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Research Article

Study on Change in Properties of concrete while using Rice Husk Ash and Waste glass

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Abstract

Concrete has become an indispensable part in construction works due to its mechanical and durability properties. The utilization of concrete ingredients such as cement and aggregates has been enhanced, which ultimately results in the ill effects on the environment. The basic objective of this research is to investigate the effect of Waste glass as partial replacement of fine aggregates and Rice Husk Ash (RHA) as partial replacement of cement in concrete. Several mixes of concrete were prepared at different replacement levels of Waste glass (0%, 10%, 20%, 30% & 40%) with fine aggregates and Rice husk Ash (0%, 5%, 10%, 15% & 20%) with cement. The water/cement ratio in all the mixes was kept at 0.55. The workability of concrete was tested immediately after preparing the concrete whereas the compressive strength of concrete was tested after 14, 28 and 60 days of curing.

Keywords: *Compressive strength, Waste glass, Rice Husk ash, Workability.*

1. Introduction

Concrete is a composite material obtained by using cement, aggregates and water. Few decades ago, these materials were easily available while now a days there is an adverse effect of the utilization of these materials. During the manufacturing Ordinary Portland Cement (OPC), a large amount of greenhouse gas (CO2) is produced from both industrial and fuel combustion. Rice Husk Ash is one of the main bi-product generated by the rice milling worldwide. After burning of rice husk at controlled condition, by product husk ash can be used as a partial replacement material with cement due to high content of silica (SiO2).The main improvement in compressive strength of concrete with the use of RHA replaced with cement is due to its physical chemical effects .Many of industrial waste such as Waste glass, Blast furnace slag etc. cause a waste disposal crisis. If fine aggregates will be replaced by waste glass of specific size with definite ratio, it will decrease the utilization of fine aggregate. Non-recyclable waste glass constitutes a problem for solid waste disposal in many municipalities in India. So, we can use Waste glass as fine aggregates by slight modification in their size and shape.

In Waste glass, soda lime glass is almost about 80%. Soda Lima glass primarily consists SiO_2 about 73%. The use of waste glass as a Corse aggregate creates a problem in concrete due to the reaction of alkalis in the pores of concrete and silica from waste glass, which is named as alkali silica reaction (ASR). Due to ASR, silica gel is formed which absorbs water and the volume of gel increases. The swelling of silica gel generates the hydrostatic pressure. If this internal pressure exceeds the tensile strength of concrete, cracks will be formed around the concrete structures. While the use of waste glass as a fine aggregate, no reaction was detected whereas this reaction was detected when it is used as coarse aggregates. Thus, this reaction can be eliminated by fining the size of glass particles. Fineness of glass particles will increase the surface area of glass particles favouring rapid pozzolanic reaction compared to ASR.

2. Material used

2.1 Cement

Bureau of Indian Standards (BIS) classified various kinds of cement according to their physical as well as chemical properties as Ordinary Portland Cement (OPC). OPC is produced in large quantities than other cements. OPC is classified into three grades, namely 33 grade, 43 grade and 53 grades depending upon the compressive strength of cement at 28 days. In this study, Ordinary Portland Cement (OPC) conformed to BIS: 8112-2013 was used. Ordinary Portland Cement (OPC) of grade 43 was used in the research and the corresponding standard for that parameter as per BIS: 8112-2013 also listed in Table 1. It was fresh and free from any lumps.

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Table 1 Properties of OPC cement

S. No	Characteristics	Value specified by BIS:8112-2013	Value obtained after experiment
1	Specific gravity	-	3.15
2	Standard consistency	-	30%
3	initial setting time	30min (minimum)	136 min
4	Final setting time	600min (maximum)	224 min
5	Compressive strength 3 days 7 days 28 days	23 N/mm^2 33 N/mm^2 43 N/mm^2	26.10N/mm^2 37.12N/mm^2 49.18N/mm^2

2.2 Coarse aggregate

The coarse aggregates were free from dust and dried to surface dry condition. As specified by BIS: 383-1970, all required properties were determined. The physical properties such as colour, shape, sieve analysis and fineness modulus were calculated and are given in Table 2.

Table 2 Properties of coarse aggregates

Colour	Grey
Shape	Angular
Maximum size	20mm
Specific gravity	2.65
Water absorption (%)	0.61
Fineness modulus	6.61

2.3 Fine aggregates

Natural sand was used as fine aggregates. The specific gravity, water absorption and fineness modulus of fine aggregates was experimentally determined as 2.71, 1.21 and 2.70 respectively. It was brown in colour with coarser shape of particles.

2.4 Rice Husk Ash

Rice husks are the hard protective coverings of rice grains which are separated from the grains during milling process. Rice husk is an amply available waste material in all rice generating countries, and it contains about 30%–50% of organic carbon. Rice husk ash (RHA) fillers are borrowed from rice husks, which are generally regarded as agricultural waste and an environmental hazard. Rice husk constitutes about 20% of the weight of rice and its composition is as follows: cellulose (50%), lignin (25%–30%), silica (15%–20%), and moisture (10%–15%). Bulk density of rice husk is small and lies in the range 90–150 kg/m^3.

