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EXPERIMENTAL STUDY ON COMBINED EFFECT OF GLASS POWDER AND GLASS FIBRES AS PARTIAL REPLACEMENT OF FINE AGGREGATES AND CONCRETE

M. PRIYANKA
PG STUDENT
DEPT. OF CIVIL ENGINEERING
AITAM, TEKKALI

V.DIVYA SRI
ASST.PROFESSOR
DEPT. OF CIVIL ENGINEERING
AITAM, TEKKALI

ABSTRACT

The aim of this study is to analyze the effect of addition of glass powder and glass fibre on the various characteristics of concrete. Glass is one of the admixtures which is used many forms in everyday life. In shops, broken glass sheets &flat solid cuttings square measure move to waste, that aren't recycled at the present and typically delivered to landfills for disposal.

This project examines the effect of replacement of fine aggregates with glass powder and glass fibres on the mechanical properties of concrete and Fine aggregates were replaced by waste glass powder as 0-15% and glass fibres as 0 - 3% by weight for M50 mix then the Compressive strength, tensile strength and modulus of elasticity at 7 to 28 days of age were compared with those of concrete made with natural fine aggregates.

It has been observed that glass fibre reinforced concrete has greater strength than glass powder mixed concrete, and that the strength of mixes increases significantly when glass fibre is used. Using glass powder in concrete is an intriguing option for saving money on waste disposal sites while also contributing to a greener environment.

Key words: Composite Material, M50 grade Concrete, Glass Powder, Glass Fibres, Compressive Strength, Split- tensile Strength.

INTRODUCTION

In the modern era, waste management is a major challenge. The glass industry in India generates a massive amount of glass waste. It is difficult to get rid of glass waste. Glass waste is typically disposed of on land, which is an inefficient solution. Glass fibre reinforced concrete is a cement, sand, water, and admixture-based matrix. A portion of the fibre that passes through the 2.36mm IS sieve is replaced by coarse aggregate. It has a wide range of applications in structural engineering, including non-structural elements such as facade panels, piping, and channels. Many advantages exist for glass fibre reinforced concrete (GFRC), as:

1. It is light in weight
2. It has fire resistance property. So, it can be used as a fire-resistant material
3. It has better strength properties

Fig.1.1GLASS POWDER

Table1.1 CHEMICAL COMPOSITION OF GLASS POWDER

CHEMICAL COMPOUND	WEIGHT (%)
SiO_2	71.4
Al_2O_3	1.4
Fe_2O_3	0.2
K_2O	0.5
CaO	10.6
MgO	2.5
Na_2O	12.7
SO_3	0.1
LOI	0.4

A simple concrete has a very low tensile strength, limited ductility, and little crack resistance. Glass fibre, when used as a supplementary material in concrete at a certain percentage, improves strain properties while also aiding in crack resistance (Purkiss; 1985). Additionally, it increases ductility, toughness, and flexural strength. Steel fibre is also used in construction, but in the modern era, glass fibre is preferred because it is corrosion-free. They are most commonly used in external building facade panels and architectural precast concrete. This material is less dense than steel and is very fine in construction shapes on the front view of any building.

Glass fibre has been used in a number of studies to improve the properties of concrete. It has been discovered that using glass fibre reduces concrete bleeding. It improves the concrete's fire resistance (Chandarmouli et al; 2010). In the current study, glass fibre is mixed into the concrete mix in proportions of 1% and 3%. The percentage of glass powder ranges from 5% to 15%. The various workability and compression strength tests are carried out, and the results are compared.

Fig1.2 Glass Fibre

Table1.2 CHEMICAL COMPOSITION OF GLASS FIBRE

CHEMICAL COMPOUND	WEIGHT (%)
SiO_2	64-66%
Al_2O_3	24-26%
Fe_2O_3	0-3%
K_2O	0-3%
CaO	0-3%
MgO	9-11%
Na_2O	0-3%

Objective of the study:

- To compare the strength of concrete when varying quantities of glass powder are used to replace fine aggregate.
- To make use of glass powder waste in order to keep the environment safe.
- Determining the degree of strength improvement obtained from the addition of glass powder to concrete.
- To compare the strength of concrete when glass fibre used as an admixture to concrete.

