AN EXPERIMENTAL STUDY ON EFFECTIVE UTILISATION OF GLASS POWDER IN CONCRETE

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Abstract- Glass is used in many forms and for different purposes in day-to-day life. It has limited life span and after use it is either stock piled or sent to landfills. Since glass is non-biodegradable, landfills do not provide an environment friendly solution. Hence, there is strong need to utilize waste glasses. Many efforts have been made to use waste glass in concrete industry as a replacement of coarse aggregate, fine aggregate and cement. Its performance as a coarse aggregate replacement has been found to be non-satisfactory because of strength regression and expansion due to alkali-silica reaction. The research shows that there is strength loss due to fine aggregate substitution also. The aim of the present work was to use glass powder as a replacement of cement to assess the pozzolanic activity of fine glass powder in concrete and compare its performance with other pozzolanic materials like silica fume and fly ash. In this project we replace Cement by glass powder in the range 5% to 30% increment of 5% is studied. It Is then tested for compressive strength and flexural strength at the age of 7, 28 and 28 days and compared with those of conventional concrete. Results are then studied for which proportion it gives higher strength.

Keywords: Glass powder, natural sand, compressive strength, flexural strength, water.

I. INTRODUCTION

Concrete is a blend of cement, sand, coarse aggregate and water. The key factor that adds value to concrete is that it can be designed to withstand harshest environments significant role. Today global warming and environmental devastation have become manifest harms in recent years, concern about environmental issues, and a changeover from the mass-waste, mass-consumption, and mass-production society of the past to a zero-emanation society is now viewed as significant.

Normally glass does not harm the environment in any way because it does not give off pollutants, but it can harm humans as well as animals, if not dealt carefully and it is less friendly to environment because it is non-biodegradable. Thus, the development of new technologies has been required. The term glass contains several chemical diversities including soda-lime silicate glass, alkali-silicate glass and boro-silicate glass. To date, these types of glasses glass powder have been widely used in cement and aggregate mixture as pozzolana for civil works. The introduction of waste glass in cement will increase the alkali content in the cement. It also help in bricks and ceramic manufacture and it preserves raw materials, decreases energy consumption and volume of waste sent to landfill. As useful recycled materials, glasses and glass powder are mainly used in fields related to civil engineering, for example, in cement, as pozzolana(supplementary cementitous materials), and coarse aggregate. Their recycling ratio is close to 100%, and it is also used in concrete without adverse effects in concrete durability. Therefore, it is considered ideal for recycling Recently, Glasses and its powder has been used as a construction material to decrease environmental problems. The coarse and fine glass aggregates could cause ASR (alkali-silica reaction) in concrete, but the glass powder could suppress their ASR tendency, an effect similar to supplementary cementations materials (SCMs). Therefore, glass is used as a replacement of supplementary cementitous materials.

II. LITERATURE REVIEW

Bhupendra Singh Shekhawat, Dr. Vanita Aggarwal[1], This paper present literature review on replacement of cement by waste glass powder which includes current and future trends of research on the use of crushed glass powder in Portland cement concrete From the above mentioned work of various researchers and our present experimental work, it is clear that glass can be used as a partial replacement of cement in concrete because of its increased workability, strength parameters like compressive strength, flexural strength and split tensile strength and also because of its increased durability measured by water absorption test and sorptivity test. As disposal of waste by-products problem is a major problem in today's world due to limited landfill space as well as its escalating prices for disposal, utilization of waste glass in concrete will not only provide economy, it will also help in reducing disposal problems. [1]

