Study of Strength and Environmental Effects on Concrete Using Fly Ash and Ceramic Waste as Fine Aggregate

Mr. Gajanand Prasad Pandey[1], Mr. Honey Gaur[2]

[1]M. Tech Scholar, Kalinga University, Raipur
[2]Assistant Professor, Kalinga University, Raipur

Abstract— *Fly ash is one of the residue generated in combustion and comprises the fine particles that rise in the flue gases. Ash which does not rise in the chimney is known as bottom ash. In an industrial concern, fly ash generally refers to ash produced during combustion of coal. Fly ash is generally obtained by electrostatic precipitations or by other different equipment prior to reach flue gases up to chimneys of coal burnt power plants, and coal as obtained from the bottom of furnaces is in this case know as coal ash.*

In the previous decades fly ash was usually released in to the atmosphere, but in recent decades pollution control equipment is compulsory required to be captured prior to release through chimney.

Traditionally the fly ash been disposed in landfills at considerable cost. However now environmental regulations in many states of our country promote the reuse of fly ash in various application of considerable interest is cement concrete using fly ash, replacing some parts aggregate for construction of highways.

Ceramic product waste of sanitary wares, house hold ceramics, electrical insulators, ceramic wall and floor tiles etc act as pollutants.

It produces dust which is harmful for public health as well as agriculture growth. Utilization of ceramic waste is the best way to protect the environment and improve the quality of product where it will be used in industries like construction industries ceramic waste can be used to produce ecofriendly concrete by partial replacement of fine aggregate.

In this thesis work fine aggregate will be replaced by fly ash and ceramic waste accordingly in the range of 10%, 20% and 30% by weight of fine aggregate in M20 grade of concrete

Keywords— *Fly ash, Ceramic waste*

I. INTRODUCTION

The use of fly ash as a cement replacement is very common yet at present, perhaps only about 50% of fly ash produced is utilized. In 2003, this figure was only about 20%, however the highest level of fly ash utilization was 63% in 2009-2012 was about 56% which was reported during second international summit fly ash utilization 2013. But the large production of fl ash in India more than 200 million ton per year at present which could over the next 20 years needs applications that consume for more quantities then today application allow. In this regard fly ash as a substitute crush stone fine aggregates with artificially produced fly ash aggregate.

This project will carry out because the largest power utility of India, presently Chhattisgarh region having 20% of countries instanced capacity is meeting more than 28% of its power requirement. During 2017-2018 about 46 million tones of fly ash produced in NTPC out of which 20.08 mt was gainfully utilized in various application areas such as issue to industries for manufactures of cement, construction industries, bricks, of road embankment mine filling, development of low lying areas.

A ceramic is a solid material comprising an inorganic compound of metal, non-metal or ionic and covalent bonds. Common examples are earthenware, porcelain, and brick.

The crystallinity of ceramic materials ranges from highly oriented to semi-crystalline, vitrified, and often completely amorphous (e.g., glasses). Most often, fired ceramics are either vitrified or semi-vitrified as is the case with earthenware, stoneware, and porcelain. Varying crystallinity and electron composition in the ionic and covalent bonds cause most ceramic materials to be good thermal and electrical insulators (extensively researched in ceramic engineering). With such a large range of possible options for the composition/structure of a ceramic (e.g. nearly all of the elements, nearly all types of bonding, and all levels of crystallinity), the breadth of the subject is vast, and identifiable attributes (e.g. hardness, toughness, electrical conductivity, etc.) are difficult to specify for the group as a whole. General properties such as high melting temperature, high hardness, poor conductivity, high moduli of elasticity, chemical resistance and low ductility are the norm,[1] with known exceptions to each of these rules (e.g. piezoelectric ceramics, glass transition temperature, superconductive ceramics, etc.). Many composites, such as fiberglass and carbon fiber, while containing ceramic materials, are not considered to be part of the ceramic family.

The earliest ceramics made by humans were pottery objects (i.e. *pots* or *vessels*) or figurines made from clay, either by itself or mixed with other materials like silica, hardened and sintered in fire. Later ceramics were glazed and fired to create smooth, colored surfaces, decreasing porosity through the use of glassy, amorphous ceramic coatings on top of the crystalline ceramic substrates. Ceramics now include domestic, industrial and building products, as well as a wide range of ceramic art. In the 20th century, new ceramic materials were developed for use in advanced ceramic engineering.