1.Materials

Ordinary Portland cement, river sand, glass powder, fine aggregate and coarse aggregate are the prime constituents and glass fibre is utilised as an admixture in this experimentation. The glass powder, a repercussion of the glass triturate process, is procured from an industry located about 10 km from Tekkali, Andhra Pradesh, India. Glass sludge is available in the form of waste as an industrial by-product comes directly from the sediments of glass factories, and that forms amid the sawing, shaping, and polishing processes of glass. The wet glass sludge is dried up preceding the preparation of the samples. The substance is sieved and at last, the glass powder is existed to be utilised in the experiments as fine aggregate.

The aggregate is primarily used to provide bulk to the concrete. Aggregates of two or more sizes are frequently used to increase the density of the resulting mix. The specific gravity of coarse aggregates is 2.75, and the bulk density is 6. The maximum coarse aggregate size is 20 mm.

The primary function of fine aggregates is to aid in the production of workability. The fine aggregates also help the cement paste keep the coarse aggregate particles suspended. Because aggregates constitute 75 percent of the body of concrete, their influence is enormous. Fine aggregates are made from river sand. Fine aggregates have a specific gravity of 2.60. Fine aggregates have a bulk density of 1700 Kg/m3 and a fineness modulus of 2.30. The cement used is ordinary Portland cement of grade 43. Cement has a specific gravity of 3.15 and a bulk density of 1450 Kg/m3.

Glass fibre is a material that, when used in certain percentages in reinforced concrete, increases the strength and ductility of the concrete.

Glass powder is a raw or waste material that is used in reinforced concrete to increase the strength of the concrete by varying the water cement ratio. The water cement ratio is assumed to be 0.42.

Table 2.1 represents the physical parameters of the aggregates utilized in the study

PHYSICAL PROPERTIES OF COARSE AGGREGATE, RIVER SAND AND GLASS POWDER

Properties	Coarse aggregate	River sand	Glass powder
Specific gravity	2.75	2.60	2.62
Absorption (%)	0.54	0.74	0.76
Moisture content (%)	0.81	0.97	0.94
fineness modulus	7.26	2.30	2.77
grading	20 mm aggregate and below	Medium	Medium

Mix Proportion:

The mix proportion of M50 grade concrete is done by utilizing the Indian standard code 10262:2019. For whose the water-cement proportion is kept as the minimal estimation of 0.42 for the slump value is 150mm, an admixture named Master Glenium sky 8777 is utilised to minimize the workability and increase the strength, the coarse aggregate of size 20mm and below.

The proportion for the mix is 1:1.07:3.40

I. METHODOLOGY

Strength Tests on Concrete:

1. Compressive Strength test:

The compressive strength tests on concrete are carried out on a compression testing machine accompanied by a range of 2.5 KN/s. The specimen utilised is a 150 mm cube and is cast and cured for 7,14, 28, days. The specimens are tested after taking the cubes from the curing tank in surface dry condition.

2. Split Tensile strength test:

The split tensile strength test is executed on a universal testing machine accompanied by a range of 2.5KN/s. A cylinder specimen of 150mm dia and 300 mm height are cast and cured for 7,14and 28 days. The specimens are tested after taking out from curing tanks in surface dry condition.

Experimental Program:

The major goal of this experiment is to determine the effect of replacing sand with glass powder waste in percentages of 0 %, 5%, 10% and 15% on the hardened qualities of cement concrete. The casting, curing, and testing of specimens are all part of the experimental effort. The experiments are carried out for each percentage, with Mix 1 being the reference mix with 0% glass powder (GP), Mix 2 being with 5% glass powder replacement, mix 3 being 10% GP, mix 4 being 15% GP.

