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EXPERIMENTAL STUDY ON THE ADDITION OF FINE GLASS TO CONCRETE

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ABSTRACT

There is a demand for the development of alternative bonds for concrete formation, waste glass powder shows the properties of pozzolanic because it contains high SiO2 and therefore, to some extent can replace cement in concrete and contribute to the development of strength. In this research study, ordinary Portland cement was replaced by waste glass powder (GLP) accordingly by 0%, 10%, 20%, 30%, 40%, and soft glass was replaced by sand at the same previous ratios, The glass was milled with a diameter of 75 microns as a partial replacement of cement, and a diameter of (0.5 to 2.5 mm) as a partial alternative to sand, the study shows increased operating ability by increasing replacement ratios, and the mixture shows a content of 350 kg/m3 better operating degrees compared to the mixture content 450 kg/m3, Pressure resistance showed an improvement in the replacement rate of 10% as an alternative to sand with a decrease in resistance as replacement ratios in the rest of the mixtures increase compared to the reference mixture, pressure resistance shows an improvement in the replacement of the glass powder as an alternative to sand compared to cement replacement, From the study the mechanism of work of ground glass and its effect on the operational ability of the concrete mixture, and can hoard the properties of the glass milled in the production of a concrete mixture with high resistance and operation, and can recycle glass residues that do not decompose as well as in getting rid of a large proportion of CO_2 gas resulting from the cement industry and reducing the cost of producing high-priced cement slat and preserving nature's wealth from sand.

Keywords: Concrete, Study on the addition of fine glass to concrete, Experimental

دراسة معملية عن إضافة الزجاج المطحون للخرسانة

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الملخص
هناك طلب على تطوير روابط بديلة لتشكيل الخرسانة، يظهر مسحوق زجاج النفايات خصائص البزولان لأنه يحتوي على SiO_2 عالي، وبالتالي، إلى حد ما يمكن أن يحل محل الأسمنت في الخرسانة ويساهم في تطوير القوة. في هذه الدراسة البحثية، تم استبدال الأسمنت البورتلاندي العادي بمسحوق زجاج النفايات (GLP) وفقا لذلك بنسبة 0٪، 10٪، 20٪ ،30٪، 40٪، كما تم استبدال الزجاج الناعم برمال بنفس النسب السابقة، في هذه الدراسة راعى الباحث عدم استخدام أي نوع من الاضافات، لمعرفة الدور الفعلي لمطحون الزجاج كبودرة زجاج بديل للأسمنت وزجاج ناعم بديل لرمل في خلطات محتوى 350 كجم/م3، و450 كجم /م3، تم عمل 16 خلطة وعدد 2 خلطة مرجعية، سمحت منهجية العمل بالفصل بين دور الاسمنت ودور مطحون الزجاج المضاف كبديل للأسمنت ورمل ودراسة تأثير هذه المادة في حقل واسع من التجارب في خلطات محتوى 350 كجم/م3، و450 كجم /م3، يعمل مطحون الزجاج وفق اليتين متوازيتين الأولى ترتبط بالسطح النوعي الكبير لمطحون الزجاج ومما يسببه هذا السطح من زيادة في التوتر السطحي للماء الذي يساهم بشكل كبير في المرحلة الرطبة باحتجاز كمية من الماء في المرحلة قبل دخوله في عملية الاماهة مما يقلل الهبوط ويزيد في حجم الفرغات، الآلية الثانية وترتبط بالخصائص الميكانيكية والطبيعة الفلزية لهذه الحبيبات وخاصة عدم امتصاصها للماء والانخفاض النسبي لزاوية الاحتكاك الداخلي مما يساهم في زي الهبوط ونفص حجم الهواء وزيادة في تراص الخلطة الخرسانية وتحسين المقاومة، مقاومة الضغط أظهرت تحسن عند نسبة استبدال 10% كبديل للرمل مع انخفاض في المقاومة كلما زادة نسب الاستبدال في باقي الخلطات مقارنة بالخلطة المرجعية، تظهر مقاومة الضغط تحسن عن استبدال مطحون الزجاج كبديل للرمل مقارنة باستبداله بالأسمنت ، من الدراسة تم فهم الية عمل مطحون الزجاج وتأثيره على قابلية التشغيل في الخلطة الخرسانية، وعلية يمكن اكتناز خصائص مطحون الزجاج في انتاج خلطة خرسانية ذات مقاومة وتشغيلية عالية، ويمكن إعادة تدوير مخلفات الزجاج التي لا تحلل وكذلك في التخلص من نسبه كبير من غاز ثاني CO_2 الناتج من صناعة الاسمنت والتخفيض من تكلفة انتاج صناعة الاسمنت عالية الثمن والحفاظ على ثروات الطبيعة من الرمال،