II. OBJECTIVES OF THE PROJECT

A. To utilize Fly ash and ceramic waste in the manufacturing of concrete.

B. To determine the optimum percentage of replacement of Fly ash and ceramic waste as fine aggregate in concrete.

C. To study the compression strength of the concrete by partially replacing the fine aggregates.

D. To study workability of concrete by partially replacing the fine aggregate.

E. Saving of natural sand by partial replacement of sand by Fly ash and ceramic waste as fine aggregate in concrete.

F. By utilization of fly ash and ceramic waste, we can prevent or reduce the environment by various hazards.

III. MATERIALS PROPERTIES

- Cement: 53 Grade ordinary Portland cement is used in the present investigation. The properties of cement are determined as per the IS 4031:1968
- Fine aggregate: Locally available river sand conforming to Grading zone 2 of IS:383-1970.
- Coarse aggregate: Locally available crushed blue granite stones conforming to graded aggregate of nominal size 20 mm as per IS:383-1970.
- Fly ash- low calcium class F dry fly ash obtained from Seepat N.T.P.C. plant, Bilaspur, Chhattisgarh, India. was used conforming to IS:3812(part-1)-2003
- Ceramic Waste - Ceramic tiles were obtained from building construction sites. For this Experiment a Varmora Verified tiles was used. Its bulk density and water absorption were 2.35 gm/cc and 0.08% respectively
- Water- water is an important factor of concrete as it actually participates in the chemical reaction with cement.
- Potable water is used in mixing of concrete.

INGREDIENTS OF FLY ASH

S.No	PARTICULARS	VALUE
1	Silicon Oxide (SiO_2) plus Aluminium Oxide (Al_2O_3) plus Iron Oxide (Fe_2O_3) minimum %	70
2	Sulfur trioxide (SO_3),Maximum %	5
3	Moisture Content, Maximum %	3
4	Loss of ignition	6

INGREDIENTS OF CERAMIC WASTE

S.No	PARTICULARS	VALUE
1	SiO_2	63.29
2	Al_2O_3	18.29
3	Fe_2O_3	4.32
4	CaO	4.46
5	K_2O	2.18
6	Na_2O	0.75

TABLE 1

PROPERTIES OF FLY ASH

S.No	PARTICULARS	VALUE
1.	Specific gravity	2.10
2.	Fineness modulus	2.23

TABLE 2

PROPERTIES OF CERAMIC WASTE

% of replacement	Cement (kg)	Fine aggregate (kg)	Fly Ash (kg)	Ceramic waste (kg)	Coarse aggregate (kg)	Vater (l)
NC 0%	13.5	24.04	-	-	30.24	6.075
10%	13.5	21.63	2.40	-	30.24	6.075
20%	13.5	19.23	4.81	-	30.24	6.075
30%	13.5	16.82	7.22	-	30.24	6.075
10%	13.5	21.63	-	2.40	30.24	6.075
20%	13.5	20.16	-	4.81	30.24	6.075
30%	13.5	16.82	-	7.22	30.24	6.075

IV. ADVANTAGES OF FLY ASH

- Considerable reduction in alkali-silica and Sulphate expansions.
- Reduce permeability at low cost.
- Increase workability at the same water content.
- Rate of bleeding is reduced.
- Improve long term strength and durability performance.
- Lower shrinkage and porosity as a result of lower water content.

V. ADVANTAGES OF CERAMIC WASTE

- Ceramics usually have combination of stronger bonds called ionic and covalent bonds.
- This type of bond result in high elastic modulus and hardness, high melting points, low thermal expansion and good chemical resistance.
- The heat of hydration of concrete is significantly lower than traditional concrete.
- The result in a lower temperature rise in a mass concrete pores which is a distinct advantages.
- Reduction in shrinkage and creep.

VI. EXPERIMENTAL METHODOLOGY

Initially the materials used in concrete are tested for its basic properties. Then the mix design is carried out according to the codal provisions with water cement ratio 0.45. In the obtained mix proportions fly ash and ceramic waste is partially replaced for fine aggregate in percentages of 10, 20 and 30, Slump test for workability of concrete is done.

The concrete specimens are casted for the above mix proportions and cured in potable water for 28 days. Then the specimens are tested for cube compressive strength test.

TABLE 3

MIX PROPORTIONS OF INGREDIENTS FOR 150mmX150mmX150mm CUBES

S.No	Test Particulars	Value obtained
1.	Specific gravity	2.5
2.	Fineness modulus	1.28

A) WORKABILITY-

Slump test is carried out for M-20 concrete mix wit water cement ratio 0.45 for replacement of fine aggregate by fly ash and ceramic waste in percentage of 10, 20 and 30.

B) COMPRESSIVE STRENGTH

The compressive test is carried out on concrete mix M20 cubical in shape. The cube specimen is of the size of 150mmX150mmX150mm.The test was carried out in the compression testing machine. Concrete cubes with Fly ash and ceramic waste in plain cement concrete were tested at 28 days.