The trials are all carried out at room temperature. The dry materials for concrete, namely cement, fine aggregate, and coarse aggregate, are combined first. Glass powder is used as a partial replacement for natural sand, followed by the addition of a calculated amount of water and thorough mixing to achieve a uniform mix. Concrete cubes are compacted on table vibrator. Layers of concrete are utilized for compressive strength testing and are cured in water as in Fig. for 28 days before being tested on a compressive testing machine (CTM)

Fig 3.1: Compressive Strength Test

Fig 3.2: Split Tensile Strength Test

Fig 3.3 curing of cubes and cylinders

Results and Discussions

The compressive strengths of concrete of grade M50 with substitution of fine aggregate with glass powder in the proportions 0 %, 5%, 10%, and 15% is shown in Table 4.1 and fig 4.1 The compressive strength values at 28 days are shown. The improvement in the strength may because glass powder being fine material filled pores in concrete making concrete dense. The dense concrete improved strength.

Table 4.1 Represents variation of compressive strength in N/mm^2

Replacement of glass powder	7 days	14days	28 days
0%	37.32	52.61	57.35
5%	39.58	54.33	59.26
10%	45.97	57.18	62.43
15%	32.69	44.42	49.38

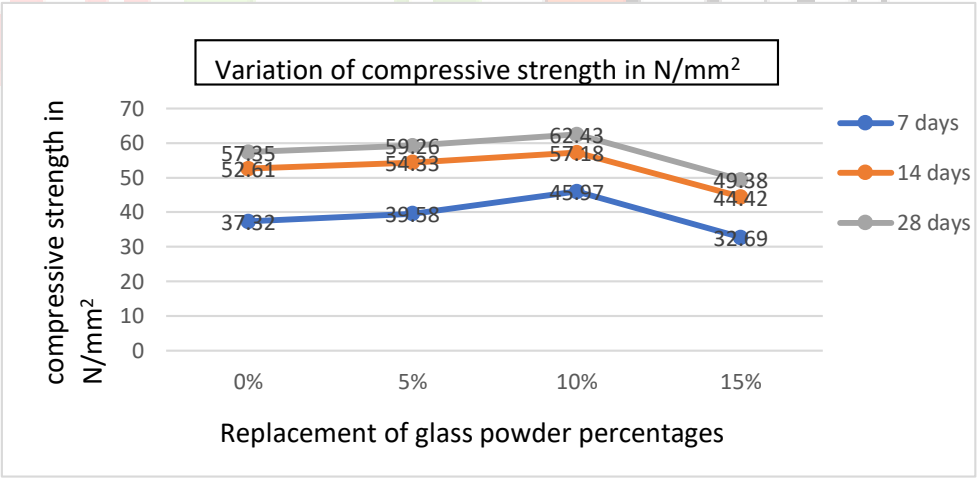

Fig 4.1 Represents variation of compressive strength in N/mm^2

The compressive strengths of concrete of grade M50 by adding of glass fibre in the proportions 0%, 3%, 4%, and 5% is shown in Table 4.2 and fig 4.2 The compressive strength values at 28 days are drawn. The improvement in the strength may because glass powder being fine material filled pores in concrete making concrete dense. The dense concrete improved strength

Table 4.2 Represents variation of compressive strength in N/mm^2

ADDING OF GLASS FIBERS	7DAYS	14DAYS	28DAYS
0%	38.94	53.53	58.37
1%	41.14	56.19	60.22
2%	43.56	58.65	63.95
3%	36.06	50.94	55.49

