INTERNATIONAL RESEARCH JOURNAL IN ADVANCED ENGINEERING AND TECHNOLOGY (IRJAET) E - ISSN: 2454-4752 P - ISSN : 2454-4744
VOL 4 ISSUE 3 (2018) PAGES 3707 - 3717
RECEIVED : 25.05.2018 PUBLISHED : 08.06.2018
June 08, 2018

EXPERIMENTAL INVESTIGATION ON CHARACTERSTIC STRENGTH OF TERNARY BLENDED CONCRETE CONTAINING INDUSTRIAL WASTE AS A POZZOLANIC MATERIAL

A.Divya Sree [1], Mr.D.Jayaseelan [2]

M.E. Structural Student[1], Assistant Professor[2]
Department of Civil Engineering,
Global Institute of Engineering and Technology, Melvisharam, Vellore 632059

Abstract:

With increasing industrialization, the industrial by-products (wastes) are being accumulated to a large extent. Leaving the waste materials to the environment directly can cause environmental problems. As a result, to fulfill the demands of sustainable construction, waste materials and by-products utilization has become an attractive alternative to disposal. In this research work, M20 grade mix of concrete (with water - binder ratio as 0.50) is adopted with glass powder (GP) and SugarCane Bagasse Ash (SCBA) as partial replacement of cement. Replacement of cement by GP from 20% to 0% by weight of cement in step of 5% and by SCBA from 0% to 20% in step of 5% respectively was adopted. In total, five different combinations of mixes were studied at three different ages of concrete namely 7,14 and 28 days. Compressive strength of cubes and split tensile test for various percentage of replacement were investigated and compared with conventional concrete to find out the maximum mix ratio. Flexural strength of concrete for the maximum mix ratio was also studied.

Keywords: Glass powder, Bagasse ash, Concrete, Compressive strength, Split tensile strength, Flexural strength.

I. INTRODUCTION

We are aware that a lot of damage is done to environment in the manufacture of cement. It involves lot of carbon emission associated with other chemicals. The researches has shown that every one ton of cement manufacture releases half ton of carbon dioxide, so there is an immediate need to control the usage of cement. Glass powder is an inert material. Much of the glass produced in the World is discarded, stockpiled or land filled. Glass is used in a variety of applications right from construction, automobiles, nose-diving submarines, doors and windows, utensils, waste containers, windscreen, medicinal bottles, soft-drink bottles, tube lights, bulbs, electronic equipments, etc. Hence, the usage of glass has increased considerably, which has in essence, contributed to the increase of waste disposal. In addition, glass waste is considered as non-decaying material that pollutes the surrounding environment. Many researchers have thus come forward and have investigated the usage of glass in powdered form as a partial replacement of cement in concrete.

Bagasse is a by-product from sugar industries which is burnt to generate power required for different activities in the factory. The burning of bagasse leaves bagasse ash as a waste, which has a pozzolanic property that would potentially be used as a cement replacement material. The Bagasse ash imparts high early strength to concrete and also reduce the permeability of concrete. The Silica present in the Bagasse ash reacts with components of cement during hydration and imparts additional properties such as chloride resistance, corrosion resistance etc. Therefore the use of Bagasse ash in concrete not only reduces the environmental pollution but also enhances the properties of concrete and also reduces the cost. It makes the concrete more durable. In this research work, M20 grade mix of concrete (with water - binder ratio as(0.50) is adopted with glass powder (GP) and SugarCane Bagasse Ash (SCBA) as partial replacement of cement. Replacement of cement by GP from 20% to 0% by weight of cement in step of 5% and by SCBA from 0% to 20% in step of 5% respectively was adopted.

II. LITERATURE SURVEY

M.V.S.S. Sastri, Dr. K. Jagannadha Rao, Dr. V. Bhiksma March [2014] published a paper titled " Compression And Flexural Strength Characteristics Of Triple Blended High Strength Recycled Aggregate Concrete", The by-products used are fly ash, condensed silica fume as binders at different percentages, and recycled aggregates as partial replacement to natural aggregates. The concrete mixtures containing both supplementary cementitious materials and recycled aggregates had shown high compressive strength (>70 MPa), high flexural strength and split tensile strength compared to control concrete.

Shamila habeeb, rekha ambi July [2014] published a paper titled "Strength and Durability Studies on Ternary Blended Concrete Containing GGBS and Bagasse Ash", In this paper the properties of ternary blended concrete with bagasse ash and GGBS has been studied. The bagasse ash replacement levels were 0,5,10,15,20,25 and 30% by the weight of cement and the GGBS replacement level was fixed as 30% for all mixes. For comparison purposes normal concrete with 100% OPC (Ordinary Portland Cement) was also tested. After studying the strength and durability properties, it was found out that the ternary blended concrete with 10% bagasse ash and 30% GGBS has showed greater improvement in the properties than all other mixes. Flexural and impact tests were done on TBC (Ternary Blended Concrete) beams with optimum dosage of bagasse ash and are compared with the control mix beams.