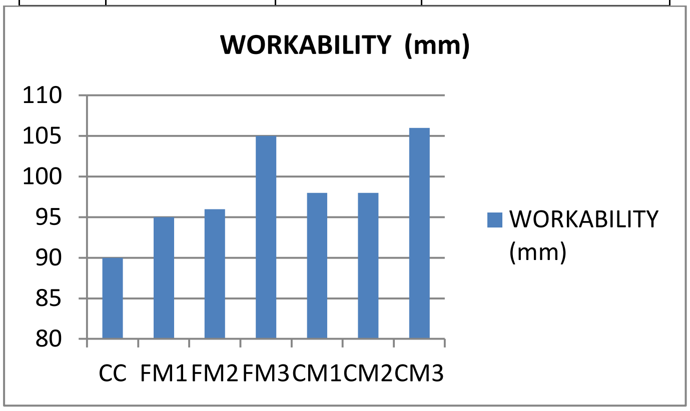
Compressive strength= load (N/mm^2) c/s area of cube

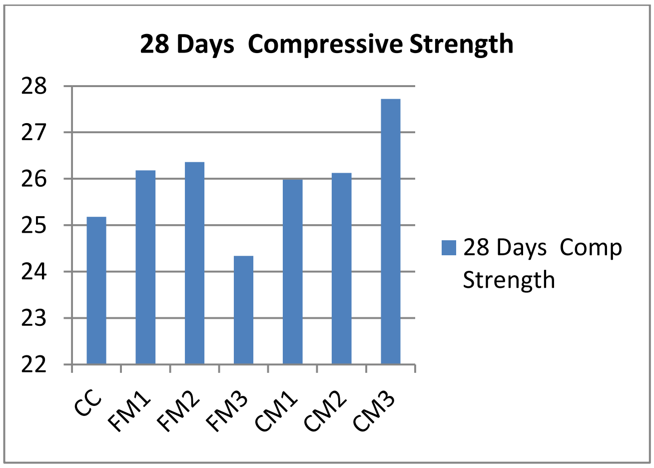
VII. TEST RESULTS

TABLE 4

COMPARISON OF WORKABILITY AND COMPRESSIVE STRENGTH OF CONCRETE

Mix	Percentage of replacement	Workability (mm)	Compressive strength 28days (N/mm^2)
CC	0	90	25.18
FM1	10%	95	26.18
FM2	20%	96	26.36
FM3	30%	105	24.34
CM1	10%	98	25.98
CM2	20%	98	26.13
CM3	30%	106	27.72





VIII. CONCLUSIONS

- The concrete is cast by partially replacing fine aggregate with fly ash and ceramic waste in various proportions such as 10%, 20% and 30%.
- Workability of concrete is in increasing order as per percentage replacement of fine aggregate with 10%, 20% and 30% by fly ash and ceramic waste.
- The compressive strength reveals high strength of 20% replacement of fly ash and at 30% replacement of ceramicwaste.
- Thus fly ash and ceramic waste can be utilized in the manufacture of concrete at replacement rate of 20% and 30% respectively.
- Using the wastage like fly ash and ceramic waste in concrete with regard to reducing the cost and keeping the environment clean along with wastage management and enhance the strength of structures is an effective measure in sustainable development.
- The tested concrete is environmental friendly green concrete as it will save scarcely available natural sand and utilize equal amount of fly ash and ceramic waste per cubic meter of concrete.

REFERENCES

[1] Ministry of Environment and forests, 1999. Utilisation of Fly Ash by Thermal power plants Notification, S.O. 763(E) Dated 14th September.
[2] Ministry of Environment and Forests, 2003. Utilisation of Fly Ash by Thermal Power plants Notification, S.O. 979(E)
[3] R.A. Kruger, South African Journal of science, 1986, 82, 177.
[4] H.A. Foner, T.L. Robl, J.C. Hower, U.M. Graham, Fuel, 1999, 78 ,215-223.
[5] Dr. Vimal kumar, Adviser, fly Ash utilisation programme, TIFAC, DST, government of india.
[6] ANAND KUMAR B.G, RV college of engineering VTI, India Behavior of Concrete Masonry Blocks with Ceramic Waste.
[7] Y Tabak, M kara, ST yildrim, Material Institute, Kocaeli, turkey ceramic tile waste as a waste management solution for concrete.
[8] IS:10262 : 2007 “specification for strength of concrete”, bureau of Indian standard NewDelhi.
[9] IS 10262 – 1982 recommended guidelines for concrete mix design- Bureau of Indian Standard, New Delhi