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Properties of concrete under the influence of waste materials as partial Supplement of Aggregate

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ABSTRACT

Concrete is a composite material obtained by using cement, aggregates and water. Few decades ago, these materials were easily available while nowadays there is an adverse effect of the utilization of these materials. During the manufacturing Ordinary Portland Cement (OPC), a large amount of green house gas (CO2) is produced from both industrial and fuel combustion. In industrial process green house gas is emitted due to the heating of limestone (CaCO3) to obtain calcium oxide.

During production of cement, fossil fuel combustion is also responsible for the emission of CO2 by 5%. Due to these emissions, there is a huge incline in the temperature of the earth, which ultimately gives rise to global warming. Moreover, Natural sand is major constituent of mix proportion of concrete used as fine aggregate. Extensive mining of natural sand for using river sand as fine aggregate had led to exploitation of river beds leading to erosion of land near water resources and downfall of water level further leading to damage to structures playing active role in connecting roads over water bodies.

In this study we are utilizing sugarcane ashes in percentage of 0, 5, 10, 15 & 20% whereas Glass waste as 0, 10, 20, 30 & 40%. In concrete to modify its properties and to utilize these non-decomposable waste in construction industry.
Keywords : Waste, construction, concrete, strength, UTM, sampling, curing.

I. INTRODUCTION

In present scenario, utilization of waste products is now well developed, as such changes the unsustainable to sustainable development by two ways. Firstly, waste materials are utilized which otherwise will be the burden on the environment and require too much land in order to dispose them.

Secondly, it will help to mitigate the problem of digging of sand.
Sugarcane Bagasse Ash is primary by product obtained by the sugar industry worldwide. As per Food and Agriculture Organization (FAO) Brazil is the first and India stands as second largest producer of sugarcane. Sugarcane bagasse is fibrous residue obtained in the process while extracting the juices in sugarcane and the shell is removed termed as sugarcane ash. That fibrous residue material (Bagasse) is the major industrial waste from sugar industry.

The particular ash constitutes 50% of cellulose, 25% of hemicelluloses and 25% of lignin. Each ton of sugarcane generates approximately 26% of bagasse and 0.62% of residue ash. Most of the bagasse is used as a fuel in boilers, distilleries and small amount for power generation in sugar factories. After burning of bagasse at controlled condition, by product bagasse ash can be used as a supplementary replacement material with cement due to high content of silica (SiO_2).

The use of SCBA as supplementary cementitious material (SCM) not only reduces the production of cement which is responsible for high energy consumption and carbon emission, but also can improve the compressive strength of cement based materials like concrete and mortar. The main improvement in compressive strength of concrete with the use of SCBA replaced with cement is due to its physical as well as chemical effects.

We can utilize WG as fine aggregate by a slight change in their size and shape. In view of the science of glass, it tends to be grouped into different classes like vitreous silica, salt silica, soft drink lime glass, borosilicate glass, lead glass and aluminosilicate glass and so on. Soft drink lime glass is chiefly utilized for the assembling of compartments, containers and sheets.

In WG, soft drink lime glass is roughly about 80%. Soft drink Lima glass, for the most part, comprises SiO2 about 73%. Materials like WG is squashed into determining sizes for use as totals in different applications, for example, water filtration, coarseness putting, sand spread for sports turf and sand substitution in concrete.

The utilization of WG as a fine total makes an issue in concrete because of the response of soluble bases in the pores of cement and silica from WG, which is named as salt silica response (ASR). Due to ASR, silica gel is framed which assimilates water and the volume of gel increments. The expanding of silica gel creates hydrostatic weight.

While the utilization of WG as fine totals, no response was recognized though this response was distinguished when it is utilized as coarse totals. Accordingly, this response can be disposed of by fining the size of glass particles. The fineness of glass particles will build the surface zone of glass particles preferring quick pozzolanic response contrasted with ASR.

II. Literature Review

Author Name	Topic Name	Research Done
Ashraf Teara et al (2018)	The use of waste materials for concrete production in construction applications	• The research stated the plausibility of utilizing reused concrete in development applications as ordinary cement. Techniques incorporate the differing extent of supplanting regular aggregates by reused coarse aggregate and the substitute of concrete by related slag concrete with fly ash. • The examination uncovered that slag and fly ash were viable valuable components in improving the properties of the cement with concrete. Without concrete, these two components couldn't assume a significant job in improving the properties. • Slag was more valuable than flyash if its sum doesn't go higher than half. Additionally, reused aggregates contribute decidedly to the solid blend, as far as pressure quality. At long last, solid quality increments when the measure of the RA enlarges, identified with either the high calibre of RA or the technique for blending or both.
Adewumi John Babafemi et al (2018)	Engineering properties of concrete with waste recycled plastic: a review	• This paper exhibits an extensive audit of the designing properties of waste reused plastic. • The impact of reused waste plastics on the new properties of cement was discussed and trailed by its effect on the mechanical and strength properties of cement. • Test results exhibited that the mechanical and solidness properties of cement were changed because of the incorporation of plastic. Nonetheless, such solid still satisfies the prerequisites of many building applications.