Piyush kumar , Anil pratap singh July [2015] published a paper titled " Effect of use of Bagasse Ash on Strength of Concrete", with increasing demand and consumption of cement ,researchers and scientist are in search of developing alternate binders that are eco friendly and contributes towards waste management. In these paper SCBA has been chemically and physically characterized and partially replaced in the ratio of 0%,5%,10%,15%&20% by weight of cement in concrete. The properties for fresh concrete are tested like slump cone test and for hardened concrete compressive strength at the age of 7&28 days by using grade M30.The test result indicate that the strength of concrete increase up to 10% SCBA replaced with cement.

Prema Kumar W P1*, Ananthayya M B2 and Vijay K May [2015] published a paper titled "Effect of partial replacement of cement with waste glass powder on the properties of concrete", Storage and safe disposal of waste glass is a huge problem for municipalities everywhere. Reuse of waste glass eliminates/reduces this problem. In this experimental work, the effect of partially replacing cement in concrete by glass powder is studied. The cement in concrete is replaced by waste glass powder in steps of 5% from 0% to 40% by volume and its effects on compressive strength, split tensile strength, workability and weight density are determined.

III. SCOPE OF RESEARCH

1) To study the existing methods of disposal of glass waste and sugarcane bagasse ash.
2) To economically compare conventional concrete with the concrete modified using glass waste and bagasse ash.
3) Feasibility of utilizing industrial waste content as a partial replacement to cement.

IV. PROPOSED METHODOLOGY

A. MATERIALS USED

Cement: I have used Ordinary Portland cement (OPC) with 53grade conforming to **IS: 8112-1987**. The specific gravity of cement is 3.15. Standard Consistency was 31.5%.

Fine aggregate: In this experimental work, we used locally available river sand. The result of sieve analysis confirms to zone – ii according to IS: 383-1970. Sand having specific gravity of 2.40 and fineness modulus 2.75 was used.

Coarse aggregate: Crushed angular aggregate passed from **20mm** sieve and retain on 10mm sieve size having specific gravity of 2.81 and fineness modulus of 7.48 was used.

Water: water is an important ingredient for concrete. Portable water was used.

Glass powder: Glass is a unique inert material and it's a non-biodegradable. Need to be reused or recycled to avoid environmental problems. Glass powder having the specific gravity of 2.43.

Sugarcane bagasse ash: The original ash had high moisture content, so to make it free from moisture , it was kept in a furnace at 700 degree Celsius for few hours and after drying the ash was ground in a mill to reduce its particle sizes until the particles were passing through 90µm sieve. The specific gravity of Bagasse ash is 2.2

INTERNATIONAL RESEARCH JOURNAL IN ADVANCED ENGINEERING AND TECHNOLOGY (IRJAET) E - ISSN: 2454-4752 P - ISSN : 2454-4744
VOL 4 ISSUE 3 (2018) PAGES 3707 - 3717
RECEIVED : 25.05.2018 PUBLISHED : 08.06.2018
June 08, 2018

B. METHODOLOGY

The basic tests are conducted on various materials like OPC53 grade cement, fine aggregate, coarse aggregate, glass powder and sugarcane bagasse ash to check their suitability for making concrete. The mix proportions of concrete are modified for using glass powder and bagasse ash as a partial replacement of cement. The cubes were cast by Replacement of cement by GP from 20% to 0% by weight of cement in step of 5% and by SCBA from 0% to 20% in step of 5% respectively was adopted. Specimens are cast as per mix design and the tests are conducted after proper curing, the tests are compressive strength of cubes (150mm x 150mm x 150mm), split tensile strength of cylinders (150mm x 300mm) and flexural strength of beam (100mm x 150mm x 1000mm). From the studies, optimum results are found out and compared with the control concrete.

C. *MIX PROPORTION*

As per the code book IS: 10262 -1979, the mix design was done for M20 grade mix and the amounts of materials were calculated.

Table 1: Mix proportion

383 kg	528.1 kg	1250.9 kg	191.6 lit.
1	1.378	3.265	0.5

Table-2 gives the quantities required for M20 grade of concrete Mixes.

