AN EXPERIMENTAL STUDY ON CONCRETE BY PARTIAL REPLACEMENT OF CEMENT & FINE AGGREGATE WITH FLY ASH & GLASS POWDER

B.Swathi [1], M.Durga prasanna [2], V.Joteesh [3]
[1] Assistant Professor, [23] Students
[1] DEPARTMENT OF CIVIL ENGINEERING
[1] DHANEKULA INSTITUTE OF ENGINEERING & TECHNOLOGY, VIJAYAWADA, INDIA.

Abstract- The advancement of concrete technology can reduce the consumption of natural resources and energy sources and lessen the burden of pollutants on environment. Presently large amount of fly ash is generating in thermal industries. The use of fly ash in concrete leads to a reduction in early strength of concrete but there is an increase in long term strength.
Glass is a transparent material produced by melting a mixture of materials at high temperature followed by cooling during which solidification occurs without crystallization. It can be recycle many times without changing its chemical properties. Using glass in concrete is an interesting possibility for economy on wastage disposals. The inclusion of fly ash in glass powder concrete reduces the alkali silica reaction and improves the workability and durability properties of concrete.
In the present investigation, a feasibility study is made to use Fly ash and Glass powder as partial replacement to Cement and Fine aggregate respectively and an attempt has been made to investigate the strength parameters of concrete (Compressive and tensile). Compressive strength & Split tensile strength of cubes & cylinders at 28days of duration had studied. Based on the test results, the compressive strength & Split tensile strength was identified.

Index Terms: Fly ash, Glass Powder, Compressive Strength, Split Tensile Strength.

I. INTRODUCTION

For a long time concrete was considered to be very durable material requiring. We build concrete structures in highly polluted urban and industrial areas, aggressive marine environments, harmful sub-soil water in area and many other hostile conditions where other materials of construction are found be non – durable. Since the use of concrete in recent years, have spread to highly harsh and hostile conditions, the earlier impression that concrete is a very durable material is being threatened, particularly on account of premature failures of number of structures.

In the past only strength of concrete was considered in the concrete mix design procedure assuming strength of concrete in all pervading factor for all other desirable properties of concrete including durability. In the recent revision of IS 456: 2000 , one of the points discussed , deliberated and revised is the durability aspects of concrete , in line with codes of practice of other countries , which have better experiences in dealing with durability of concrete structures. One of the main reasons for deterioration of concrete in the past is that too much emphasis is placed on concrete compressive strength. As a matter of fact advancement in concrete technology has been generally on the strength of concrete. It is now recognized that strength of concrete alone is not sufficient. The degree of harshness of the environment condition to which concrete is exposed over its entire life is equally important. Therefore, both strength and durability have to be considered explicitly at the design state. It is interesting to consider yet another view point regarding strength and durability relationship.

II. FLY ASH

The abundant production of fly ash from coal based thermal power plants as waste products becoming problem for their disposal and it is also hazardous to the environment. The inclusion of fly ash in glass powder reinforced concrete reduces the environmental pollution and improves the workability and durability properties of concrete. In the present experimental investigation glass fibres in different volume fractions with 25% and 40%replacement of cement by fly ash has been used to study the effect on compressive strength, split tensile strength, flexural strength of concrete. For each mix standard sizes of cubes, cylinders as per Indian Standards were cast and tested for compressive strength, split tensile strength at age of 28 days as per Indian Standards.

III. GLASS POWDER

Glass is a unique inert material that could be recycled many times without changing its chemical properties. A major concern regarding the use of glass in concrete is the chemical reaction that takes place between silica-rich glass particles and the alkali in the pore solution of concrete, i.e., alkali-silica reaction. This reaction can be very detrimental to the stability of concrete, unless appropriate precautions are taken to minimize its effects. Glass is a amorphous material with high silica content, thus making it potentially pozzolana when particle is less than 75mm.

