Experimental Study on Properties of Concrete with Partial Replacement of Glass Powder and CETP Ash for Fine Aggregate and Cement

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Abstract **-** Concrete is a family of different material like binding material (cement+ fly ash), fine aggregate, coarse aggregate and water. Today construction cost is very high with using conventional materials due to unavailability of natural materials. This problem can be solved by total replacement of concrete with different material which is not convenient in terms of required properties [2]. Due to this limitation of unavailability of material which plays the vital role of concrete we have only choice of partial replacement of concrete ingredients by waste materials [4]. If we can partially replace the cement and fine aggregate with the material with desirable properties then we can save natural material and reduce emission of CO2 in to the atmosphere. This industrial waste dumping to the nearest site which spoils the land and atmosphere as well as it also affects aesthetics of urban environment so use of this waste material in concrete is cost effective as well as environment friendly way to disposal of waste [5]. The primary objective of this study is to select the waste material which gives desirable properties with concrete. This study includes investigation on the mechanical and chemical properties of concrete produced by partial replacement of cement and fine aggregate with effluent treatment plant waste, CETP Ash and glass powder respectively.

Keywords **- Glass powder, CETP Ash, Fine aggregate, Concrete, Replacement.**

I .INTRODUCTION

Concrete is the mixture of cement, water, sand and gravel that hardens into a super-strong building material. In its simplest form, concrete is a mixture of cement paste and aggregates. The paste comprising of cement and water, coats the surfaces of fine and coarse aggregates [1]. Through a chemical reaction called hydration of paste, the mixture hardens and gains strength to form the rock-like mass known as concrete. Within this process, lies the key to a remarkable trait of concrete: it is plastic malleable and can be shaped in any form when newly mixed, it is strong, retains shape and durable when hardened. The desired output is gained by careful selection of its ingredients. Cement is factory made and tested as per Indian Standard Specifications (ISS) before dispatch [8]. Water, if it is odorless and potable, is generally good for use in concrete. Aggregates are the important constituents in the concrete composite that helps in reducing shrinkage and impart economy to concrete production. In this work it is aimed to achieve an optimum content of CETP Ash as a considerable partial replacement of cement [6].

II. MATERIALS

The materials predominantly used in this study is CETP sludge, Glass powder, Ordinary Portland cement, fine aggregates, coarse aggregates and water

A. Glass Powder

Solid waste generation has reached up to 300MT in India with 0.7% of glass waste. To prevent this glass waste reaching landfill it can be economically used as a partial replacement for fine aggregate after converting them into powder. Glass powder 2.36 mm sieve has been successfully used as 20% replacement for fine aggregate without any compromise in the properties and the strength of the concrete.

B. CETP ASH (Common Effluent Treatment Plant)

Common Effluent Treatment Plant processing waste water from tanning industry with zero liquid processing technique gives sludge and salt as by-products, from which sludge can be converted into ash after burning as a partial replacement for cement. To obtain optimum percentage of replacement to ensure target strength 5%, 10%, 15% of cement were replaced by CETP ash successfully.

C. Aggregates

The quality, Class, and shape of aggregates can impact the physical qualities, such as flow ability and compaction quality. Specific gravity test and sieve analysis were carried on and completed according to IS:2386-1963 and the requirements as per IS 383-1970 is satisfied.

D. Cement

In the current experiment Ordinary Portland Cement of 53 Grade is utilized affirming to IS: 8112- 1989. The physical qualities of bond are acquired by directing suitable experiments as per IS 269:4831 and requirements as per IS 8112:1989

III.MATERIAL TESTING

To investigate the properties of material such as fine aggregate, coarse aggregate used for casting the specimen various laboratory tests were performed & the test results were obtained were compared with the Indian standard values.