M Mahesh et al (2016)	**Experimental study on e–waste concrete and comparing with conventional concrete**	• The paper dealt with the probability of utilizing the waste polyethene as incomplete substitution of the fine or coarse aggregate in concrete. Concrete with 2%, 4%, 6% pounded/non pummeled polyethene material was set up after the preparation of blend structure. • Different tests on concrete-like explicit gravity, fineness, setting time, and so on., tests on coarse and fine aggregates like sieve investigation, fineness modulus, explicit gravity was performed. Blend configuration utilizing IS Code strategy was done and 3D shapes and cylinders were cast for M25 grade concrete with and without plastics and tests on the concrete-like slump, cube tests and cylinder tests were performed to comprehend their conduct and convenience as a substitution. The standard mechanical properties of concrete like compressive quality, split elasticity were examined and contrasted against the results of any standard specimen. • Conclusion stated Plastic Waste can be adequately re-utilized without influencing the mechanical properties impressively (5-10%). With an expansion in the level of plastic, there's an abrupt lessening in early quality however the quality created to the incentive as that of the regular M25 solid when 28-day tests were performed. It was seen that for more rate expansion of plastics i.e 6% in the achieved case, the 7-day quality diminished when contrasted and ordinary cement.
MANIKANDAN M et al (2017)	**Application of paper waste in cement concrete**	• demonstrated experimental analysis to decide the impacts of reused concrete aggregate (RCA) under the restoring states of 2.1 pH in sulphuric corrosive (H2SO4) and 0.5 N in Hydrochloric Acid (HCl) severally. The substitution rates of RCA were 0%, 5%, 10% and 15% individually. The incomplete substitution of RCA to accomplish the mechanical properties (compressive and flexural quality) and compound properties (erosion obstruction and soluble base assault) of cement by using E-waste as contrasted and the normal regular cement. • The investigation presented the significant work supplanting of E-waste in the generation of low-cost concrete in structural designing society.

		• concluded that usage of fractional substitution of E-waste as coarse aggregate was the best option as an alternative to the traditional cement. The transfer of E-waste can be utilized as a coarse aggregate, the decrease in the weight on landfill arranging and natural contamination. The outcomes presented that the great quality, more noteworthy sturdiness and expansion of E-waste displays an expansion in compressive quality up to 15% substitution. Soluble base total response shows the bar cause without harm and breaks under 0.5 pH restoring states of HCl.

III. Objectives of the study:

- To study the compressive strength characteristic of concrete using waste glass (as partial replacement of fine aggregate) and sugarcane bagasse ash (as partial replacement of cement).
- To study the workability characteristic of concrete using waste glass and sugarcane bagasse ash.
- To study the effect of elevated temperature on compressive strength of concrete using waste glass and sugarcane bagasse ash.

IV.Materials used in the Procedure

1. **Ordinary Portland cement (OPC)-** In this investigation, Ordinary Portland Cement (OPC) fit in with BIS: 8112-2013 was utilized collected from "Vaishnavi Traders" Infront Of Dr. Pathak, Tili Ward, Rajghat Road, Sagar, Madhya Pradesh.
2. Both the course aggregate and fine aggregate was collected from Huteb Hardware, Teen Batti Sagar.

Course Aggregates are aggregates, the most of which are retained on 4.75-mm BIS Sieve.
Fine aggregates are aggregate, the most of which pass through 4.75-mm BIS Sieve.

3. **Sugarcane Bagasse Ash-**Sugarcane Bagasse Ash (SCBA) is an agro waste, is by product of bagasse. Bagasse is fibrous residue after the extraction of sugar from sugarcane. When this bagasse is burn at controlled temperature conditions, it turns into bagasse ash. It has chemical composites like SiO_2, AL_2O_3 and $Fe_2 O_3$. After burning, waste residue is collected from the boiler. To meet the requirements of replaced material, ash was sieved through 45 micron sieve. Bagasse ash used in this research was collected from the boiler of a sugar mill named Ramdev Mills situated at Bankhedi, Madhya Pradesh.

Fig 1: Sugar Bagasse

4. Waste Glass (WG)

In this study, WG was collected from various places of the city. This WG is generally known as ground glass. It includes container glass, bulb glass and flat glass. Thereafter, ground glass is wasted with water to remove dust particle and other undesirable materials from ground glass. In order to attain the right size for having proper fin aggregates sieved thought 4.75mm. After the consummation of half going through BIS-strainer, that ground glass was prepared for the utilization as fine aggregate in concrete. The glass waste (WG) was collected from Arihant Glass Industry situated in Makronia Chouraha, Sagar.