Recently, some attempts have been made to use ground glass as a replacement in concrete. The objective of this paper is to present the results of experimental investigations on physical and mechanical properties of concrete made with sheet glass powder concrete. Natural fine aggregate is substituted by weight by sheet glass powder at rates varying from 10, 20, 30, percentages. Compressive and tension are evaluate and compared up to 28 days of ages.

OBJECTIVE

By using the fly ash and glass powder, we have find out the compressive strength and split tensile strength of the concrete for 28 days with different percentages.

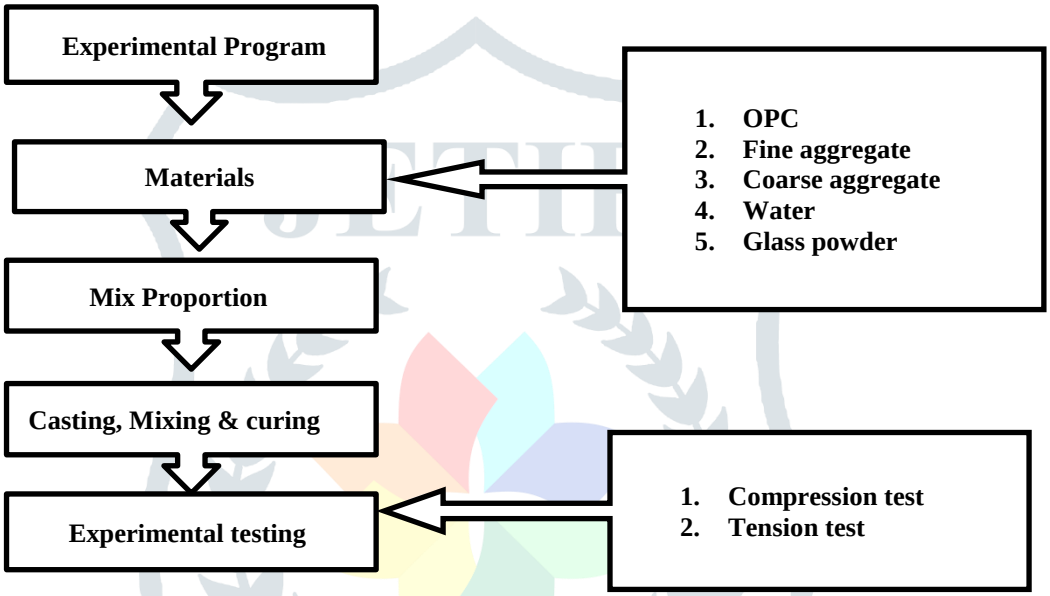
SCOPE OF THE STUDY

a. In the present study, the compressive strength and spilt tensile strength of concrete with partial replacement of cement and sand with fly ash and glass powder has been studied.

b. Further the same can be extended by using different types of waste materials with different proportions to reduce the weight of concrete and to influence the environmental balance.

IV. MATERIALS & EXPERIMENTAL METHODOLOGY

In the present work, various materials like Cement, Fine aggregate, Coarse aggregate, Fly ash, Glass powder, Water were used. From the experimental results, it was found that the specific gravity, Initial setting time, Final setting time of cement was 3.15, 90 minutes, and 150 minutes respectively. It was found that the Specific gravity and Fineness modulus of fine aggregate (G) was 2.49 and 2.87 respectively. It was found that the specific gravity and average water absorption of coarse aggregate was 2.75, 22 % respectively. The specific gravity of fly ash was 2.92. The Specific gravity of glass powder was 2.4.



V. DESIGN FOR M30 GRADE AS PER IS 10262:2009

Cement is replaced by 0%,10%,20%,30% fly ash and sand is replaced by 0%,10%, 20% and 30% glass powder and these specimens were tested for compression, split tensile strengths. The variations of compressive strength, split tensile strength are discussed in the result section. The concrete mix proportions were designed as per IS:10262-2009 code for M30. The steps involved in the design of concrete mix as per IS: 10262-2009, IS: 456-2000.

