel properties. Scientists, engineers and technologists are continuously on the lookout for materials, which can act as substitute for conventional materials or which possess such properties as would enable new designs and innovations resulting in to economy, so that a structure can be built economically. There have been so far many attempts to develop new materials, which is the combination of two or more materials. Such materials are called composite materials.

Investigations have been made by partial replacement of waste glass in place of fine aggregates and fly ash in place of cement. Also revealed that with proper proportioning of waste glass the required strength can be achieved at 28 days.

In the present investigation fly ash has been used as a partial replacement of cement and waste glass has been used as partial & complete replacement of fine aggregate and it is cured in different environments.

Fly ash is a naturally-cementations coal combustion by-product. It is extracted by the precipitators in the smokestacks of coal-burning power plants to reduce pollution. About 120 coals based thermal power stations in India are producing about 112 million tone fly ash per year. With the increasing demand of power and coal being the major source of energy, more and more thermal power stations are expected to be commissioned/augment their capacities in near future.

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fly ash has been considered as a "Pollution Industrial Waste". The Majority of thermal power plants 84% are run by coal.

Glass is amorphous solid material which is produced at high temperatures followed by crystallization. The effective use of waste glass for partial and full replacement of sand as an admixture in cement mortar and concrete has established in the country in recent years.

Recent investigation of waste glass has indicated greater scope for their utilization as a construction material. Greater utilization of waste glass will lead to not only saving such construction material but also assists in solving the problem of disposal of this waste product.

The recent investigations have also indicated the necessity to provide proper collection methods for waste glass so as to yield waste glass of quality and uniformity, which are primer requirements of waste glass for use as construction materials.

Chemical attack on concrete results in disintegration of concrete. The rate of disintegration determines the durability of concrete structures. All the reactions take place due to the aggressive substances present in the environment or within the concrete and their diffusion towards the reactive substance. The rate of chemical reactions depends mainly on the presence of water either in liquid form or gas forms and the rate of transport of the aggressive substances within and into the concrete. These reactions are often take place on longer periods of exposure of several years resulting in their detrimental effect.

In this investigation that Pozzolon cements are produced by adding pozzolons such as flyash in 20% replacement for Portland cement. On the 28th day of production, the produced specimens are stored in HCl solution. The strengths are determined after the mortars are stored in solution for 56 days and 90days.

II. LITERATURE REVIEW

P.Turgut and E. S.Yahlizade(4) investigated on "Research into Concrete Blocks with Waste Glass"- a parametric experimental study for producing paving blocks using fine and coarse waste glass is presented. Some of the physical and mechanical properties of paving blocks having various levels of fine glass (FG) and coarse glass (CG) replacements with fine aggregate (FA) are investigated. The test results show that the replacement of FG by FA at level of 20% by weight has a significant effect on the compressive strength, flexural strength, splitting tensile strength and abrasion resistance of the paving blocks as compared with the control sample because of pozzolanic nature of FG. The compressive strength, flexural strength, splitting tensile strength and abrasion resistance of the paving block samples in the FG replacement level of 20% are 69%, 90%, 47% and 15 % higher as compared with the control sample respectively. It is reported in the earlier works the replacement of FG by FA at level of 20% by weight suppress the alkali-silica reaction (ASR) in the concrete. The test results show that the FG at level of 20% has a potential to be used in the production of paving blocks. The beneficial effect on these properties of CG replacement with FA is little as compared with FG.

- *Ahmad Shayan "Value-added Utilisation of Waste Glass in Concrete"(2)* concluded that A large proportion of the post consumer glass is recycled into the packaging stream again, and some smaller proportion is used for a variety of purposes including concrete aggregate. However, a significant proportion which does not meet the strict criteria for packaging glass is sent to landfill, taking the space that could be allocated to more urgent uses. Glass is unstable in the alkaline environment of concrete and could cause deleterious alkali-silica reaction problems. This property has been used to advantage by grinding it into a fine glass powder (GLP) for incorporation into concrete as a pozzolonic material. In laboratory experiments it can suppress the alkali-reactivity of coarser glass particles, as well as that of natural reactive aggregates. It undergoes beneficial pozzolonic reactions in the concrete and could replace up to 30% of cement in some concrete mixes.
- *Rasheeduzzafar* et al. reported that blending of plain cements with 10% or 20% silica fume with improved corrosion resistance.

Detvelin et al. reported that for any given curing conditions, the use of either 5%silicafume with 30%slag has more pronounced effect on chlorides permeability.

R.K. Dhir et al. concluded that specifying by strength, cement content or W/C ratio alone cannot ensure adequate durability in chloride-containing environment.

J.R Makehnie et al. Is reported that, amongst the various factors responsible for the premature deterioration of structures, corrosion of reinforcing steel owing to the ingress of chlorides in concrete has been identified as the most damaging factor.

W.J.Mc Carter et al. [14] concluded that the absorption of chloride solution into concrete is less than absorption of water.

