Study on Behaviour of Concrete Subjected To Elevated Temperature by Partially Replaceing Cement with Glass Powder

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Abstract: **CO_2 gas is the main reason for the global warming green house effect. CO_2 contributes global warming about 65%. Global cement industry contributes 7% of green house effect by emitting CO_2 gas to the atmosphere .Hence, there is a need of alternative materials for the control of environmental pollution. Hence, cement is also replaced by many waste products like bagasse ash, glass powder etc.., due to shortage of disposal site. This study aims at investigating the suitability of glass powder to replace cement in Concrete mix. In this study, cement is replaced by glass powder in various Percentages (0%, 5%, 10%, 15%, 20%) while keeping all parameters as constant. Mix proportions were obtained from IS 10262:2009. The compressive strength, split tensile strength, Modulus of elasticity for optimum proportion. These test were done for specimens of control mix and specimens of glass powder (0%, 5%, 10%, 15%, 20%) at room and sustained elevated temperature. The influence of elevated temperatures on mechanical properties of concrete is of very much importance for fire resistance studies and also for understanding the behaviour of concrete at elevated temperature.**

Key Words: Cement, glass powder, M-sand, elevated temperature, mechanical properties, MOE(modulus of elasticity

1.INTRODUCTION

As we know that now a days, many developing countries have shortage disposal waste site and it becomes very serious problem. For this reason, the use of waste product as resources for many industries like recycling glass, cement production to control environmental pollutions.in present, many glass industry recycling the waste glass in production of glass bottles etc. But only selected waste glass can be used in the production. This is because, manufactures only can use waste glass that has been pre-sorted by colour and type. wastes colour mixed glass still it end up at landfill site. Since waste glass still gave us a problem, many research going on in use of waste glass powder and glass pieces in concrete production as a
replacement to cement and fine aggregates. The main reason of this study to control the environmental pollution by re-using the waste glass product and to produce the effective, efficient and economical concrete

This study aims at investing the suitability of glass powder to replace cement in Concrete mix. In this study, cement is replaced by glass powder in various Percentages (0%, 5%, 10%, 15%, 20%) with water/cement ratio of 0.53. Mix proportion for M30 were obtained from IS 10262:2009. The compressive strength, split tensile strength, Modulus of elasticity for optimum proportion. These test were done for specimens of control mix and specimens of glass powder (0%, 5%, 10%, 15%, 20%) at room and sustained elevated temperature(100^0C, 200^0C, 300^0C and 400^0C) for duration of 2 hours.

2. LITERATURE REVIEW

N.Kumarappan (2013) this paper investigate the performance of concrete containing glass powder as partially substitution of cement. Portland cement(PC) was partially replaced with 0%, 10%, 20%, 30% and 40% of glass powder. Testing included ultrasonic pulse velocity, compressive strength and absorption. Specimens were cured in water at 20^0C. for each mix 3 cubes of 150*150*150mm in size were prepared. the results indicate that the maximum strength of concrete occurs at around 10% glass powder beyond 10% glass powder strength of concrete reduces.

Shilpa raju et al (2014) In this paper they study on the % of replacement of cement with glass powder to control the global warming which is caused by the emission of CO_2 gas to the atmosphere. among all the green house gas, CO_2 has major contribution in green house effect. Cement emits 7% CO_2 to the atmosphere. In this paper the cement is partially replaced by waste glass powder by varying percentage 5%, 10%, 15%, 20%, 25%, 30%, 35% and 40%. The specimens were tested for, compressive, flexural strength at the age of 7, 28 and 90 days and results compared with the conventional concrete. Results conclude that by replacing the cement with 20% glass powder high strength concrete can be obtained.

C. B. K.Rao. et al (2015) In this paper studies on the behavior of concrete at elevated temperature. The experiment on specimens subjected to elevated temperature 100, 200, 300 and 400^0C.the results shows that, there will be loss in compressive strength at elevated temperature is more for high strength concrete than normal strength concrete.

Vandhiyan et al (2012) In this study, they aims at use of industrial waste product to the valuable application. In addition that, can improve the construction material properties in cost and strength. The recycled glass powder has been used in the concrete production in concrete and mortar. Cement is replaced in various percentage like 5%, 10% and 15%. Test on compressive, split tensile, flexural and consistency for the above proportions. The result shows the concrete with glass powder gives economic and superior strength concrete can be made.

3.MATERIAL

3.1 CEMENT

Ordinary Portland cement of 53 grade confirming to IS-8112-1989 was used. The physical properties are tabulated as shown below (Table-1)

Tabele-1 Physical properties of cement (53)

NO	Properties	Value
1	Specific gravity	3.1
2	Soundness	1.5mm
3	Initial setting time	210minutes
4	Final setting time	295minutes
5	Normal consistency	28.3%
6	Fineness m^3/Kg	320
7	28days compressive strength	58.25MPa

3.2 fine aggregate

Manufacture sand used as fine aggregate. The physical properties of fine aggregate are given below Table-2

Table-2 Physical properties of M-sand

Properties	Value
Specific Gravity	2.54
Fineness modulus	2.54
Bulk density (Kg/m^3)	1594

Table-3 Seive analysis details of M-sand

Is sieve	Percentage of passing
4.75mm	97.4
2.36mm	89.2
1.18mm	68.0
600micron	51.4
300micron	28.2
150micron	11.8
Pan	0

3.3 Coarse aggregate

Locally available rock stone aggregate of nominal size 20mm mixed aggregate are used. The physical properties of these coarse aggregate are as below