Design of M30 as per IS: 10262:2009.

a) Maximum size of aggregate = 20 mm
b) Degree of workability = 0.90
c) Degree of workability = Good
d) Type of exposure = Mild

Test data for materials:

a) Specific gravity of cement = 3.15
b) Specific gravity of fine aggregate = 2.49
c) Specific gravity of coarse aggregate = 2.75

Design of concrete (M30)

1) Determine the target mean strength f_{ck}' $= f_{ck} + 1.65(S)$
$= 30 + (1.65 \times 5)$
$= 38.25\ N/mm^2$

2) Selection of water – cement ratio (W/C) = 0.42
Max water content = 176 kg
(Nominal max size of aggregate 20mm)

3) Cement content from W/C = 176/0.42
Cement = 420 kg

4) Valve of all in aggregates
   a) Percent of CA as total aggregates = 0.62
   b) Change of W/C = 0.5-0.42 = 0.08
   c) CA in all aggregate = (0.08/0.05) x 0.01 = 0.016
   d) Total all in aggregates (e') = 0.62 + 0.016 = 0.636

5) Value of all fine aggregates (e') = 1-0.636 = 0.364

6) The mix of calculation as per unit volume
   e) Volume of cement = (mass of cement / specific gravity) x (1/1000)
      = (420/3.15) x (1/1000)
      = 0.133 m^3
   f) Volume of water = (mass of water / specific gravity) x (1/1000)
      = (176/1) x (1/1000)
      = 0.176

   g) Volume of admixture = Nil
   h) Volume of all in aggregates = (1- 0.133 – 0.176)
      = 0.691

   i) Mass of Coarse aggregates = (e' x Volume of CA x Sp. gravity x 1000)
      = 1208.56 kg

   j) Mass of fine aggregates = (e' x volume of FA x Sp.gravity x 1000)
      = (0.364 x 0.691 x 2.49 x 1000)
      = 626.94 kg

Water	C	FA	CA
176	420	626.29	1208.56
0.42	1	1.49	2.87

VI. COMPRESSIVE STRENGTH TEST:

Compressive strength or crushing strength is the main property observed in testing the cubes. The cubes of size 150 x 150 x 150mm were casted. After 24 hours, the specimens are removed from the moulds and subjected to curing for 28 days in portable water. After curing, the specimens are tested for compressive strength using compression testing machine of 2000 kN capacity (IS: 516 – 1959). Cubes are tested to calculate Compressive strength by applying gradual loading in Compression Testing Machine. The maximum load at failure occurs on the top of the machine. For M30 grade concrete, 16 Cubes were prepared for partial replacement of cement & sand by flyash & glass powder (i.e; 0%,10%,20%,30%) of age 28 days.

The Compressive strength has been calculated by the formula:

Compressive strength = ultimate compressive load/cross sectional area
= P/A
= load/area N/mm^2

VII. SPLIT TENSILE STRENGTH TEST:

Split tensile strength is the most important property of concrete. Concrete generally weak in tension. So to improve tensile behaviour of concrete, split tensile strength is important. The tensile strength of concrete is necessary to determine the load at which the concrete members may crack. It is also important in reducing formation of cracks in concrete. Cylinders are casted for calculating split tensile strength. The cylindrical specimens are also tested in universal testing machine. Here the cylinder split into the two parts and reading observed on the top of the machine.

The split tensile strength has been calculated by the formula:

Split tensile strength = $2P / \pi LD$

P = failure load (applied load)
L = height of the cylinder specimen
D = diameter of mould

For M30 grade concrete, 16 Cylinders were prepared for partial replacement of cement & sand by flyash & glass powder (i.e; 0%,10%,20%,30%) of age 28 days. The specimens 150 mm diameter and 300mm height casted were tested after 28 days of curing measured from the time water is added to the dry mix. The load was applied axially without shock till the specimen was crushed.