Shilpa Raju, Dr. P. R. Kumar (July -2014) [2]," *Effect of Using Glass Powder in Concrete*" The global warming is caused by the emission of greenhouse gases, such as CO2, to the atmosphere. Among the greenhouse gases, CO2 contributes about 65% of global warming. The global cement industry contributes about 7% of greenhouse gas emission to the earth's atmosphere. Consequently efforts have been made in the concrete industry to use waste materials as partial replacement of coarse or fine aggregates and cement. Waste glass is one materials when ground to a very fine powder shows pozzolanic properties which can be used as a partial replacement for cement in concrete. In this paper, an attempt has been made to find out the strength of concrete containing waste glass powder as a partial replacement of cement for concrete. Cement replacement by glass powder in the range 5% to 40% increment of 5% has been studied. It was tested for compressive strength and flexural strength at the age of 7, 28 and 90 days and compared with those of conventional concrete. Results showed that replacement of 20% cement by glass powder was found to have higher strength. Also alkalinity test was done to find out resistance to corrosion.[2]

Dhanaraj Mohan Patil, Dr. Keshav K. Sangle [3] ," *Experimental Investigation Of Waste Glass Powder As Partial Replacement Of Cement In Concrete*" Concrete is a construction material composed of cement, aggregates (fine and coarse aggregates) water and admixtures. Today many researches are ongoing into the use of Portland cement replacements, using many waste materials like pulverized fly ash (PFA) and ground granulated blast furnace slag (GGBS). Like PFA and GGBS a waste glass powder (GLP) is also used as a binder with partial replacement

of cement which take some part of reaction at the time of hydration, also it is act as a filler material. In this study, waste glass powders have been used as replacements to the concrete ingredient i.e. cement and the mechanical properties like compressive strength are measured. Also we were studied the size effect of glass powder on strength of concrete. For checking strength effect of replacement of cement by glass powder, the cement is replaced at 10%, 20% and 30%. For study of size effect of glass powder the powder is divided in to two grades one is glass powder having size less than 90 micron and another is glass powder having particle size ranges from 90 micron to 150 micron. It is found from study, Initial strength gain is very less due to addition of GLP on 7th day but it increases on the 28th day. It is found that 20% addition of GLP gives higher strength. And also GLP size less than 90 micron is very effective in Enhancement of strength. [3]

Ashutosh Sharma, Ashutosh Sangamnerkar (February 2015) [4]" *Glass Powder – A Partial Replacement for Cement?"* The research work is (was done to) determination of the effect of the use of 'Glass Powder' as a replacement of cement to assess the pozzolanic nature of fine glass powder when mixed in concrete and compare the difference in performance with other pozzolanic materials are mixed in concrete like silica fume and fly ash. The present study shows that waste glass, if ground finer than 600µm shows a pozzolanic behavior. It reacts with lime at early stage of hydration forming extra CSH gel thereby forming denser cement matrix. Thus early consumption of alkalis by glass particles helps in the reduction of alkali-silica reaction hence enhancing the durability of concrete. Numbers of test were conducted to study the effect of 5%, 10% and 15% replacement of cement by glass powder on compressive strength and durability. The particle size effect was evaluated by using glass powder of size 600µm-100µm.The results showed that the maximum increase in strength of concrete occurred when 10% replacement was done with glass powder.[4]

III. MATERIAL USE

Under this experimental investigation, following materials are using which are given as below:-

- Cement
- Sand
- Aggregate
- Glass Powder

A.**Cement:-**

Grade: 43

Type: Ordinary Portland cement.

Table 1 Properties of Cement

Sr.No.	Physical Properties	Value
1	Specific Gravity	3.14
2	Initial Setting Time	155
3	Final Setting Time	270
4	Final Consistency	33%

B. **Aggregate:-**

Aggregates are those chemically inert materials which when bonded by cement paste form concrete. Aggregates constitute the bulk of the total volume of concrete and hence they influence the strength of concrete to great extent.

1) ***Fine Aggregates:*** The material which passed through I.S. Sieve No. 480 (4.75mm) is termed as fine aggregates. The source for fine aggregate used is from natural river bed. The fine aggregate used which have fineness modulus of 3.1, specific gravity of 2.62.