Table 2: Proportion of replacing materials

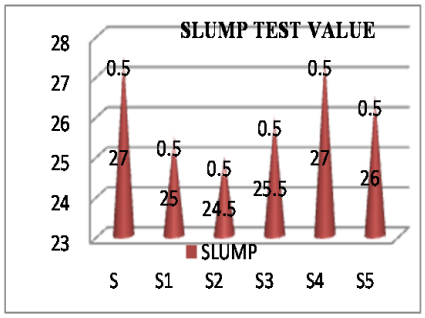
Mix Design	**Cement**	**SBCA**	**GP**	**FA**	**CA**
S	100%	0%	0%	100%	100%
S1	80%	0%	20%	100%	100%
S2	80%	5%	15%	100%	100%
S3	80%	10%	10%	100%	100%
S4	80%	15%	5%	100%	100%
S5	80%	20%	0%	100%	100%

INTERNATIONAL RESEARCH JOURNAL IN ADVANCED ENGINEERING AND TECHNOLOGY (IRJAET) E - ISSN: 2454-4752 P - ISSN : 2454-4744
VOL 4 ISSUE 3 (2018) PAGES 3707 - 3717
RECEIVED : 25.05.2018 PUBLISHED : 08.06.2018
June 08, 2018

V. EXPERIMENTAL RESULTS

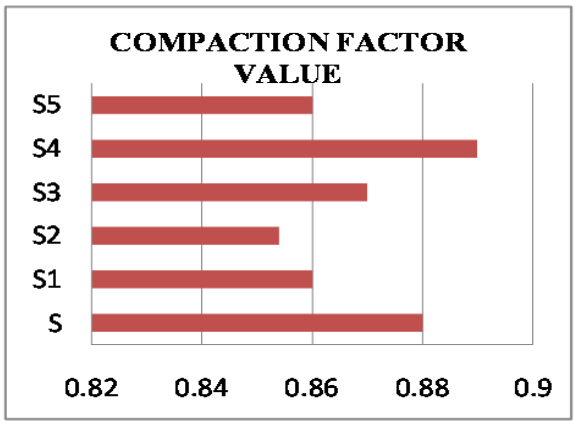
A. WORKABILITY TEST ON CONCRETE

Slump test: Slump test is conducted on fresh concrete of different mix proportions. The slump cone test carried out on various samples of concrete of M20 grade and results are graphically represented in Fig.1.



During the whole research work water to cement ratio was kept 0.5, no extra amount of water is added to get slump. From the results, it can be seen that replacement of cement by GP from 20% to 0% by weight of cement in step of 5% and by SCBA from 0% to 20% in step of 5% in the concrete of M20 grade slump value may also increased.

Compaction Factor test: Compacting factor test also used to determine the workability of fresh concreteFig.2 shows the variation of compaction value of concrete using Glass powder and Bagasse ash.



B. COMPRESSIVE STRENGTH TEST

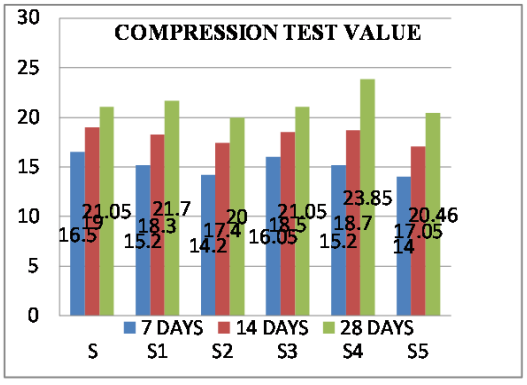
Concrete cubes of size 150 mm X 150 mm X 150 mm were prepared and the specimen is cured, it is tested for compressive strength. The maximum load at failure reading was taken

INTERNATIONAL RESEARCH JOURNAL IN ADVANCED ENGINEERING AND TECHNOLOGY (IRJAET) E - ISSN: 2454-4752 P - ISSN : 2454-4744
VOL 4 ISSUE 3 (2018) PAGES 3707 - 3717
RECEIVED : 25.05.2018 PUBLISHED : 08.06.2018
June 08, 2018

Fig.3 shows the compressive strength of concrete using Glass powder and Bagasse ash at 7th , 14th and 28th day.