A. Tests on Fine Aggregate

TABLE 1 TEST RESULTS ON FINE AGGREGATE

S.no	TEST	RESULT
1	Specific gravity	2.69
2	Fineness modulus	2.67

B. Tests Coarse aggregate

TABLE 2 TEST RESULTS ON COARSE AGGREGATE

S.no	TEST	RESULT
1	Specific gravity	2.60
2	Fineness modulus	6.62

C. Tests on Glass Powder

TABLE 3 TEST RESULTS ON FINE AGGREGATE

S.no	TEST	RESULT
1	Specific gravity	2.86
2	Fineness	2.21

D. Tests on Cement

TABLE 4 TEST RESULTS ON CEMENT

S.no	TEST	RESULT
1	Consistency	30%
2	Initial Setting Time	30 minutes
3	Final Setting Time	510 minutes
4	Specific gravity	3.15
5	Fineness	3%

E. Tests on CETP Ash

TABLE 5 TEST RESULTS ON FINE AGGREGATE

S.no	TEST	RESULT
1	Specific gravity	3.04
2	pH(10% Suspension)	9.48

TABLE 6 TEST RESULTS ON CETP ASH (CHEMICAL COMPOSITION)

S.no	1	2	3	4	5	6	7
Chemical	Ca	O	Si	Fe	S	C	Al
Percentage	77.1	8.1	7.53	3.36	1.81	1.1	1.0

IV. MIX

PROPORTIONS

The mix ratio is designed for M30 grade of concrete as per IS 10262-2009. The values for mix design is obtained from the preliminary tests conducted.

A. STIPULATIONS FOR PROPORTIONING:

- Grade designation: M30
- Type of cement: OPC 53 GRADE
- Maximum nominal aggregate size: 20mm
- Minimum cement content: 310Kg/m^3
- Exposure condition: moderate Type of aggregate : crushed angular aggregate
- Maximum cement content: 540kg/m^3

The obtained Mix Proportion is for Cement: Fine aggregate: Coarse aggregate is : - 1 : 1.551 : 2.581. The replacements are experimented for 5%, 10% and 15% replacements of cement by CETP Ash and 20% replacement of fine aggregate by glass powder. The percentage of glass powder is kept constant at 20% from the preliminary test results and compared with conventional concrete.

TABLE 7 MIX PROPORTIONS

Mix Number	Concrete Mix (Glass powder & CETP Ash)	Weight of Cement Kg	Weight of Fine aggregate Kg	Weight of Coarse aggregate kg	Weight of Glass Powder Kg	Weight of CETP Ash Kg
1	20% and 0	14.249	17.68	36.76	4.42	-
2	20% and 5%	13.536	17.68	36.76	4.42	0.713
3	20% and 10%	12.824	17.68	36.76	4.42	1.425
4	20% and 15%	12.112	17.68	36.76	4.42	2.137

V. TEST RESULTS

A. Slump Cone test (Workability)

TABLE 8 SLUMP CONE TEST

MIX	SLUMP VALUES (mm)
5% CETP ash	75
10% CETP ash	84
15% CETP ash	95

B. Compressive Strength Test

TABLE 9 COMPRESSIVE STRENGTH TEST

REPLACEMENT %		MIX	7TH DAY (N/mm²)	28TH DAY (N/mm²)
GLASS	CETP ASH			
20	0	1	23.2	34.3
20	5	2	24.5	36.6
20	10	3	26.3	39.3
20	15	4	23.4	35