2) ***Coarse Aggregates:*** The material whose particles are of such size as are retained on I.S. Sieve No. 480 (4.75mm) is used as coarse aggregates. The aggregate used which have specific gravity of 2.82 and fineness modulus of 7.5.

3***) Glass Powder:***

Table 2 Properties of Glass Powder

Oxides	Oxides Present In Glass Powder (%)
CaO	11.42
SiO2	72.61
Al2O3	1.38
Fe2O3	9.70
MgO	0.79
K2O	0.43

IV. RESULT AND DISCUSSION

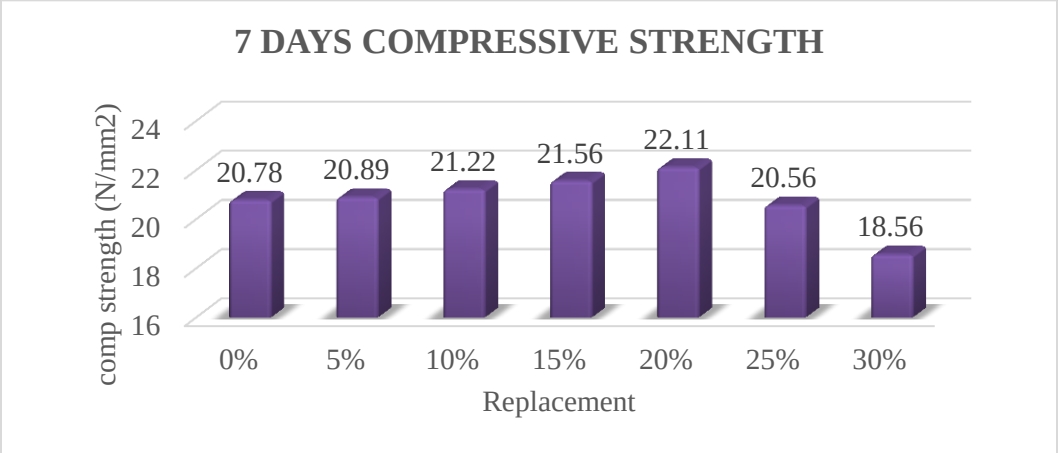
M25 Grade Compressive Strength:

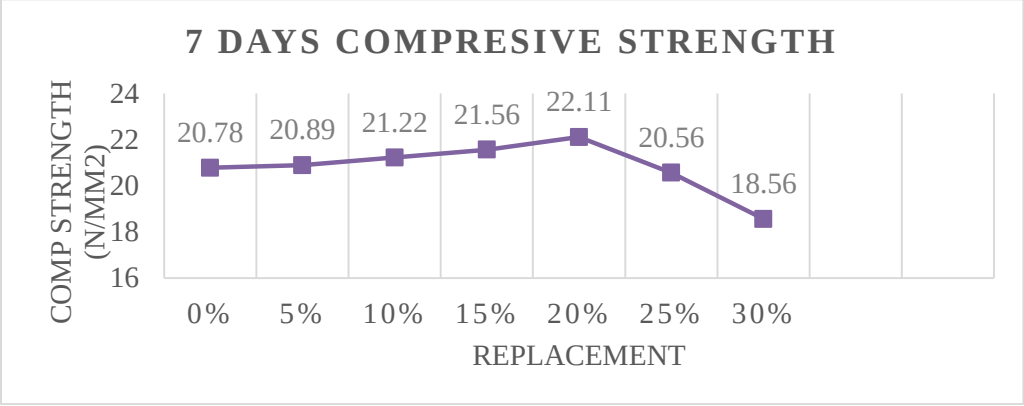
Table2 Test Results of Control mix:-

Mix Proportion	Curing Days	Compressive Strength N/mm^2		Avg. of Compressive Strength N/mm2
		sample1	sample2	
1:1.55:3.02	7 days	19.7	21.7	20.78
	14 days	26.2	28	27.11
	28 days	30	31.6	31.56