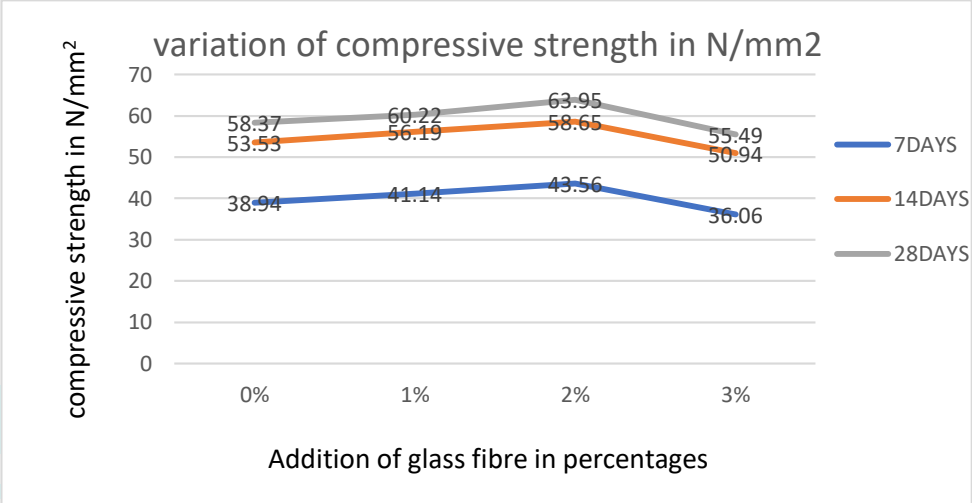

Fig 4.2 Represents variation of compressive strength in N/mm^2

The compressive strengths of concrete of grade M50 with substitution of fine aggregate with glass powder and glass fibre in the proportions 0 %, 5% &1%, 10% &2%, and 15% &3% is shown in Table 4.3 and fig 4.3 The compressive strength values at 7,14 and 28 days are drawn. The improvement in the strength may because glass powder being fine material filled pores in concrete making concrete dense. The dense concrete improved strength

Table 4.3 Represents variation of compressive strength in N/mm^2

COMBINED EFFECT OF GP AND GF	7 DAYS	14 DAYS	28 DAYS
0%	39.32	54.06	58.96
5% & 1%	41.70	57.36	62.63
10% & 2%	43.85	60.33	65.93
15% & 3%	32.81	45.43	50.48