VIII. RESULTS & DISCUSSIONS:

Cement and sand is replaced with flyash & glass powder at 0%, 10%,20% and 30%. Compressive strength & split tensile strength of cube & cylinder specimens at 28 days are noted down below. The results are as follows:

Table no. 1 28 Days average Compressive strength & Split tensile strength results for M30 grade

Mix.No	% of Flyash	% of Cement	% of Sand	% of Glass Powder	% of Coarse Aggregate	W/C	28 Days average Compressive Strength (MPa)	28 Days average Split tensile Strength (MPa)
C1	0%	100%	100%	0%	100%	0.42	41.81	3.11
C2	0%	100%	90%	10%	100%	0.42	42.56	3.13
C3	0%	100%	80%	20%	100%	0.42	43.26	3.16
C4	0%	100%	70%	30%	100%	0.42	42.31	3.10
C5	10%	90%	100%	0%	100%	0.42	43.26	3.16
C6	10%	90%	90%	10%	100%	0.42	43.39	3.17
C7	10%	90%	80%	20%	100%	0.42	43.54	3.19
C8	10%	90%	70%	30%	100%	0.42	43.23	3.13
C9	20%	80%	100%	0%	100%	0.42	42.31	3.11
C10	20%	80%	90%	10%	100%	0.42	42.51	3.14
C11	20%	80%	80%	20%	100%	0.42	39.28	3.12
C12	20%	80%	70%	30%	100%	0.42	38.52	3.10
C13	30%	70%	100%	0%	100%	0.42	35.52	3.12
C14	30%	70%	90%	10%	100%	0.42	36.12	3.10
C15	30%	70%	80%	20%	100%	0.42	36.52	3.00
C16	30%	70%	70%	30%	100%	0.42	29.25	2.96

Based on the test results obtained from the compressive strength test & split tensile strength test on 28days, the graph between Mix No. Vs Compressive strength was shown in Fig 1 and Mix No. Vs Split tensile strength was shown in Fig 2.