Table3 Test Result for 7 days:-

Sr. No	Glass powder	Load(KN)	Avg. Load(KN)	Strength (N/mm²)	Avg. Strength (N/mm²)
		7 Days			
1	Control Mix	445 490	468	**19.77** 21.77	20.78
2	5%	445 495	470	19.77 22	20.89
3	10%	435 420	478	19.33 18.66	21.22
4	15%	530 440	485	23.55 19.55	21.56
5	20%	455 505	498	20.22 22.44	22.11
6	25%	430 595	463	19.11 26.44	20.56
7	30%	390 445	418	17.33 19.77	18.56





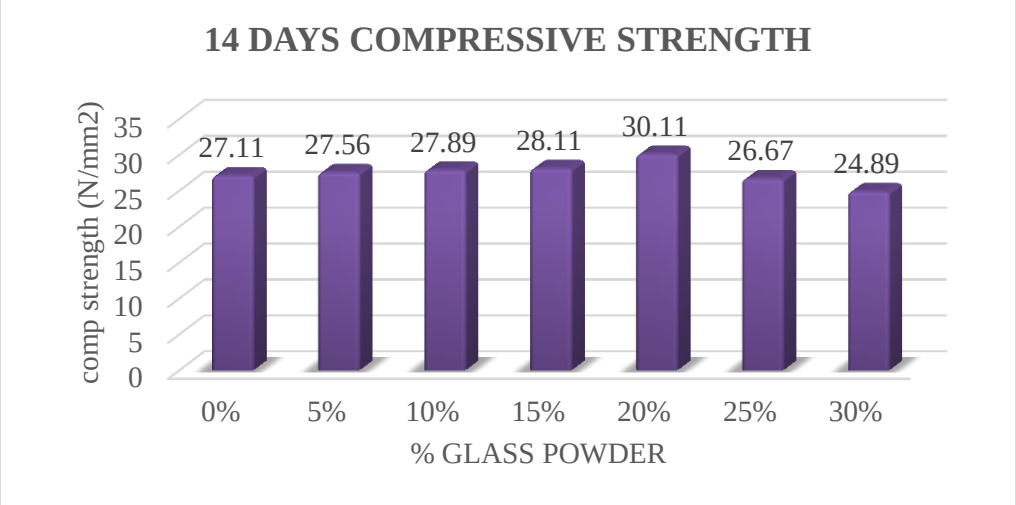
Observation:

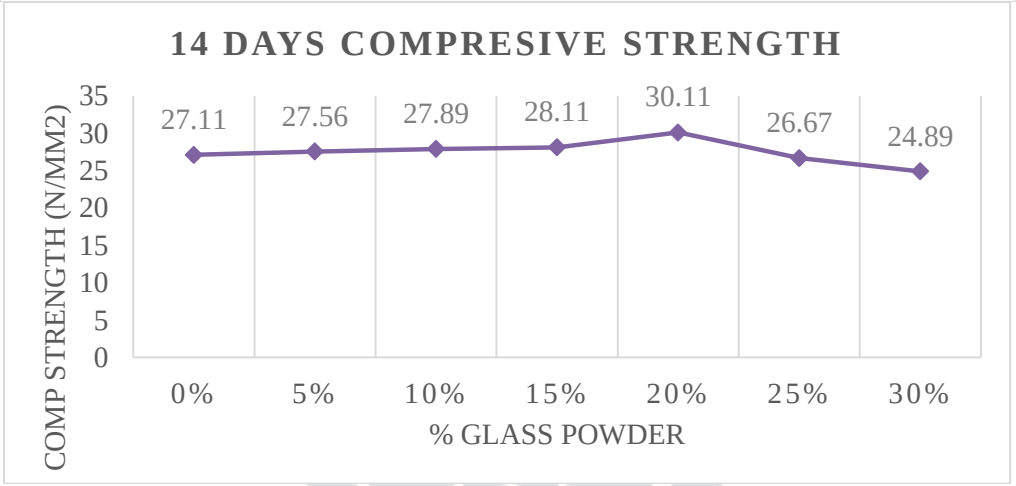
In this graph we can see that the compressive strength of control mix is minimum than 5% to 20% replacement of cement by glass powder but it maximum than 25% to 30% replacement of cement by glass powder. Hence Maximum Strength at 7days by replacing cement by glass powder is obtained at 20% replacement of cement by glass powder.

