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PERFORMANCE OF GLASS POWDER AND GEOSYNTHETICS IN CONCRETE

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Abstract - The interest of the construction community in using waste or recycled materials in concrete is increasing because of the emphasis placed on sustainable construction, the waste glass from in and around the small shops is packed as a waste and disposed as landfill. Since glass is non-biodegradable, landfills do not provide an environment friendly solution. Hence, there is strong need to utilize waste glasses.

This study was conducted to investigate the effect of using waste glass powder in concrete. The performance of control sample and concrete was determined by the workability test and compressive strength test. The workability of concrete is determined using the slump test and compacting factor test. Mean while compressive strength test is done to determine the strength of concrete. For each type of concrete, a total of six 150mmx150mmx150mm cubes 300x150 mm cylinder were casted for compressive strength.

Not only the glass powder here made an attempt to incorporate geo-synthetics, a material is used in reinforced soil as fibres in concrete. Geo synthetics are used widely a soil reinforcement, separators, drainage, filters and also used across the globe in various infrastructure projects. In spite of several studies being done in geo-synthetics with soil, geo-synthetics fibre had never been added with concrete. This is an attempt made to check the viability of using geo-synthetic as fibre in concrete.

Key Words: Geo-synthetics, Glass powder, Compressive strength, Tensile strength, workability.

1. INTRODUCTION

Concrete is the most extensively used factitious construction material in the world. It is obtained by mixing of fine aggregates, coarse aggregates and cement with water and sometimes admixtures in required proportions. Fresh concrete or plastic concrete is freshly mixed material which can be molded into any shape hardens into a rock-like mass known as concrete. The hardening is because of chemical reaction between water and cement, which continues for long period leading to stronger with age.

The concrete mixes containing ground glass had more adhesive consistency in comparison with control concrete mix. Mixes containing glass powder with additional crushing were more fluid, than mixes enclose glass powder without additional crushing. waste glass, if ground finer than 100µm shows a pozzolanic presence .It perform with lime at early stage of hydration forming added calcium silicate hydrate gel thereby forming enormous cement matrix. The fresh consumption of alkalis by glass particles mollify alkali-silica reaction hence increase durability of concrete.

Moreover, there is a limit on the possibility of natural aggregate and minerals used for making cement, and it is necessary to weaken energy consumption and radiation of carbon dioxide resulting from construction processes, solution of this problem are sought thought usages of waste glass as a partial replacement of Portland cement. Waste glass when ground to a very fine powder, SiO_2 reacts chemically with alkalis in cement and form cementations amount that help contribute to the strength development. Also it may be due to the glass powder effectively filling the voids and giving rise to a dense concrete microstructure as a result waste glass powder offers resistance against expansive forces caused by sulphates and penetration of sulphates ion into the concrete mass.

2. LITERATUREREVIEW

Vasudevan Gunalaan and Kanapathypillay Seri Ganis [2013], R.Vandhiyan et al [2013], Kumarap pan N. [2013], Khatib J.M. et al [2012], JangidJitendra B. and Saoji A.C. [2012] , Chikhalikar S.M. and Tande S.N. [2012] , Nassar Roz-Ud-Din and Soroushian Parviz [2012], Vijayakumar G. et al[2013], Nwaubani Sunny O. and Poutos Konstantinos I.[2013] , Patel Dhirendra et al [2012], Dali J.S. and Tande S.N. [2012], Bajad M.N. et al [2011], Oliveira L.A Pereira de et al [2010], Malik M. Iqbal et al [2013], Khmiri A. et al[2012], Patil Dhanraj Mohan and Sangle Kehav K. [2012], Gopala Krishnan Ramasamy and Govindaraja Dharshnamoorthy [2011], Wang Her-Yung and Hou Tsung-Chin [2011].

3. SCOPE AND OBJECTIVE

Using waste glass powder in concrete also gives a good result and has a high potential to increase the concrete strength with reducing the usage of 100% Portland cement. It is better to grind the waste glass into a fine glass powder (GP) for incorporation into concrete as a pozzolanic/ cementitious material. It withstand favorable pozzolanic

reactions in the concrete and could replace up to 30% of cement in some concrete mixes with suitable strength improvement.

The waste glass are possessed from disposal area and core it to powder or into cementitous form as it will use as certain proportion of cement replacement . After that, all the related laboratory experiments conducted to achieve the research objectives.