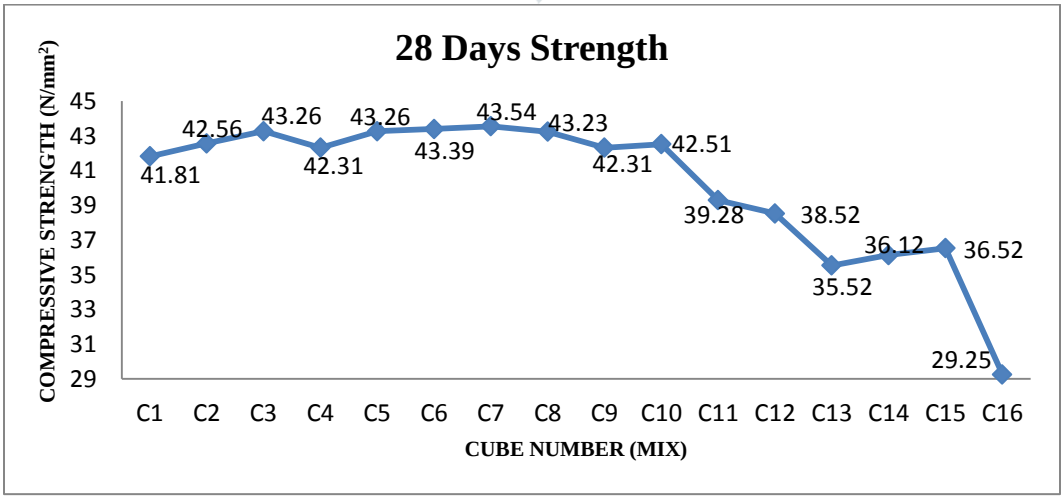


Fig no. 1 Compressive Strength on 28 days

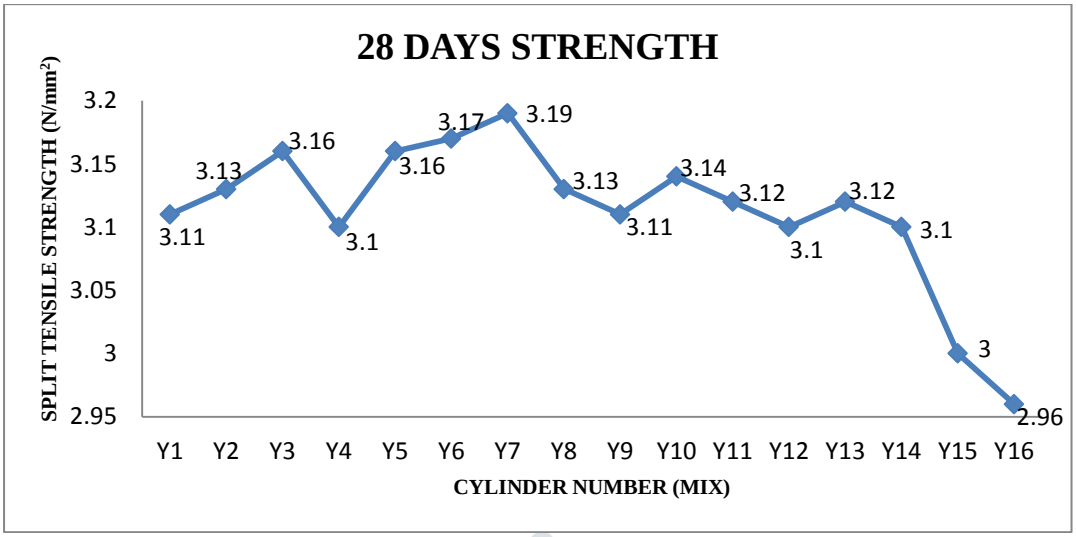


Fig no. 2 Split tensile Strength on 28 days

IX. CONCLUSIONS

After the analysis of the result of the experimental programme, the following conclusions were arrived.

- By the partial replacement of cement by fly ash & sand by glass powder can improve the mechanical properties (Compressive strength & Split tensile strength) of the concrete.

1) The Mix No.7 (C7) of cube is concluded as economical and ideal mix based on the results obtained in compressive strength.
2) The Mix No.7 (Y7) of cylinder is concluded as economical and ideal mix based on the results obtained in Split tensile strength.

REFERENCES

[1] Incorporation of Waste Glass Powder as Partial Replacement of Fine Aggregate in Cement Concrete (Dr. M.Vijaya Sekhar Reddy, P.Sumalatha, M.Madhuri and K.Ashalatha).
[2] Experimental Investigation Of Partial Replacement Of Cement With Fly Ash And Sand With Bottom Ash And Glass Used In Concrete (T.Subramani , C.Sumathi).
[3] Replacement of Sand by Sheet Glass Powder in Concrete (R Ramasubramani1, S Divya1 and Vijay1).
[4] Experimental investigations on partial replacement of cement with fly ash in design mix concrete (Prof. Jayeshkumar Pitroda, Dr. L.B.Zala, Dr.F.S.Umrigar).
[5] IS: 2386-1963 part I to VII. Indian standard methods for test for aggregate for concrete. Bureau of Indian standards, New Delhi.
[6] IS: 516-1959, Indian Standard methods of test for strength of concrete. Bureau of Indian Standards, New Delhi.
[7] IS: 10262-2009 and SP: 23:1982 Recommended Guidelines for concrete mix. Bureau of Indian Standards, New Delhi.
[8] IS: 8112-1989, Specifications for 43 grade ordinary Portland cement, Bureau of Indian Standards, New Delhi.
[9] IS: 12269-1987 Specification for 53 grade ordinary Portland cement.
[10] IS 456 – 2000 : Indian Standard Code of Practice for plain and Reinforced Concrete.
[11] IS 383-1970 : Specification for coarse and fine aggregate from natural source for concrete.