Fig 2: Glass fiber

Steps Involved in experimental setup:

The basic steps involved in the slump test were summarized as follows:

a) The shape for the slump test is a frustum of a cone, 300 mm of stature. The base is 200 mm in distance across and it has a little opening at the head of 100 mm.
b) The base is set on a smooth surface and the compartment is loaded up with concrete in three layers, whose functionality is to be tried.
c) Each layer is packed multiple times with a standard 16 mm breadth steel pole, adjusted toward the end.

d) When the shape is loaded up with concrete, the top surface is struck off (levelled with form top opening) utilizing screening and moving movement of the packing pole.
e) The shape must be solidly held against its base during the whole activity with the goal that it couldn't move because of the pouring of cement and this should be possible utilizing handles or stools brazed to the form.
f) Immediately after filling is finished and the solid is levelled, the cone is gradually and painstakingly lifted vertically, an unsupported solid will presently slump.
g) The decline in the stature of the focal point of the slumped concrete is known as a slump.

Fig 3: Mixing

Fig 4: Cube casting

Fig 5 : Curing of samples

V. Experimental Results

Workability of Samples:

Table 1 : Workability

Mix	SCBA (%)	WG (%)	Slump (%)
S1	0		0
S2	5		-2.72
S3	10		-6.36
S4	15		-13.63
S5	20	0	-17.27
S6	0		1.82
S7	5		-5.46
S8	10		-8.18
S9	15		-13.63
S10	20	10	-18.18
S11	0		6.36
S12	5		0.9
S13	10		-1.82
S14	15		-10
S15	20	20	-11.81
S16	0		15.45
S17	5		8.18
S18	10		3.64
S19	15		-4.54
S20	20	30	-6.36
S21	0		20.9
S22	5		20
S23	10	40	11.82
S24	15		10

S25	**20**		**8.18**

Compressive strength of concrete samples

Table 2 : Compressive strength

Mix	**SCBA (%)**	**WG (%)**	**Average compressive strength (N/mm²) of concrete for different curing days**		
			14 days	**28 days**	**60 days**
S1	**0**		**23.01**	**27.35**	**32.1**
S2	**5**		**23.63**	**28.41**	**33.44**
S3	**10**	**0**	**24.06**	**29.01**	**33..99**
S4	**15**		**23.33**	**27.86**	**32.42**
S5	**20**		**22.84**	**26.93**	**31.81**
S6	**0**		**22.87**	**27.1**	**31.93**
S7	**5**		**23.51**	**28.17**	**33.28**
S8	**10**	**10**	**23.92**	**28.79**	**33.86**
S9	**15**		**23.21**	**27.65**	**32.32**
S10	**20**		**22.71**	**26.74**	**31.61**
S11	**0**		**22.43**	**26.55**	**31.23**
S12	**5**		**23.05**	**27.59**	**32.64**
S13	**10**	**20**	**23.53**	**28.19**	**33.15**
S14	**15**		**22.73**	**27.11**	**31.42**
S15	**20**		**22.29**	**26.11**	**30.84**
S16	**0**		**21.65**	**25.79**	**30.14**
S17	**5**		**22.25**	**26.83**	**31.45**
S18	**10**	**30**	**22.68**	**27.21**	**32**
S19	**15**		**21.99**	**26.28**	**30.49**
S20	**20**		**21.46**	**25.68**	**30.1**
S21	**0**		**21.14**	**24.8**	**29.17**
S22	**5**		**21.79**	**25.84**	**30.49**
S23	**10**	**40**	**22.23**	**26.5**	**31.04**
S24	**15**		**21.44**	**25.27**	**29.56**
S25	**20**		**20.96**	**24.36**	**29.3**