III. EXPERIMENTAL ANALYSIS

MATERIALS USED IN CEMENT CONCRETE:

Cement: (ANJANI cement of 53grade ordinary Portland cement was used)

Ordinary Portland cement (53 grade) available in the local market of standard brand was used in the investigation. Portland cement is most commonly used type of cement in the world today. Care has been taken that it has to be stored in airtight containers to prevent it from being affected by the atmospheric and monsoon moisture and humidity.

Fine Aggregate (Sand):

The size of the fine aggregate is below 4.75mm, natural sand used as the fine aggregate in concrete mix. Sand may be obtained from rivers, lakes but when used in concrete mix, it should be properly washed and tested to ascertain the total percentage of clay silt, slit and other organic matters does not exceed the specified limit.

Coarse Aggregate:

The material whose particles of size retained on i.s. sieve no. 4.75mm is termed as coarse aggregate. The size of coarse aggregate depends upon the nature of the work. The coarse aggregate used in the experimental investigation is 20mm size, crushed on angular in shape. The aggregates are free from dust before used in the concrete.

Fly ash:

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Fly ash is the material produced in small dark flecks by the burning of powdered coal. It is also known as pulverised fuel ash. In this investigation fly ash is replaced with cement due to its pozzolanic nature.

Waste Glass:

Waste glass is a new source . supersol is an artificial light porous foamed material that is made by crushing , milling, banking and foaming waste glass. The waste glass is available from recycling plant.

HCL:

Acid etching involves allowing the reaction of a dilute solution of hydrochloric acid to the concrete surface. The acid chemically reacts with surface laitance1, dissolving it and allowing it and other water soluble contaminants to be washed away.

IV. TESTS CONDUCTED

Compressive Strength Of Concrete Specimens:

Compressive strength of concrete is the most important parameter and representative of almost overall quality of concrete. It mainly depends upon the water/cement ratio of the mix and curing and age after it is cast. Compressive strength of concrete is determined by testing the cylindrical or cubical specimens of concrete using a compression testing machine, at various age such as: 7 days and 28 days

Fig I: Compression Testing Machine

The measured compressive strength of the specimen shall be calculated by dividing the maximum load applied to the specimen during the test by the cross sectional area calculated from mean dimensions of the section and shall be expressed to the nearest kg/cm^2, average of all values shall be taken as the representation of the batch provided and individual variation is not more than that -15 percent of average.

Compressive Strength = Max. Load/Area = (W/A)

Where, W = Maximum Load on Cube

A = Effected cross sectional area

Final values are adopted using standard deviations.

Split Tensile Strength:

The splitting tests used for determining the tensile strength of concrete sometimes referred to as split tensile strength of concrete

This test is Compression–testing machine by placing the cylindrical specimen horizontally, so that its axis is horizontal between the plates of the testing machine. The load is applied uniformly at a constant rate until failure by splitting along the vertical diameter takes place. Load at which the specimen failed is recorded. Test is performed as per IS: 5816-1970.

The Split Tensile strength of cylinder specimens of size 150 mm X 300 mm. The cylinders were tested by placing them uniformly. Specimens were taken out from curing tank at the age of 7, 14, 28, 56 and 90 days of moist curing and tested after surface water dipped down from specimens. This test was performed on Testing Machine as shown in figure.

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FIG II: Split tensile strength (f_s) = (2W)/(πLD)

Where, W = Maximum Load on Cylinder
L = Length of the Cylinder
D = Diameter of the Cylinder
d = Depth of the Prism

Fire Resistance Test:

In this project tests performed for checking the fire resistance of concrete cube specimens in which cement and fine aggregate are partially replaced by fly ash and waste glass, at the temperatures 100˚c to 500˚c in muffle furnace for 1hour and 2hours respectively. This test was conducted after 28 days curing. After the respective curing periods the cube specimens were dried at room temperature for some time confirming that the specimens is free from wetness. Then the specimens which are to be tested are placed in muffle furnace and the time is to be noted. After the required time muffle furnace is switched off and cubes are taken out and are kept to cool at room temperature. Then the specimens are tested at universal testing machine. The cube specimens are placed on the machine such that the load is applied centrally. This test was conducted after 28 days .

DURABILITY:

In present project, the durability tests are conducted by partial replacement of cement with fly ash and sand with waste glass mineral such as, HCL acid. The response of HCL acid attack on concrete for various percentages was studied by observations like loss in strength .For conducting these tests; concrete cubes with different percentages were casted. These cubes were immersed in 0.5% 0.75%, 1% solutions of chloric acid for different periods of 7, 14, 28, 56days and 90days, and deterioration was studied by means of loss of strength.

V. EXPERIMENTAL RESULTS

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

S.NO	Mix Type	Compressive Strength		
		7 days	28 days	90 days
1	A0	28.97	52.12	55.33
2	A5	29.205	52.96	56.25
3	A10	29.781	53.63	57.25
4	A15	27.37	50.34	53.64
5	A20	24.138	46.75	50.34

WHERE
A0 = 0% replacement of cement by fly ash.
A1 = 5% replacement of cement by fly ash.
A2 = 10% replacement of cement by fly ash.
A3 = 15% replacement of cement by fly ash.
A4 = 20% replacement of cement by fly ash.