3. 1 CONCRETE MIX

The fickle which can be contained are water cement ratio, maximum aggregate size, aggregate grading, and use of admixtures. Conversation between the effects of volatile complicate mix design and successive adjustments following preliminary mixes are usually necessary. IS 10262(1989) & 10262(2009) are used.

3.2 CEMENT, WATER AND AGGREGATES

Concrete is prepared by mixing various constituents like cement, aggregates, water etc. which are economically available. Ordinary Portland cement of 43 grades conforming to IS 8112 was used throughout the work. The fine aggregate used in this investigation was clean river sand, whose maximum size is 4.75 mm, conforming to grading zone II. Blue granite crushed with Machine stone angular in shape was used as coarse aggregate. Two size of course is used; one 16 mm Passing through 12.5 mm retained and other 25 mm passing through 20mm retained. As per IS: 2386 – 1963 recommendations the following properties of coarse aggregates were determined.

3.3 PHYSICAL PROPERTIES

Table 1: Shows physical properties of glass power

S.NO	PHYSICAL PROPERTIES OF GLASS POWDER	
1	SPECIFIC GRAVITY	2.6
2	FINENESS PASSING 150µm	99.5
3	FINENESS PASSING 90 µm	98

3.4 CHEMICAL PROPERTIES

Table 2: Shows chemical properties of glass power

S.NO	CHEMICAL PROPERTIES OF GLASS POWDER	
1	Ph	10.25
2	COLOUR	GRAYISH WHITE

4. EXPERIMENTAL INVESTIGATION

4.1 INTRODUCTION

The experimental program was designed to study the compressive strength and split tensile strength of M40 grade concrete with and without addition of glass powder and geo-grids.

The program consists of casting and testing a total number of 144 specimens. In this 72 cylinders with dimensions of 300mmx150mm and 72 cubes of 150x150x150mm were used. Of these 72 cylinders, 3 cylinders for each grade and each type (various percentages of glass powder 0%, 5%, 10%,15%, 20% and 25%) are casted. Of these 72 cubes, 3 cubes for each grade and each type (various percentages of glass powder 0%, 5%, 10%, 15%, 20% and 25%) are casted.

Table 3: Details of specimens

% of replaced glass powder	3days of curing		28days of curing	
	Cubes	Cylinders	Cubes	Cylinders
0%	3	3	3	3
5%	3	3	3	3
10%	3	3	3	3
15%	3	3	3	3
20%	3	3	3	3
25%	3	3	3	3

Total cubes = 36, Total cylinders = 36
Another set of cubes and cylinders are casted with geo-grids
Total no. of cubes = 36 X 2 = 72, Total no. of cylinders = 36 X 2 = 72

4.2 MATERIALS USED

The materials used in this investigation are 53 Grade Ordinary Portland cement, Fine Aggregate, Coarse Aggregate, Water, Glass Powder, Geo-synthetics

4.2.1 CEMENT

Cement used in the investigation was 53 Grade Ordinary Portland cement confirming to IS12269. The cement was obtained from a single consignment and of the same grade and Latter procuring the cement was stored properly.

Table 4: Properties of cement

S.NO	PROPERTY	TEST METHOD	TEST RESULT	IS STANDARD
1	Normal Consistency	Vicat Apparatus (IS: 4031 Part - 4)	29	.....
2		Sp. Gr bottle (IS:4031 Part - 4)		
3	Initial setting Time Final setting Time	Vicat Apparatus (IS: 4031 Part - 4)	42 Minutes 658 Minutes	30 Minutes 600 Minutes
4	Fineness	Sieve test on sieveno.9 (IS: 4031 Part – 1)	8%	10%

4.2.2 FINE AGGREGATE

The Fine aggregate conforming to Zone-2 according to IS 383 was used The fine aggregate used was obtained from a nearby river source. The sand obtained was sieved asper IS sieves (i.e. 2.36, 1.18, 0.6, 0.3, and 0.15mm).

4.2.2 COURSE AGGREGATE

Table 5: Properties of fine and coarse aggregate

S.NO	PROPERTY	TEST METHOD	FINE AGGREGATE	COARSE AGGREGATE
1	Specific gravity	Pycnometer IS:2386 Part 3-1986	2.7	2.65
2	Bulking	IS:2386 Part 3-1986	6% wc	.....
3	Fineness	Sieve Analysis (IS:2386Part 2-1963)	2.64	6.04

4.2.3 Glass powder

Glass powder is an acutely fine powder made from ground glass. It can be used in a number of industrial and craft applications and is often available through supplier of glass and to be very uniform, with an even consistency. Costs vary, depending on the level of grind and the applications.