Table 3 : Compressive Strength of Cube

Sl. No.	Mix	Average Compressive Strength In N/mm ^{2}		
		7 Days	14 Days	28 Days
1	S	16.50	19	21.05
2	S1	15.20	18.30	21.70
3	S2	14.20	17.40	20.00
4	S3	16.05	18.50	21.05
5	S4	15.20	18.70	23.85
6	S5	14.00	17.05	20.46



INTERNATIONAL RESEARCH JOURNAL IN ADVANCED ENGINEERING AND TECHNOLOGY (IRJAET) E - ISSN: 2454-4752 P - ISSN : 2454-4744
VOL 4 ISSUE 3 (2018) PAGES 3707 - 3717
RECEIVED : 25.05.2018 PUBLISHED : 08.06.2018
June 08, 2018

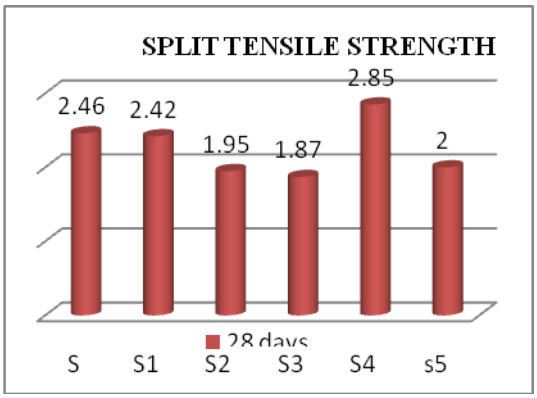
The experimental results show that the maximum compressive strength was obtained with S4 (15% SBCA + 5% GP). The compressive strength of S4 mix was 18% more than that of S (conventional mix). This increase was attributed to pozzolanic property of Supplementary Cementitious Materials (SCM) added viz., SBCA and GP.

C. SPLIT TENSILE STRENGTH TEST

The cylindrical specimens of size 150 mm of diameter 150 mm and height 300mm were casted and the specimen is cured, it is tested for split tensile on 28th day. The maximum load at failure reading was taken.

Fig.4 shows the split tensile strength of concrete using Glass powder and Bagasse ash at 28th day.

Table 4: Split Tensile Strength of Cylinder at 28 days



The split tensile strength of M20 grade of concrete cylinder are reached maximum value of as per IS code. The results showed that the split tensile strength is increased in S4 mix (i.e., 15% replacement of bagasse ash and 5% replacement of Glass powder in pozzolanic materials), beyond that the split tensile

INTERNATIONAL RESEARCH JOURNAL IN ADVANCED ENGINEERING AND TECHNOLOGY (IRJAET) E - ISSN: 2454-4752 P - ISSN : 2454-4744
VOL 4 ISSUE 3 (2018) PAGES 3707 - 3717
RECEIVED : 25.05.2018 PUBLISHED : 08.06.2018
June 08, 2018

strength value reduced but it more than the split tensile strength of control mix. The results showed that the concrete increases the tensile strength of about 15 % with that of control mixture

D.FLEXURAL STRENGTH

All the beams are of same dimensions, 2000mm length, 150mm wide and depth 200mm. 2no‟s 12mm dia bars at bottom and 2no‟s 8mm dia bars at top and 130mm spacing 8mm dia stirrups is used as reinforcement.

The specimens were tested using point loading by 100 T loading frame. The deflection and flexural strength of beam was calculated by placing LVDT at the mid span of the beam. In this two point loading method, the load was divided into two parts. Here 'P' is the total load given on the beam through the loading frame and was divided into two separate loads by placing two I sectioned rollers below the beam and the load was transferred to beam. The load at first crack was noted.

Sl.No	**Mix**		**Tensile Strength In N/mm ^{2}**
1	0%	0%	2.46
2	0%	20%	2.42
3	5%	15%	1.95
4	10%	10%	1.87
5	15%	5%	2.85
6	20%	0%	2.00

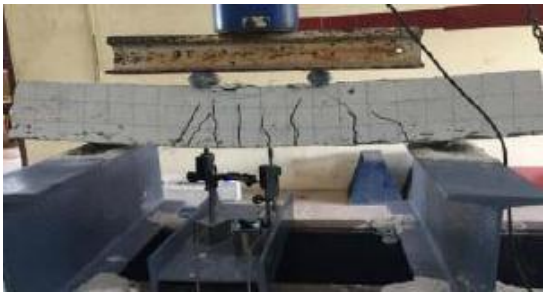
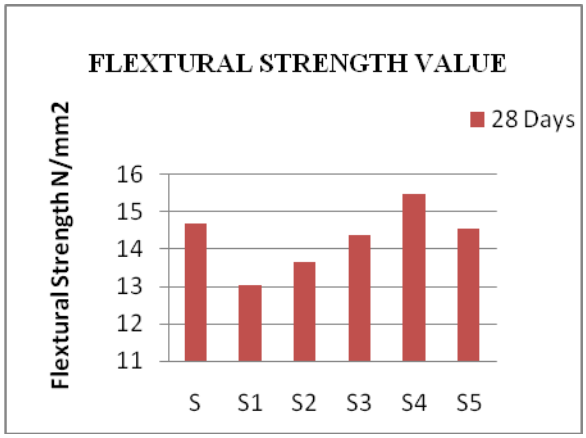