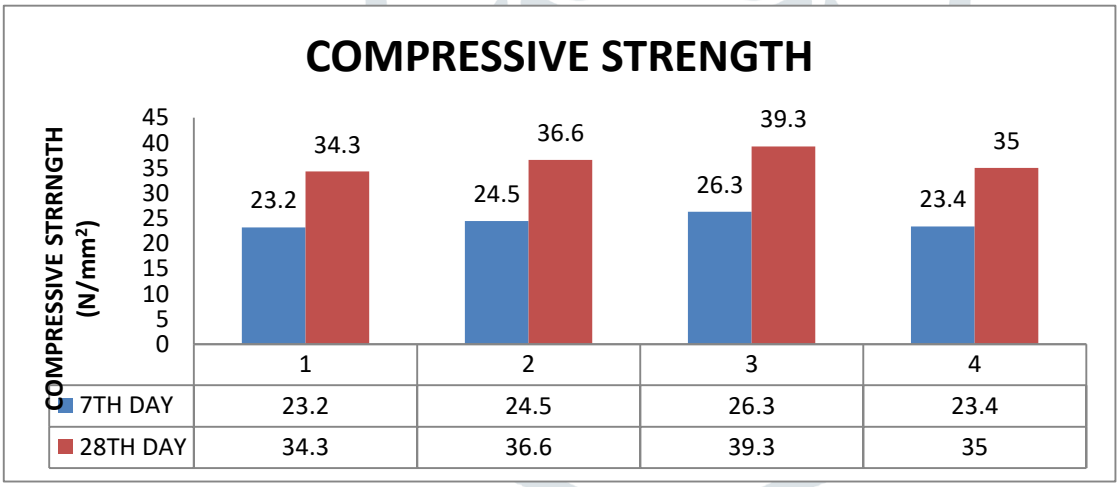

Fig.1 Compressive Strength Test

The compressive strength is found to be increasing from 5%, 10% of the content of CETP ash and it starts to get reduced with the increase i.e for 15% of CETP ash. So the optimum percentage of CETP ash to achieve a better compressive strength is 10%.

C. Split Tensile Strength Test

TABLE 10 SPLIT TENSILE STRENGTH TEST

REPLACEMENT %		MIX	7TH DAY (N/mm²)	28TH DAY (N/mm²)
GLASS	CETP ASH			
20	0	1	2.29	3.31
20	5	2	2.51	3.69
20	10	3	2.64	3.88
20	15	4	2.42	3.44

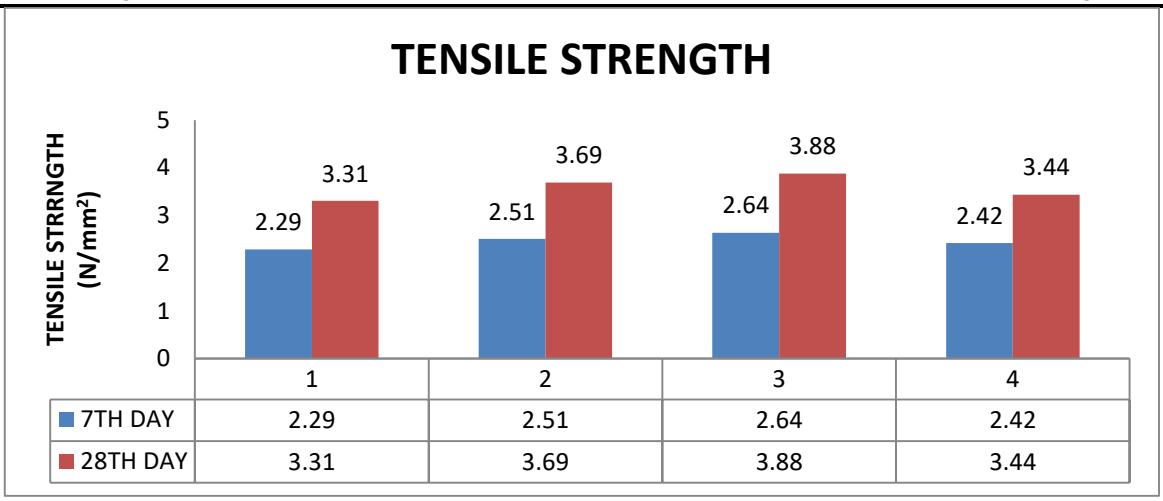

Fig.2 Split Tensile Strength Test

The tensile strength is found to be increasing from 5%, 10% of the content of CETP ash and it starts to get reduced with the increase i.e for 15% of CETP ash. So the optimum percentage of CETP ash which gives a better tensile strength is 10%

VI. DISCUSSION

- From the results obtained, the optimum percentage of CETP Ash as a substitute of cement is 10% by its weight.
- The maximum compressive strength at 28th day obtained by replacing the fine aggregate and cement with optimum percentage of glass powder and CETP ash is 39.3 N/mm^2.
- The maximum split tensile strength at 28th day obtained by replacing the fine aggregate and cement with optimum percentage of glass powder and CETP ash is 3.88 N/mm^2.
- The optimum workability is achieved at 10% replacement of cement with CETP ash.

VII.CONCLUSION

This study was to replace the fine aggregate by a waste material and replacement cement by utilizing industrial by-product and satisfying workability and performance requirements. Based on the results obtained in this research, it can be concluded that Glass powder and CETP Ash(10% by weight of cement) finds to be a potential substitute as fine aggregate and cement to enhance the mechanical properties of concrete.

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