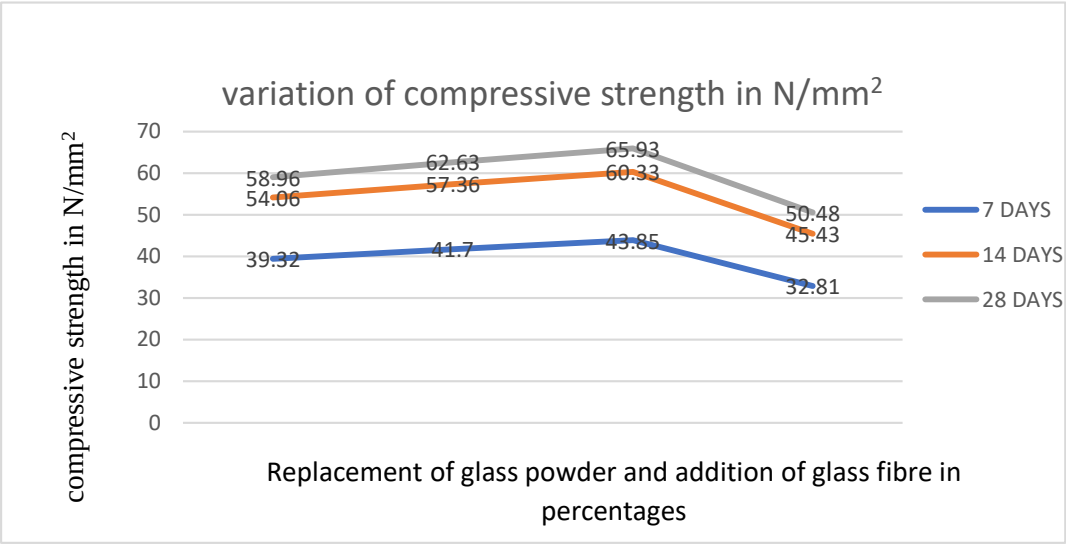

Fig 4.3 Represents variation of compressive strength in N/mm^2

The split tensile strengths of concrete of grade M50 with substitution of fine aggregate with glass powder in the proportions 0 %, 5%, 10%, and 15% is shown in Table 4.4 and fig 4.4 The split tensile strength values at 7,14 and 28 days are drawn. The improvement in the strength may because glass powder being fine material filled pores in concrete making concrete dense. The dense concrete improved strength

Table 4.4 Represents variation of split tensile strength in N/mm^2

Replacement of glass powder	7 days	14days	28 days
0%	4.42	6.12	6.80
5%	4.45	6.16	6.85
10%	4.71	6.52	7.25
15%	4.3	5.95	6.62

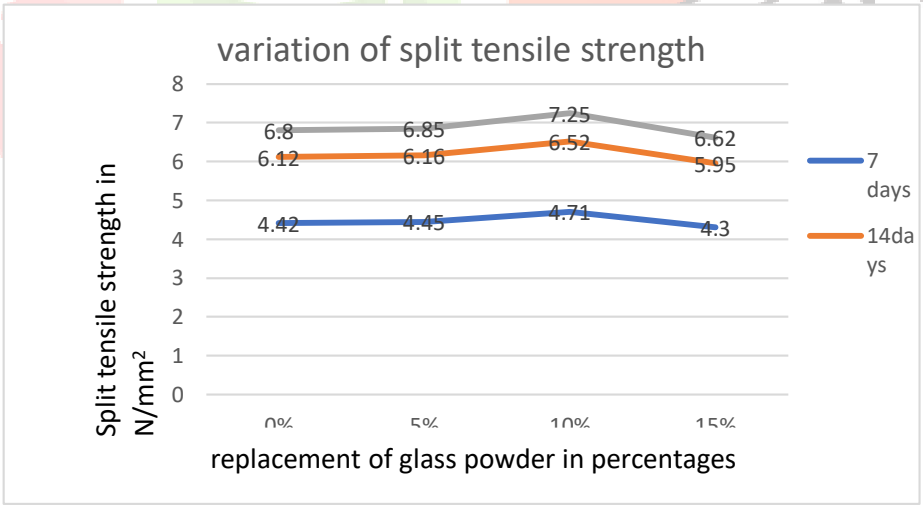

Fig 4.4 Represents variation of split tensile strength in N/mm^2

The split tensile strengths of concrete of grade M50 with substitution of fine aggregate with glass fibers in the proportions 0 %, 3%, 4%, and 5% is shown in Table 4.5 and fig 4.5 The split tensile strength values at 7,14 and 28 days are drawn. The improvement in the strength may because glass powder being fine material filled pores in concrete making concrete dense. The dense concrete improved strength.