Table 4 Test Result for 14 Days:-

Sr. No	Glass powder	Load(KN)	Avg. Load(KN)	Strength (N/mm²)	Avg. Strength (N/mm²)
		14 Days			
1	Control Mix	590 630	610	**26.22** 28	27.11
2	5%	590 650	620	26.22 27.77	27.56
3	10%	575	628	25.55	27.89

		680		30.22	
4	15%	575 690	633	26.44 30.44	28.11
5	20%	665 690	678	29.55 30.66	30.11
6	25%	555 645	600	24.66 28.66	26.67
7	30%	605 515	560	26.88 22.88	24.89





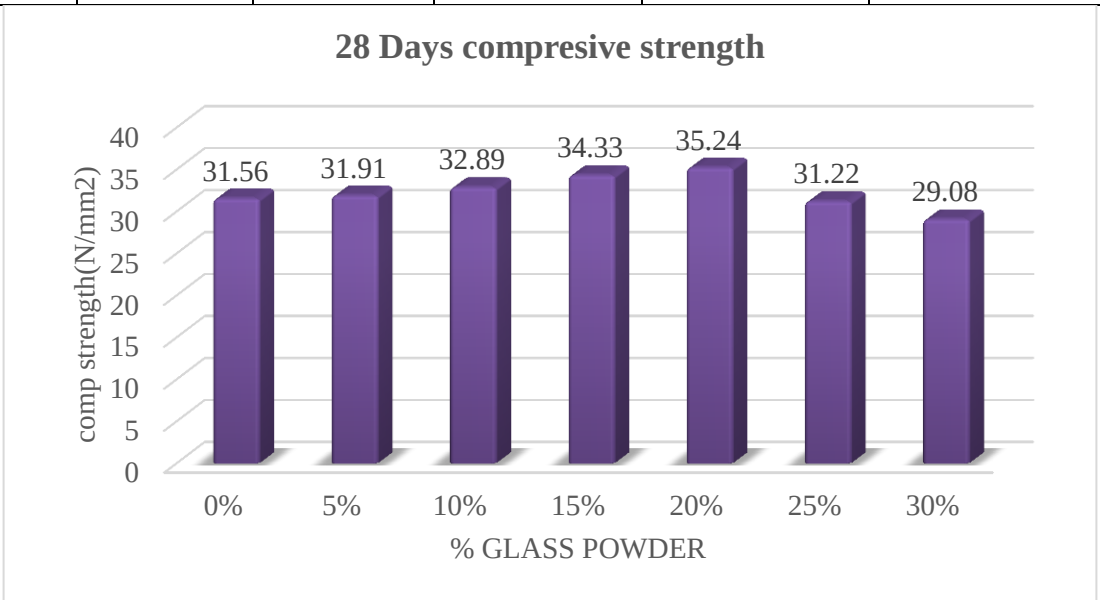
Observation:-

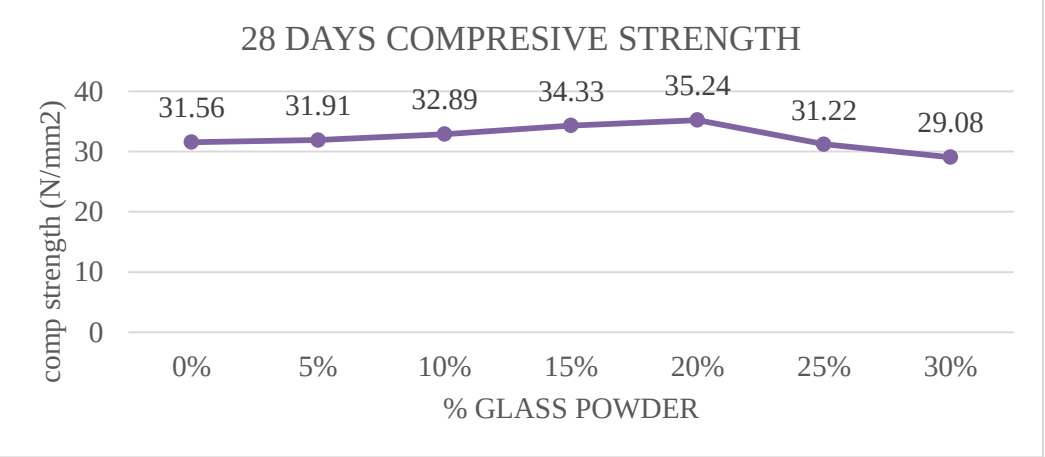
In this graph we can see that the compressive strength of control mix is minimum than 5% to 20% replacement of cement by glass powder but it maximum than 25% to 30% replacement of cement by glass powder. Hence at 14 days maximum strength is obtained at 20% replacement of cement by glass powder.

Table5 Test Result for 28 Days:-

Sr. No	**Glass powder**	**Load(KN)**	**Avg.Load(KN)**	**Strength(N/mm²)**	**Avg. Strength (N/mm²)**
		28 Days			
1	Control Mix	675 745	710	**30** 33.11	31.56
2	5%	690 745	718	30.66 33.11	31.91
3	10%	725 755	748	32.22 33.55	32.89
4	15%	790 755	773	35.11 33.55	34.33
5	20%	775 790	793	35.33 35.11	35.24