Table 6: Properties of Glass powder

S.NO	PROPERTY	TEST METHOD	TEST RESULT
1	Normal Consistency	Vicat Apparatus (IS: 4031 Part - 4)	58
		Sp. Gr bottle (IS:4031 Part - 4)	
3	Fineness	Sieve test on sieveno.9 (IS: 4031 Part – 1)	13%

4.2.4 GEOSYNTHETICS

Geosynthetic clay liners, geocomposites and geofoam. The polymeric nature of the products makes them correct for use in the ground where high levels of durability are required. Accordingly formulated, however, they can also be used in uncovered applications. Geosynthetics are available in a wide range of forms and materials, each to suit a slightly different end use. These products have a wide territory of applications and are presently used in many civil engineering and private development applications along with roads, railroads, airfields, and embankments, reservoirs etc.

BASIC CHARACTERISTICS OF GEOSYNTHETICS

- Non-corrosiveness
- Highly resistant to biological and chemical degradation
- Long term durability under soil cover
- High flexibility

4.2.5 CONPLAST-SP: 430

Conplast SP430 is a chloride free, super plasticizing admixture placed on selected sulphonated naphthalene polymers. It is supplied as a brown solution which immediately disperses in water.

Table 7: Properties of Conplast-sp: 430

S No	Property	Result
1	Form	Liquid
2	Colour	Brown.
3	Specific gravity	1.220 to 1.225 at 30^0 C
4	Air entrainment	Approx.1% additional air is entrained.
5	Workability	Can be used to produce flowing concrete that requires no compaction.
6	Compressive strength	Early strength is increased upto 20%. Generally, there is improvement in strength upto 20% depending upon W/C ratio and other mix parameters.
7	Durability	Reduction in w/c ratio enables increase in density
8	Dosage	Rate of addition is generally in the range of 0.5-2.0 litres/100 kg cement

5. MIX DESIGN

MIX DESIGN FOR CONVENTIONAL CONCRETE

Cement content = 427.5 kg /meter^3
Water = 171 liters
Fine aggregate = 782.52 kg /meter^3
Coarse aggregate = 970.12 kg/meter^3
Water-cement ratio = 0.40

Table 8: Mix proportion of different replacements

%OF REPLACEMENT	WATER	MATERIALS(all are in kg/m^3)				MIX PROPORTION
		Cement	Fine Aggregate	Coarse Aggregate	Glass Powder	
5%	0.4	397.58	822.25	1018.8	20.92	1:2.06:2.56:0.065
10%	0.4	376.65	822.25	999.6	41.85	1:2.18:2.65:0.11
15%	0.4	355.72	820.46	1016.6	62.77	1:2.30:2.85:0.17
20%	0.4	334.8	801.62	1020.9	83.7	1:2.39:3.04:0.31
25%	0.4	313.87	800.22	19.15	104.62	1:2.54:3.24:0.34

6. EXPERMENTAL PROGRAM

Workability is the equity of freshly mixed concrete that resolves the ease with which it can be equity mixed, placed, consolidated and polished without segregation. The workability of fresh concrete was consistent by means of the conventional slump test as per IS: 1199(1989). Before the fresh concrete was cast into moulds, the slump value of the fresh concrete was measured using slump cone.

Fig -1: workability of the concrete

6.2 CASTING

The specification of moulds was fitted such that there are no gaps between the plates of the moulds. If there are small gaps they were filled with plaster of Paris. The moulds then oiled and kept ready for casting. The wet mix is poured into the moulds in three layers with each layer being given 25 blows with a tamping rod. At the end of casting the top surface was made plane using trowel and a hacksaw blade to ensure a top uniform surface.