Figure 5 shows the load and the beam made with S4 mix

INTERNATIONAL RESEARCH JOURNAL IN ADVANCED ENGINEERING AND TECHNOLOGY (IRJAET) E - ISSN: 2454-4752 P - ISSN : 2454-4744
VOL 4 ISSUE 3 (2018) PAGES 3707 - 3717
RECEIVED : 25.05.2018 PUBLISHED : 08.06.2018
June 08, 2018

Table 5: Flexural strength of Beam

Mix	Peak load (KN)	First crack load (KN)	Max deflection in mm	Deflection under loads in mm	Ultimate Flexural strength
S	46.6	23.4	9.27	6.68	14.68
S1	45.3	22.46	9.48	6.40	13.03
S2	46.32	22.13	10.5	6.35	13.63
S3	48.05	23.36	9.36	5.42	14.34
S4	49.7	24.00	9.13	4.37	15.45
S5	48.7	23.4	9.23	4.52	14.52



From the flexure test, the peak load carrying capacity of S4 mix (15% SCBA 5% GP) had increase in strength of 5.8% in comparison with that of conventional mix and the load at first crack was also higher than that of the conventional mix by 3%. The load and the beam made with S4 mix are shown in the Figure 5.

VI. CONCLUSION

From the experimental results, the maximum mix ratio percentage was found to be S4 mix (15% SCBA +5% GP). In this research, Out of the total weight requirement of the binder (Cement), 20% by weight of total binder was fulfilled with SCM viz., combination of SCBA as 0% to 20% in step of 5% and GP as 20% to 0% in step of 5%. The remaining 80% of the total requirement of binder was Cement i.e.,

cement percentage as binder was kept constant at 80% for all mix ratio. Totally five different combinations of mix ratios were studied for a curing period of 7days, 14 daysand 28 days.

After detailed study of the result and analysis the following conclusions were made for M20 grade concrete.

1. Slump Result Comparison with Partial Replacement of Glass powder and Bagasse ash mixes have reached maximum value as per IS code

2. The experimental results show that the maximum compressive strength was obtained with S4 (15% SBCA + 5% GP). The compressive strength of S4 mix was 18% more than that of S (conventional mix)..

3. The split tensile strength of M20 grade of concrete cylinder are reached maximum value of as per IS code.

4. The compaction factor increased as the percentage of increases partially replaced concrete mixes and increased in comparison with the conventional concrete.

5. Overall the compressive strength and flexural strength were increased compared with conventional without adding any chemicals or superplasticizer.

6. Due to the pozzolanic properties of both SCBA and GP, there was an increase in strength in some mechanical properties like compressive strength , split tensile strength and flexural strength.

VII. ACKNOWLEDGEMENT

The authors would like to express their sincere thanks to the Honorable chairman. The Principal 0f Global Institute of Engineering and Technology, Melvisharam, Vellore for the support and faculties provided to pursue this study..

VIII. REFERENCES

- M.V.S.S. Sastri, Dr. K. Jagannadha Rao, Dr. V. Bhiksma, “Compression And Flexural Strength Characteristics Of Triple Blended High Strength Recycled Aggregate Concrete”, International Journal of Civil Engineering and Technology-(Ijciet) Volume 5, Issue 3, March(2014), pp. 268-274
- Shamila habeeb, rekha ambi, “Strength and Durability Studies on Ternary Blended Concrete Containing GGBS and Bagasse Ash”, International Journal of Scientific & Engineering Research, Volume 5, Issue 7, July-2014, ISSN 2229-5518
- Piyush kumar , Anil pratap singh, “ Effect of use of Bagasse Ash on Strength of Concrete”, IJCSE - International Journal of Civil & Structural Engineering Research Vol. 2, Issue 7, July 2013, ISSN: 2319-8753

- Prema Kumar W P1*, Ananthayya M B2 and Vijay K, "Effect of partial replacement of cement with waste glass powder on the properties of concrete", International Journal of Scientific & Engineering Research, volume 5, Issue 7, May- 2015
- IS 10262 2009 Indian Standard for Concrete Mix Proportioning – Guidelines, Bureau of Indian Standards, New Delhi, India.
- IS 456 2000 Indian Standard Plain and Reinforced Concrete - Code of Practice, Bureau of Indian Standards, New Delhi, India.
- IS 516 1959 Indian Standard Methods of Tests for Strength of Concrete, Bureau of Indian Standards, New Delhi, India.
- SP : 23-1982 : Handbook on concrete mixes