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TABLE II :REPLACEMENT OF CEMENT WITH FLY ASH AND SAND WITH WASTE GLASS

S.NO	Mix Type	Compressive Strength		
		7 days	28 days	90 days
1	B0	28.6	52.24	56.5
2	B1	29.79	54.31	56.29
3	B2	30.2	54.72	56.96
4	B3	27.4	50.52	53.58
5	B4	25.11	48.64	50.12

WHERE
B0 = 0% replacement of sand by waste glass & 0% replacement of cement by fly ash.
B1 = 10% replacement of sand by waste glass & 10% replacement of cement by fly ash.
B2 = 20% replacement of sand by waste glass & 10% replacement of cement by fly ash.
B3 = 30% replacement of sand by waste glass & 10% replacement of cement by fly ash.
B4 = 40% replacement of sand by waste glass & 10% replacement of cement by fly ash

FIRE RESISTANCE TEST VALUES
FOR REPLACEMENT OF CEMENT BY FLY ASH AND FINE AGGREGATE BY WASTE GLASS:

TABLE III 28-DAYS COMPRESSIVE STRENGTH RESULTS OF IN MPA

% Replacement		Mix Type	28 days compressive strength at different temperatures					
Fly ash	Waste Glass		room	100	200	300	400	500
0	0	B1	52.24	51.83	51.20	48.42	43.62	37.52
5	10	B2	54.31	53.91	53.53	49.9	44.15	38.71
10	20	B3	54.72	54.37	53.59	54.83	49.55	43.87
15	30	B4	50.52	50.09	49.34	46.42	42.99	35.38
20	40	B5	48.64	48.28	47.17	43.6	40.29	34.17

VI. CONCLUSIONS

Based on the experimental study concrete for M40 grade concrete, the following conclusions are drawn:

1. The compressive strengths of concrete (with 0%, 5%, 10%, 15% and 20% of weight replacement of cement with fly ash and 0%, 10%, 20% 30% and 40% of weight replacement of FA with waste glass) cured in Normal water for 7, 28, 56 and 90 days have reached the target mean strength.
2. The spilt tensile strengths of concrete (with 0%, 5%, 10%, 15% and 20% of weight replacement of cement with fly ash and 0%, 10%, 20% 30% and 40% of weight replacement of FA with waste glass) cured in Normal water for 7, 28, 56 and 90 days have reached the target mean strength.
3. The compressive strengths of concrete (with 0%, 5%, 10%, 15% and 20% of weight replacement of cement with fly ash and 0%, 10%, 20% 30% and 40% of weight replacement of FA with waste glass) cured in 0%, 0.5%, 0.75% and 1% of HCL for 7, 56 and 90 days have reached the target mean strength.
4. On replacement of 10%,20% and 5% ,10% of FA by waste glass and cement by fly ash in concrete mix their is an increase in compressive strength of 4.5% and 5.8% at 7 days, 4.5% and 5.5% at 28 days is observed when compared to control mix.
5. The spilt tensile strength of concrete increases at 10%,20% and 5%,10% replacement of fine aggregate by waste glass and cement by fly ash 2.23% and 4.83% at 7 days ,3.68% and 4.12% at 28 days when compared to control mix.
6. The compressive strengths of concrete cured in different concentrations of (0%, 0.5%, 0.75%) HCL acid solution for 7, 56 and 90 days indicate that at 0.75% of HCL acid there is increase in strength and beyond that the strengths decreases.
7. The strength decreases in acidic environment with age of concrete also with increasing of fly ash and waste glass content in concrete.
8. The compressive strength after exposing the specimens to temperatures of 100^0,200^0,300^0,400^0 and 500^0 c respectively in furnace for 60 minutes their is a nominal decrease in compressive strengths at the elevated temperatures.

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International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 12, December-2016

REFERENCES

[1] Optimization of fly ash in concrete :High lime fly ash as a replacement for cement and filler material by Carolyne Namagga[1], Rebecca A. Atadero[2]
[2] Fly ash a partial replacement of cement in concrete and durability study of fly ash in acidic environment by T.G.S.Kiran and M.K.M V Ratnam
[3] High early strength concrete containing large quantities of fly ash by Tarun R. Naik[1] and Bruce W. Ramme[2]
[4] Sustainability in construction: using fly ash as a cement replacement by Phil seabrook PEng[1] and Kevin Campbell PEng[2]
[5] Effect of fly ash on properties of concrete by P. R. Wankhede[1], V. A. Fulari [2]
[6] Effect of partial replacement of cement by fly ash and lime sludge on strength characteristics of concrete by Ravindra kumar.
[7] Gainful utilization of fly ash and hypo sludge in concrete by Dr.jayeshkumar pitroda.
[8] A miniscule endeavour for accomplishing hypo sludge , fly ash brick in Indian context by Apurva Kulkarni[1], Samruddha Raje2, Juned Peerzada3, Mamata Rajgor4.
[9] Assessment of concrete masonary units containing aggregate replacement of waste glass and rubber tire particles by Jerry w.isler.
[10] The use of fly ash and lime sludge as partial replacement of cement in mortar(2014). by Vaishali sahu[1], V. Gayathri[2].

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