Fig. 1 Rice husk Ash

2.5 Waste glass

Glass in an inert material but it is not possible to recycle the whole waste glass. In this study, waste glass was collected from various places of the city. This waste glass is generally known as ground glass. Thereafter, ground glass is wasted with water to remove dust particle and other undesirable materials from ground glass. After that it was fined to change them physical properties. To provide suitable size as fine aggregates, it was sieved through 4.75mm sieve. After the completion of 50% passing through BIS-sieve, waste glass was ready for the use as fine aggregates in concrete.

Fig.2 Waste glass

2.6Water

Water is an essential constituent of concrete as it is responsible for chemical reaction with cement. Mixing and curing water should not contain undesirable organic substances or inorganic constituents in excessive proportions. It was free from organic matter, silt, chloride and acidic material as per BIS: 456-2000.

3. Workability of concrete

The workability of concrete decreased with increase in percentage of RHA, while there is a huge incline in workability with increase in percentage of WASTE GLASS. The slump value falls down from 110 mm to 91 mm with 0% to 40% replacement of RHA with cement, due to rough and angular shape of RHA partials. On the other hand, as the percentage of waste glass is increased from 0% to 40%, slump values instantly increased from 110 mm to 133 mm. It was observed that the slump value was highest (about 133mm) at 0% replacement of RHA with combination of 40% waste glass. This is mainly due to the non -porous structure of the waste glass.

4. Compressive strength of concrete

The compressive strength of all the mixes was determined at the ages of 14, 28 and 60 days for the various replacement levels of RHA with cement and waste glass with fine aggregates. The values of average compressive strength and percentage loss for different replacement levels of RHA (0%, 5%, 10%, 15%, 20%) and waste glass (0%, 10%, 20%, 30% and 40%) at the end of different curing periods (14 days, 28 days & 60 days) are given as follow:

Table 3 Test results for average compressive strength of concrete when waste glass is 0%

Mix	RHA	Waste glass (%)	Average compressive strength(N/mm^2) of concrete for different curing days		
			14days	28days	60days
C1	0	0	23.02	27.40	32.15
C2	5		23.60	28.40	33.48
C3	10		24.10	29.06	40.01
C4	15		23.40	27.90	32.60
C5	20		22.90	26.98	31.95

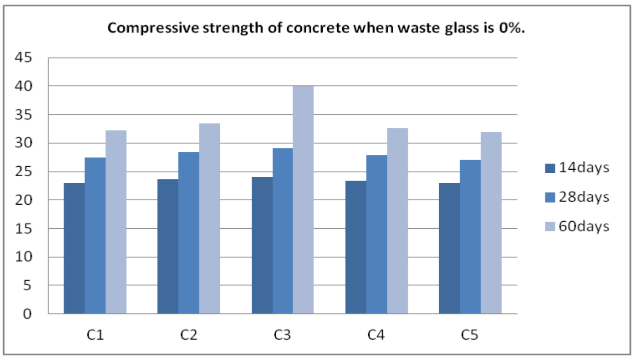


Table 4 Test results for average compressive strength of concrete when waste glass is 10%.

Mix	RHA	Waste glass (%)	Average compressive strength(N/mm^2) of concrete for different curing days		
			14days	28days	60days
C6	0	10	22.90	27.15	31.98
C7	5		23.55	28.19	33.60
C8	10		24.01	28.85	33.98
C9	15		23.30	27.80	32.40
C10	20		22.98	26.90	31.98

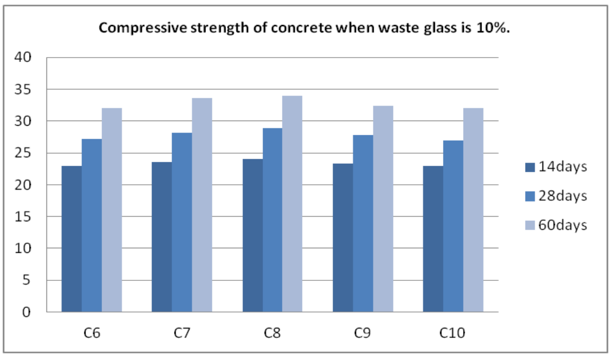


Table 5 Test results for average compressive strength of concrete when waste glass is 20%

Mix	RHA	Waste glass (%)	Average compressive strength(N/mm^2) of concrete for different curing days		
			14days	28days	60days
C11	0	20	22.60	26.98	32.21
C12	5		23.25	27.85	32.75
C13	10		23.70	28.35	33.45
C14	15		22.85	27.35	31.65
C15	20		22.35	26.40	31.10

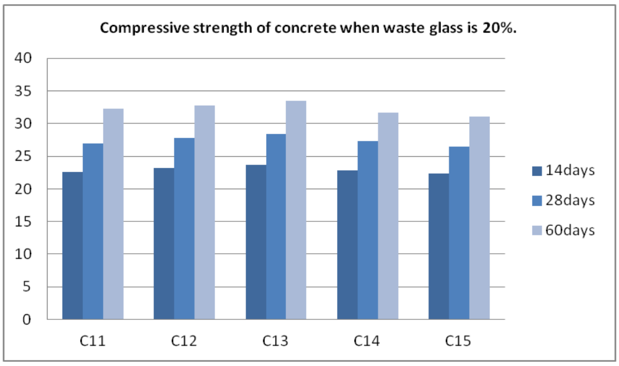


Table 6 Test results for average compressive strength of concrete when waste glass is 30%