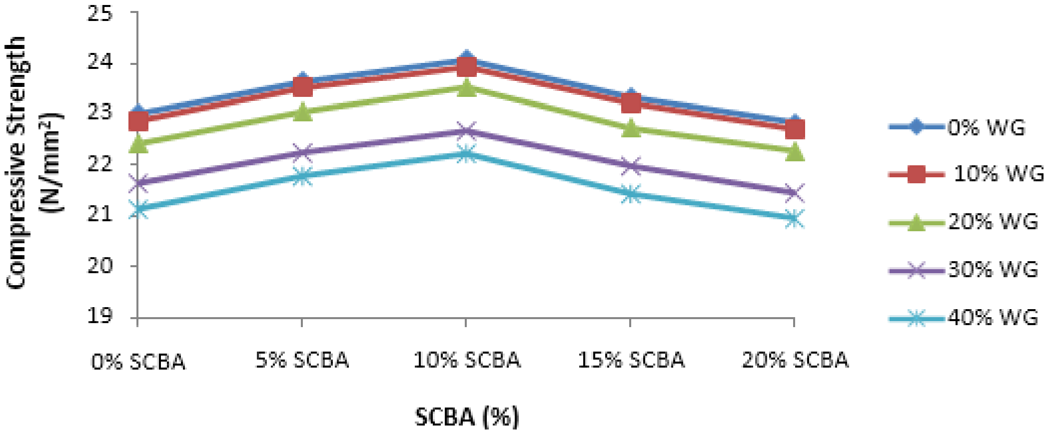

Fig 6: Compressive strength

Table 3 : Cost of samples

Mix	Cement (Rs/m³)	SCBA (Rs/m³)	Fine Aggregates (Rs/m³)	WG (Rs/m³)	Coarse Aggregates (Rs/m³)	Total Cost (Rs/m³)	Percentage decrease in cost
S1	1648.96	0	145.64	0	155.92	1950.52	0
S2	1566.53	26.88	145.64	0	155.92	1894.97	2.8
S3	1484.05	53.78	145.64	0	155.92	1839.39	5.7
S4	1401.62	80.66	145.64	0	155.92	1783.83	8.5
S5	1319.19	107.54	145.64	0	155.92	1728.29	11.3
S6	1648.96	0	131.07	14.56	155.92	1950.51	0
S7	1566.53	26.88	131.07	14.56	155.92	1894.96	2.8
S8	1484.05	53.78	131.07	14.56	155.92	1839.38	5.7
S9	1401.62	80.66	131.07	14.56	155.92	1783.82	8.5
S10	1319.19	107.54	131.07	14.56	155.92	1728.28	11.3
S11	1648.96	0	116.51	29.12	155.92	1950.51	0
S12	1566.53	26.88	116.51	29.12	155.92	1894.96	2.8
S13	1484.05	53.78	116.51	29.12	155.92	1839.38	5.7
S14	1401.62	80.66	116.51	29.12	155.92	1783.82	8.5
S15	1319.19	107.54	116.51	29.12	155.92	1728.28	11.3
S16	1648.96	0	101.94	43.69	155.92	1950.51	0
S17	1566.53	26.88	101.94	43.69	155.92	1894.96	2.8
S18	1484.05	53.78	101.94	43.69	155.92	1839.38	5.7
S19	1401.62	80.66	101.94	43.69	155.92	1783.82	8.5
S20	1319.19	107.54	101.94	43.69	155.92	1728.28	11.3
S21	1648.96	0	87.38	58.25	155.92	1950.51	0

S22	1566.53	26.88	87.38	58.25	155.92	1894.96	2.8
S23	1484.05	53.78	87.38	58.25	155.92	1839.38	5.7
S24	1401.62	80.66	87.38	58.25	155.92	1783.82	8.5
S25	1319.19	107.54	87.38	58.25	155.92	1728.28	11.3

VI. CONCLUSION

The investigation of the workability characteristics, strength characteristics and thermal stability of concrete containing SCBA and WG was done. In experimental work twenty five concrete mixes were prepared each with 0.55 water/cement ratio by replacing the cement with SCBA from 0% to 20% and fine aggregates with WG from 0% to 40%. In order to determine the effect of replacement of SCBA and WG on compressive strength, 225 cubes of 15 cm X 15 cm X 15 cm in size were prepared by varying percentage of SCBA and WG. The effect of elevated temperature on compressive strength was also investigated by same number of 10 cm X 10 cm X 10 cm sized cubes. Apart from this, results were statically analyzed by analysis of variance method. From the whole experimental study, it can be concluded that:

i. The workability of concrete decreases with the increase in percentage of SCBA content. On the other hand there is hike in slump value i.e increase in workability as replacement of WG increases.
ii. The slump values decreased from 110 mm to 91 mm with increase in percentage of SCBA from 0% to 20%. However, as the percentage of WG is increased from 0% to 40% workability starts increasing from 110 mm to 133 mm.
iii. The replacement of WG with fine aggregates decreases the compressive strength of concrete for all curing ages. As the percentage of WG increases there is a continuous loss in strength at every replacement level.
iv. The combination of 10% SCBA and 20% WG give better results without any loss in strength for all curing age. For instance, the value of compressive strength at 28 days is about 28.19.
v. In order to make higher strength concrete compared to reference mix, the combination of 10% SCBA and 10% WG is the most significant for higher strength and acceptable workability with 5.7 % decrease in cost.
vi. The results obtained from statistical analysis reveals that the addition of SCBA and WG significantly affects the compressive strength at all curing ages (14 days, 28 days and 60 days).
vii. The cost analysis shows that the utilization of waste materials is not only eco-friendly solution but also provides economic benefits to concrete industries.

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