Table 4.5 Represents variation of split tensile strength in N/mm^2

ADDING OF GLASS FIBERS	7DAYS	14DAYS	28DAYS
0%	4.42	6.12	6.80
1%	4.46	6.18	6.87
2%	4.78	6.58	7.32
3%	4.27	5.89	6.55

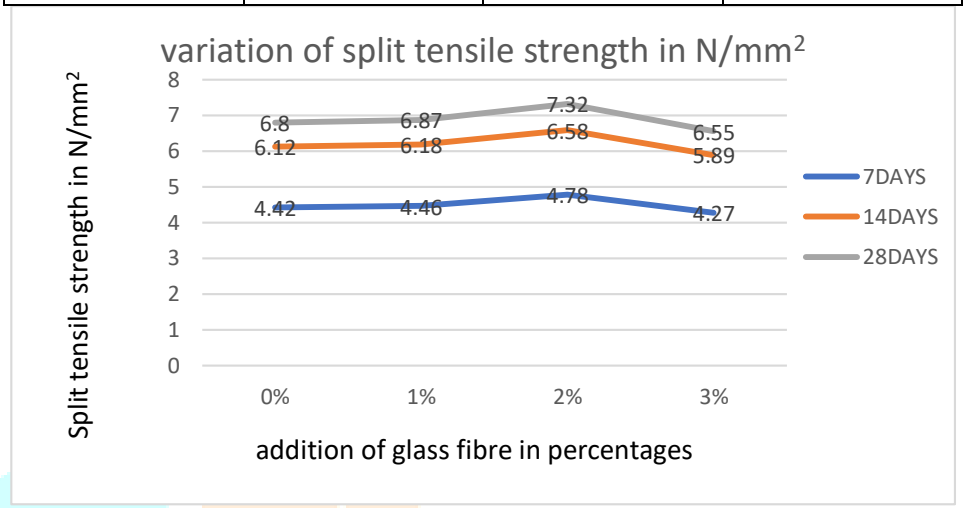

Fig 4.5 Represents variation of split tensile strength in N/mm^2

The split tensile strengths of concrete of grade M50 with substitution of fine aggregate with glass powder and glass fibre in the proportions 0 %, 5% &1%, 10% &2%, and 15% &3% is shown in Table 4.6 and fig 4.6 The compressive strength values at 7,14 and 28 days are drawn. The improvement in the strength may because glass powder being fine material filled pores in concrete making concrete dense. The dense concrete improved strength

Table 4.6 Represents variation of split tensile strength in N/mm^2

COMBINED EFFECT OF GP AND GF	7 DAYS	14 DAYS	28 DAYS
0%	4.42	6.12	6.80
5% & 1%	4.49	6.17	6.83
10% &2%	4.89	6.53	7.22
15% & 3%	4.23	5.86	6.47

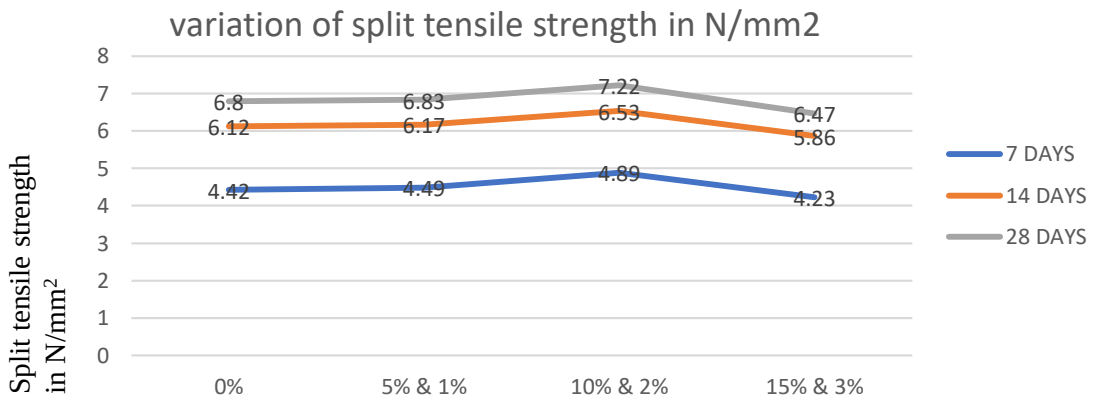

Fig 4.6 Represents variation of split tensile strength in N/mm^2

Conclusion

It can be concluded that both glass powder and glass fibre can be used in concrete to improve its strength and workability, but the combined effect of glass powder and glass fibres as well as glass powder does not increase final strength significantly, whereas glass fibre does. As a result, glass fibre is a good alternative for improving the properties of ordinary concrete, while glass powder provides greater strength than ordinary concrete.

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