Table 9: Casting of cubes Total = 72

% of glass powder	Length of Geo-grid	Cubes			
		Glass powder		Glass powder + geo-grid	
		3days of curing	28days of curing	3days of curing	28days of curing
0%	140mmX140 mm	3	3	3	3
5%	140mmX140 mm	3	3	3	3
10%	140mmX140 mm	3	3	3	3
15%	140mmX140 mm	3	3	3	3
20%	140mmX140 mm	3	3	3	3
25%	140mmX140 mm	3	3	3	3

Table 10: casting of cylinders Total = 72

% of glass powder	Length of Geo-grid	Cylinders			
		Glass powder		Glass powder + geo-grid	
		3days of curing	28days of curing	3days of curing	28days of curing
0%	250mmX1300mm	3	3	3	3
5%	250mmX130mm	3	3	3	3
10%	250mmX130mm	3	3	3	3
15%	250mmX130mm	3	3	3	3
20%	250mmX130mm	3	3	3	3
25%	250mmX130mm	3	3	3	3

6.3 COMPRESSIVE STRENGTH TEST FOR CUBES

The compressive strength of any material is characterized as the resistance to failure down the activity of compressive forces. Especially for concrete, compressive strength is a crucial parameter to determine the performance of the material during service conditions. Concrete mix can be graceful to obtain the required engineering and durability equity. Some of the other engineering properties of seasoned concrete carry Creep coefficients, Elastic Modulus, Tensile Strength, density, coefficient of thermal expansion etc.

Fig 2: Shows compressive strength test for cubes

6.4 SPLIT TENSILE STRENGTH TEST FOR CYLINDERS

Split tensile strength test on concrete cylinder is a method to resolve the tensile strength of concrete. The concrete is appropriate weak in tension due to its brittle nature and is not normal to resist the direct tension. The concrete establish cracks when subjected to tensile forces.