Mix	RHA	Waste glass (%)	Average compressive strength(N/mm^2) of concrete for different curing days		
			14days	28days	60days
C16	0	30	21.45	26.15	30.62
C17	5		23.10	26.98	31.78
C18	10		22.95	27.48	31.98
C19	15		22.00	26.45	30.86
C20	20		21.65	25.98	31.00

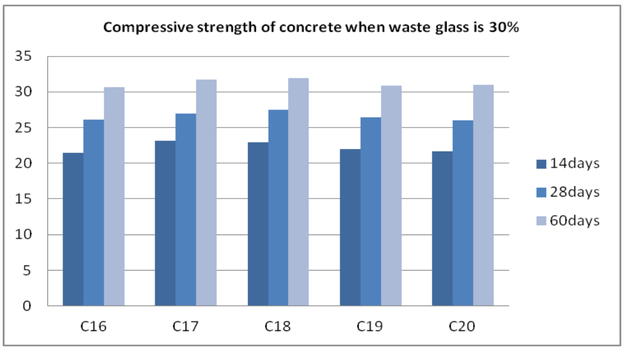
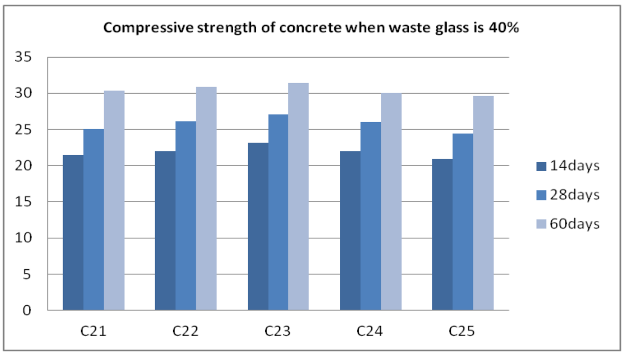


Table 7 Test results for average compressive strength of concrete when waste glass is 40%

Mix	RHA	Waste glass (%)	Average compressive strength(N/mm^2) of concrete for different curing days		
			14days	28days	60days
C21	0	40	21.45	25.01	30.40
C22	5		21.98	26.15	30.90
C23	10		23.12	27.10	31.40
C24	15		21.99	25.98	30.01
C25	20		20.97	24.45	29.65



Conclusions

In the present study, the workability characteristics, strength characteristics of concrete containing RHA and waste glass are investigated. In order to determine the effect of replacement of RHA and waste glass on compressive strength, cubes of 150mm X 150mm X 150 mm in size were prepared by varying percentage of RHA and waste glass. From the whole experimental study, it can be concluded that:

i) The workability of concrete decreases with the increase in percentage of RHA content. On the other hand, there is hike in slump value i.e. increase in workability as replacement of waste glass increases.
ii) The maximum improvement in compressive strength is observed at 10% of RHA but beyond 10% replacement of RHA strength starts decreasing. There is a significant reduction in compressive strength at 20% replacement of RHA.
iii) The combination of 10% RHA and 20% waste glass give better results without any loss in strength for all curing age.
v) In order to make higher strength concrete compared to reference mix, the combination of 10% RHA and 10% waste glass is the most significant.

References

Cordeiro G C, Filho R D T, Tavares L M and Fairbairn E M R (2008) Pozzolanic activity and filler effect of rice husk ash in Portland cement and lime mortars. *Cem Concr Compos*:30: 410–18.

Shivam Singhal, Abhishek Tiwari and Anuj Kumar,2018 Study the strength of concrete by using silica fume and GGBS with magnetized water, International Journal of Current Engineering and Technology Pages : 1318-1321

Malik M I, Bashir M, Ahmad S, Tariq T, Chowdhary U Study of Concrete Involving Use of Waste glass as Partial Replacement of Fine Aggregates *IOSR Journal of Engineering (IOSRJEN)* Vol. 3, ISSN: 2278-8719, PP 08-13.

A Tiwari, P Saharan Study of behaviour of translucent concrete using rice husk and steel fiber, SSRG International Journal of Civil Engineering (SSRGIJCE) 3 (7), 130-135

Worrell E, Price L, Martin N, Hendriks C and Meida L O (2001) Carbon Dioxide Emission from the Global Cement Industry. *Annu Rev Energy Environ* 26: 303–29

SISMAN, Can Burak, Erhan GEZER and Israfil KOCAMAN, 2011. Effects of organic waste (rice husk) on the concrete properties for farm buildings. *Bulg. J. Agric. Sci.,* 17: 40-48.

Behnood A and Ghandehari M (2009) Comparison of compressive and splitting tensile strength of high-strength concrete with and without polypropylene fibres heated to high temperatures. *Fire Saf J* 44:1015-22.