Table-4 physical properties of coarse aggregate

NO	Properties	Value
1	Specific gravity	2.634
2	Bulk density Kg/m^3	1614
3	Fine modules	7.35

Material for M-30 concrete

Table-5 Ingredients for 1m^3 concrete

Cement	330
Water	174.9 litres
Fine aggregate	704.93
Coarse aggregate	1167.23
Super plasticizers	.5% of cement

Percentage replacement of cement with glass powder

Table-6 replaced material for 1m^3 concrete

% of replacement	0	5	10	15	20
Cement	330	313.5	297	280.5	264
Glass powder	0	16.5	33	49.5	66

4. EXPERIMENTATION

The physical properties of materials used that is cement, M-sand, coarse aggregate, glass powder are tested initially. The exact amount of concrete ingredients(table-5 & table-6) were weighed and mixed thoroughly in the concrete mixer till the consistent mix was achieved. The workability of fresh concrete was measured by slump test. Fresh concrete are casted in to standard cubic mould size of 150mm and cylinder mold size of 150mm diameter & 300mm in length. Compaction is carried on a vibrating table. A set of 3 cubes and 3 cylinders were casted and cured for 28 days by varying percentage of cement replaced by glass powder (0%, 5%, 10%, 15% and 25%). Curing of cubes and cylinders is done for period of 28 days. The test specimens were kept at elevated temperature of 100°C, 200°C , 300°C and 400°C each for duration of 2 hours. The compressive strength, split tensile strength of thermally treated concrete specimens after cooling was determined and for the optimum strength of concrete proportion MOE test are done for elevated temperatures.

Table7 compressive strength at elevated temperature (MPa)

sample	Compressive strength (Mpa)				
	RT	100'C	200'C	300'C	400'C
control mix	35	37.00	35.00	33.20	32.20
5%	36	38.60	35.18	31.03	30.03
10%	40	42.96	40.96	35.55	34.55
15%	37	38.40	36.30	33.48	31.48
20%	36	34.20	32.66	31.98	30.98

Graph: compressive strength v/s % of replacement

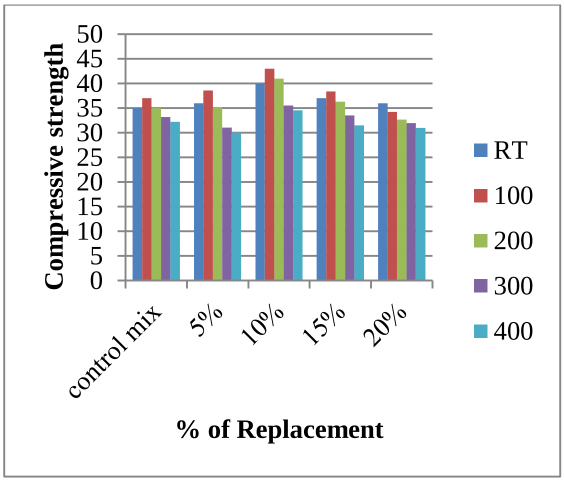
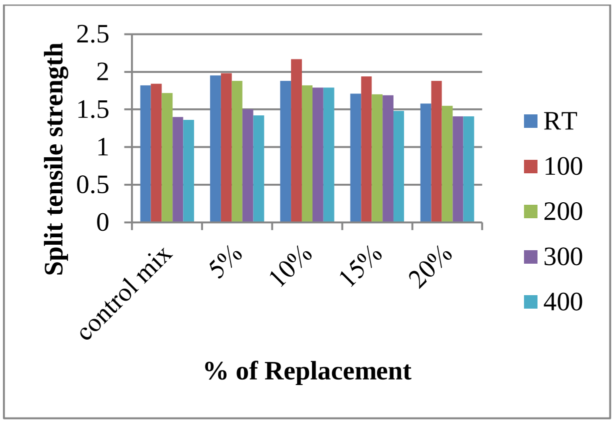


Table-8 split tensile strength of concrete at elevated temperatures (MPa)

sample	Split tensile strength (Mpa)				
	RT	100'C	200'C	300'C	400'C
control mix	1.82	1.84	1.72	1.40	1.36
5%	1.95	1.98	1.88	1.50	1.42
10%	1.88	2.17	1.82	1.79	1.79
15%	1.71	1.94	1.70	1.69	1.48
20%	1.58	1.88	1.55	1.41	1.41

Graph- split tensile v/s % of replacement



MOE test for 10% replacement at elevated temperatures

Temperature	MOE (MPa)
Room temperature	27660
100^0C	28723
200^0C	26957
300^0C	26912
400^0C	27002

5. RESULTS AND CONCLUSION

The conclusions based on the experimental results are as below

1. At room temperature with the replacement of cement with glass powder up to 20% the strength of the concrete has increased.
2. The maximum value of the compressive strength is obtained for replacement of 10% cement with glass powder.
3. With the increase in the temperature, at all the percentage replacements of cement with glass powder, except for 20% replacement, compressive strength of concrete has found to increase up to a temperature of 100^0C. Beyond the temperature of 100^0C the compressive strength of concrete has decreased with increasing temperature.
4. The maximum value of the split tensile strength is obtained for replacement of 10% cement with glass powder.
5. With the increase in the temperature, at all the percentage replacements of cement with glass powder split tensile strength of concrete has found to increase up to a temperature of 100^0C. Beyond the temperature of 100^0C the split strength of concrete has decreased with increasing temperature.
6. For 10% replacement, which has higher compressive strength at all temperatures, with the increase in the temperature, modulus of elasticity of concrete has found to increase up to a temperature of 100^0C. Beyond the temperature of 100^0C the modulus of elasticity has decreased with increasing temperature.

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