Fig 3: Shows split tensile strength test for cylinders

7. INTERPRETATION OF TEST RESULTS

7.1 RESULTS FOR COMPRESSIVE STRENGTH TEST

7.1.1 GLASS POWDER CONCRETE

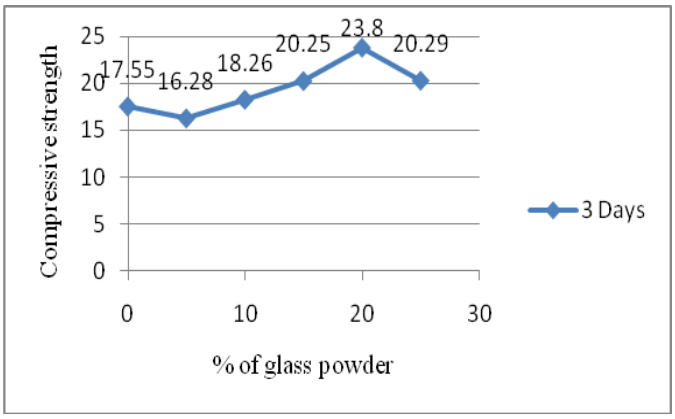

Chart 1: compressive strength of glass power for 3days curing

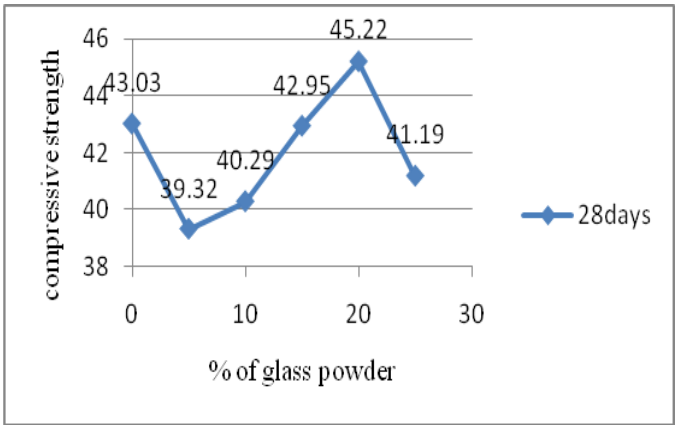

Chart 2: compressive strength of glass power for 28days curing

7.1.2 GEO-GRID + GLASS POWDER CONCRETE

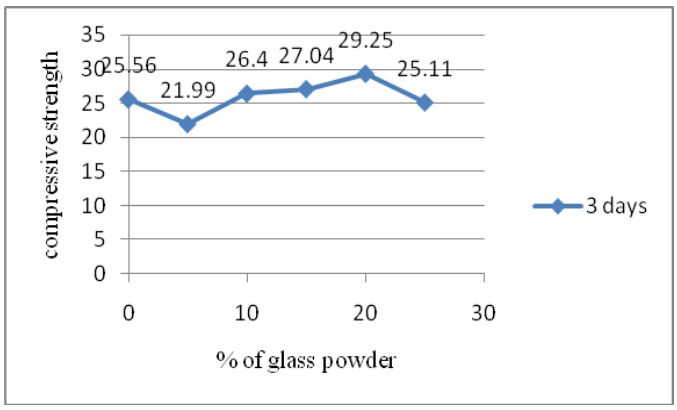

Chart 3: compressive strength of geo-grid & glass power for 3days curing

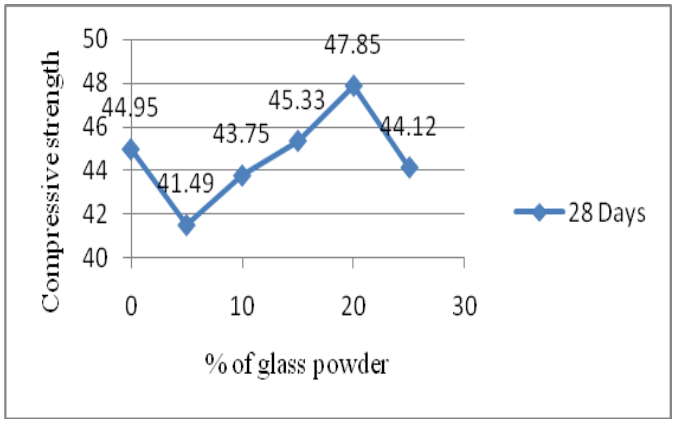

Chart 4: compressive strength of geo-grid & glass power for 3days curing

7.2 RESULTS FOR SPLIT TENSILE STRENGTH TEST

7.2.1GLASS POWDER CONCRETE

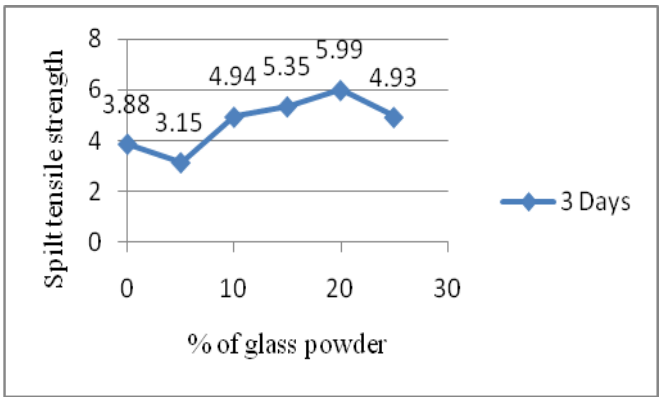

Chart 5: split tensile strength of glass power for 3days curing

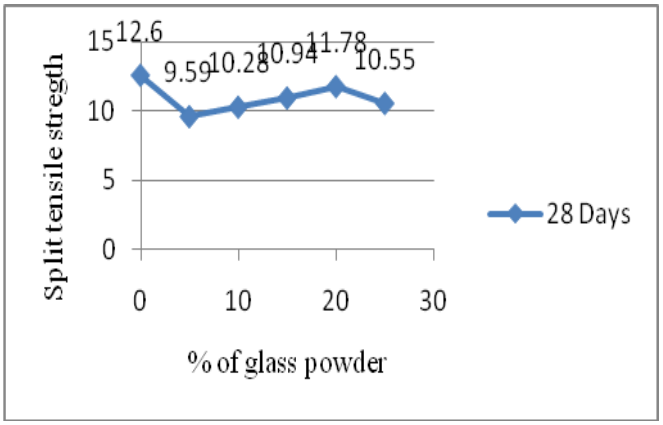

Chart 6: split tensile strength of glass power for 28days curing

7.2.2 GEO-GRID + GLASS POWDER CONCRETE

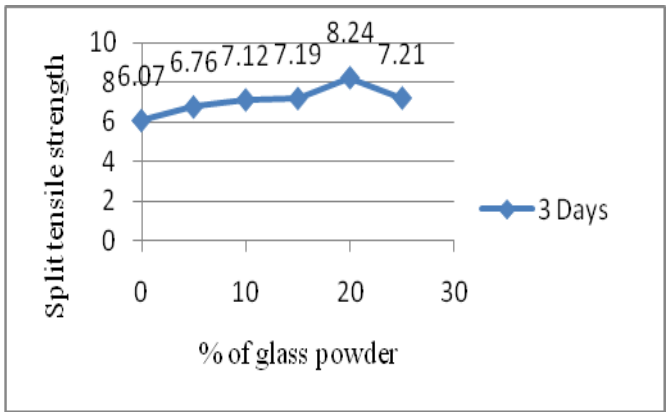

Chart 7: split tensile strength of geo-grid & glass power for 3days curing

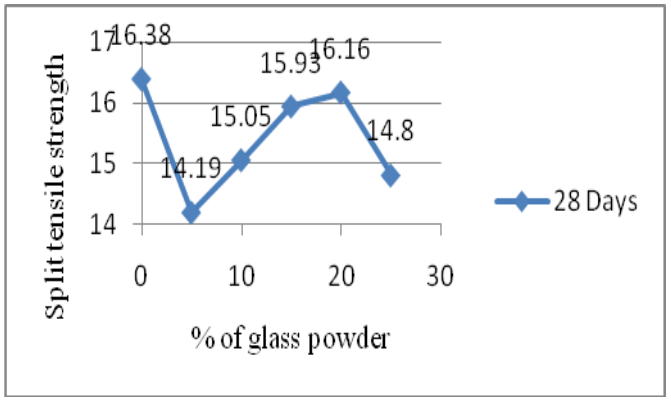

Chart 8: split tensile strength of geo-grid & glass power for 28days curing

7.3 Interpretation of Compressive Strength of Different Replacements

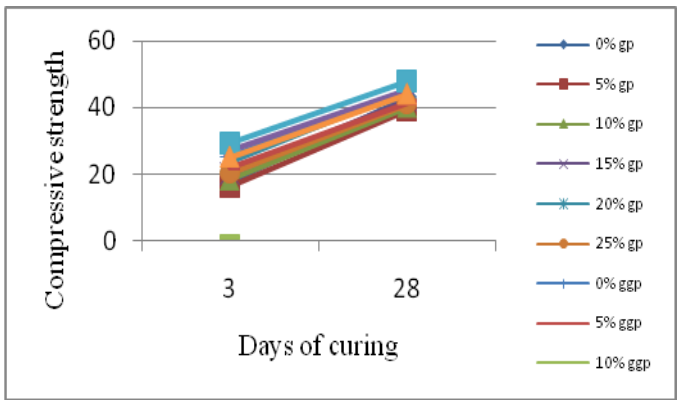

Chart 9: Compressive Strength of Different Replacements

7.4 Interpretation of Split Tensile Strength of Different Replacements