6	25%	715 690	703	31.77 30.66	31.22
7	30%	640 665	653	28.44 29.55	29.08

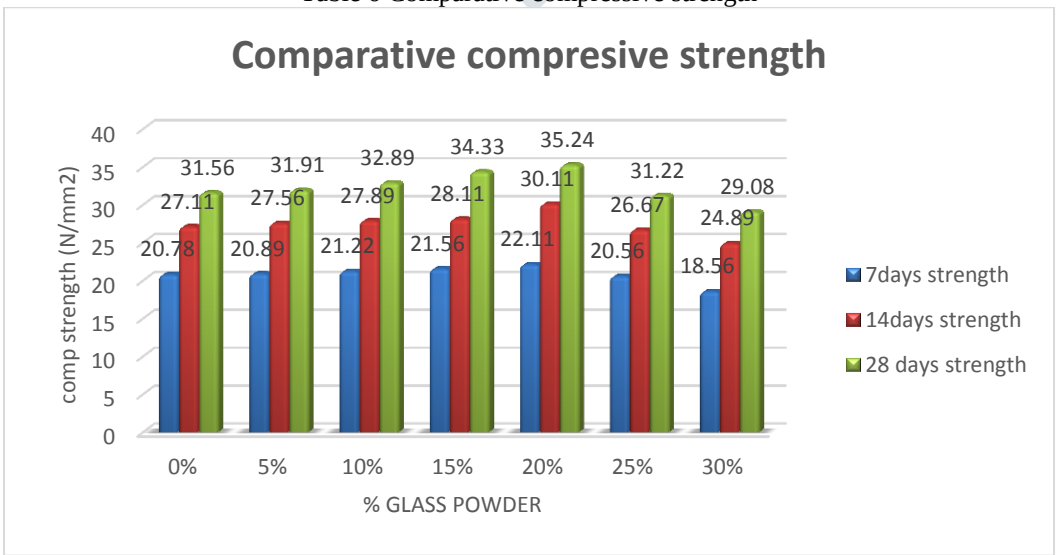


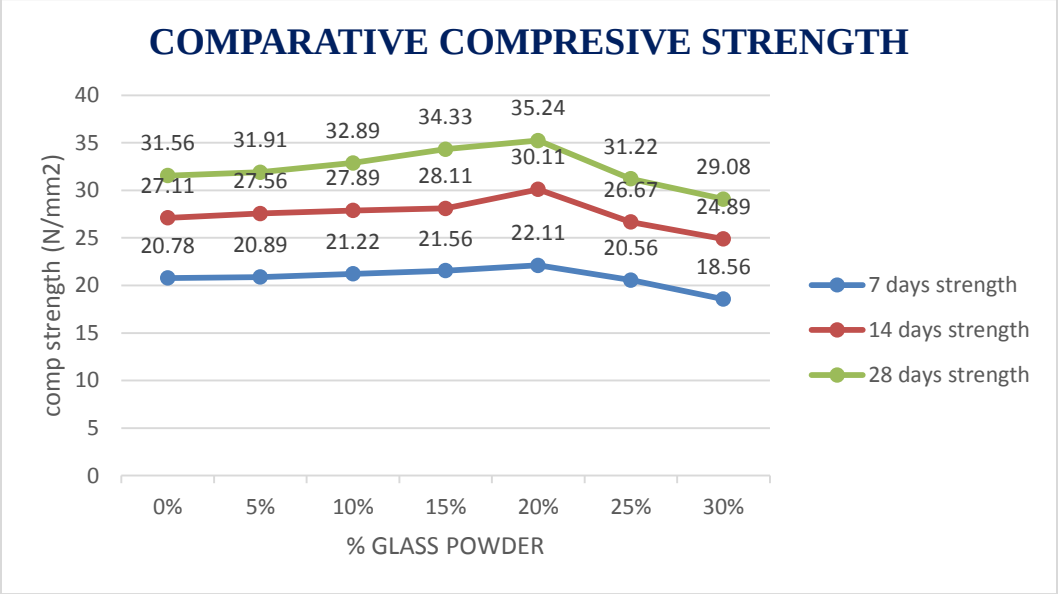


Observation:-

In this graph we can see that the compressive strength of control mix is minimum than 5% to 20% replacement of cement by glass powder but it maximum than 25% to 30% replacement of cement by glass powder. Hence maximum strength at 28days is obtained for 20% replacement of cement by glass powder.

Table 6 Comparative compressive strength





Observation:-

In this graph we can see that the compressive strength of control mix is minimum than 5% to 20% replacement of cement by glass powder but it maximum than 25% to 30% replacement of cement by glass powder.

Hence by comparing strength of concrete by replacing cement by glass powder the maximum strength is obtained at 20% replacing cement by glass powder.at strength is very much less at 25% and 30% replacing cement by glass powder.

V. CONCLUSION:-

I. The most suitable mix proportion is the 15% to 20% replacement of waste glass powder to cement which gives maximum strength to concrete.

II. Used of glass powder in concrete will eradicate the disposal problem of waste glass powder, reduce emission of harmful pollution by cement manufacturer industry into our environment and thus prove to be environment friendly.

III. Very finely ground glass has been shown to be excellent filler and may have sufficient pozzolonic properties to serve as partial cement replacement, the effect of ASR appear to be reduced with finer glass particles, with replacement level.

IV. Considering the strength criteria, the replacement of cement by glass powder is feasible. Therefore we can conclude that the utilization of waste glass powder in concrete as cement replacement is possible.

V. The increase in strength up to 20% replacement of cement by waste glass powder may be due to pozzolanic reaction of glass powder and it may be due to the glass powder effectively filling the voids and giving rise to dense concrete microstructure. However, beyond 25% the dilution effect takes over and the strength starts to drop. Thus it concludes that 20% was the optimum level for replacement of cement with glass powder.

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