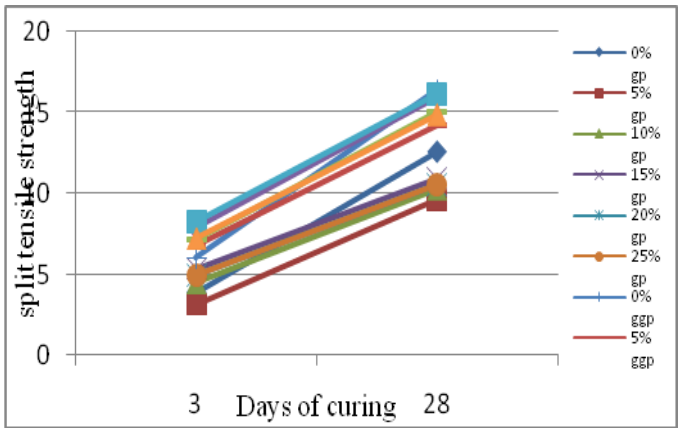

Chart 10: Split Tensile Strength of Different Replacements

8. CONCLUSIONS

The present work consist of testing Cylinders and cubes to understand the development of compressive strength, spilt tensile strength of concrete with different percentages of glass powder. Based on this work the following conclusions are drawn.

Replacement of glass powder in cement by 20% increases the ultimate strength and0.85 times the ultimate strength , further increase in the percentage of glass powder resulted in the decrease of the ultimate strength and0.85 times the ultimate strength.

Replacement of glass powder in cement by 20% shows the maximum spilt tensile strength of the concrete. Placing of geo-grids in concrete increases the compressive and split tensile strength of the concrete.

It is considered that the glass powder would provide much greater opportunities for value adding and cost recovery, as it could be used as replacement for expensive materials such as silica fume, fly ash and cement.When used as finely ground powder to substitute Portland cement, this constitutes a positive response to global environmental problems such as high carbon dioxide emissions generated by Portland cement production. In addition it would reduce extraction of natural materials such as limestone. Addition of geo-grids to the concrete provides high compressive and tensile strength to the concrete.

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