الكلمات المفتاحية: الخرسانة، دراسة على إضافة الزجاج الناعم الى الخرسانة، تجريبية

1 INTRODUCTION
Concrete is the most prevalent material in the field of construction and as a result of the pollution that occurs due to the manufacture of some materials involved in the manufacture of concrete such as cement so concrete is one of the most serious sustainability and environmental issues that it currently faces around the world, recycled materials, such as glass waste (WG) resulting from construction waste can preserve cement and natural raw materials if used as partial alternatives to those materials [1], Glass is an inorganic solid, usually transparent or un translucent, easy to break, not permeable to natural materials. Although it has been used since ancient times, it is still very important in various uses, such as buildings, tools, household utensils and telecommunications equipment, Glass types vary widely according to their components and physical properties, The most common type of glass throughout the ages, especially in our time, is that used in the manufacture of windows and drinking utensils, which is lime soda glass, which consists of 75% of silica, sodium oxide and calcium oxide; with or without other additives, The production life of glass is 5000 years Until the 1st century BC when it appeared in the Middle East, objects made of glass were the basis of ornament and small containers for cosmetics so glass is considered a very [2], Glass is considered to be of great importance in all areas of life, has greater credit in building and installations directions, as it is used in destinations, and the manufacture of windows, The types of glass differ greatly due to the difference in their components and physical properties, As for the components involved in the composition of the glass, according to the percentage of their contribution: silica sand or silicon dioxide SiO_2 sodium carbonate or soda ash $Na2Co_3$, calcium carbonate or limestone $CaCo_3$ in addition to some mineral oxides to obtain certain colors such as chrome oxide green and sulfur oxide For brown [3], The qualities retained by fine glass powder

such as amorphous structure, non-biodegradable nature, and ease of availability in all places are considered to create a new vision as all these qualities and the nature of this material make it glass powder that it can be used as pozzolanas materials motivated by solving various environmental problems[4], Glass is usually used in the construction field, which made it the most productive of waste. Most of the damaged quantity is sent either for recycling after some physical and chemical treatments are carried out to get rid of the accompanying impurities or to general dumpsites to occupy vast areas that in turn contribute to increasing environmental pollution, especially It is not degradable with time due to the stability of its chemical properties [5] , Glass is one of the most common materials despite the importance of glass and it is a useful material and although many of them are recycled, there is a lot of waste glass that is not recycled and occupies a lot of landfill and has a great harmful impact on the environment [6], Disposal of glass waste has been a major challenge especially in places and urban areas around the world, and it is a long recognized thing in the field of construction that many wastes can be used instead of raw materials, and since cement produces a lot of CO_2 in a large amount, and for the wide use of waste it is important that the properties of the resulting materials of sons are satisfactory [7], Across the world, glass waste represents a significant and growing burden and there is a need to find options for these large quantities of broken and contaminated glass waste that is not currently being recycled[8], Quantities of waste glass have been rising rapidly during the recent decades due to the high increase in industrialization and the considerable improvement in the standards of living, but unfortunately, the majority of these waste quantities are not being recycled but rather abandoned causing certain serious problems such as the waste of natural resources and environmental pollution[9], In the Club for Environmental Impact Treatment associated with cement manufacturing, there is a demand to develop alternative binders for forming concrete. Waste glass powder exhibits pozzolanic properties because it has a high content of SiO_2 and thus, to some extent, it can displace cement in concrete and contribute to the development of compressive strength, During the past decades, glass waste has been recognized as large and is increasing year by year in stores, construction areas and factories. The use of waste glass in the concrete construction sector is beneficial, as the concrete production cost will be reduced [10], The research laboratory is interested in using glass as a material to improve the properties of the concrete mixture in terms of resistance and operation as the glass contains distinctive mechanical properties in terms of resistance and non-absorption [11], The research was not limited to the study of the effect of glass on the resistance of concrete to pressure, but the study also focused on the study of tension and bending and the impact on the phenomenon of bloating and the degree of operation to study the effect of colored alkaloids on the structure of concrete [12], The importance of research on this subject is the difference in the objectives and results of studies and researches, where several studies have shown that it plays a negative role in adding it to the concrete mixture while other studies supported its importance and feasibility of using it [13], The effects of partial replacement of cement with glass powder in concrete have been studied, and therefore it has been found that it can be replaced to some extent contributing to the development of strength. The cement was partially replaced by a glass powder in varying proportions such as 10%, 20% and 30% and many concrete cylinders were poured with a sample of ordinary concrete [14], Recycled glass waste has been effectively used as a partial substitute for sand in concrete. A series of tests have been conducted to determine the properties of components, fresh concrete and solid concrete, including their durability, to verify the appropriateness of using recycled glass sand (RGS) in concrete The experimental results confirm that the addition of RGS can be a good alternative to natural sand and, therefore, can be used effectively in industrial applications [15], Sand and gravel are among the most exploited materials in the world as well as exceed fossil fuels and are always used in most of the work in the production of concrete, and because of the impact of river streams restrictions were imposed on the use of river sand so it was necessary to look for alternative materials [16].

2 Experimental work

2.1 Material

2.1.1 Cement

Ordinary Portland Cement Type I was used. The grade used was CEM I 52.5 N. produced locally in accordance with Egyptian standard code ESS (4756-1 /2009). The physical, chemical and mechanical properties of this cement are given in **Table 1**.

Table 1: Properties of cement type O.P.C

Chemical	Composition%	Physical properties	Compressive strength(N/mm^2)
Sio_2	21.06	Fineness(cm^2/g)3545	3 days 22.4
Al_2o_3	5.41	Specific gravity3.15	7 days 35.6
Cao	62.78	Soundness(mm)1.55	28 days**57** .3
Fe_2o_3	3.75	Initial setting time (minutes) 54	
MgO	.92		
So_3	2.92		
LOI	.038		

2.1.2 Fine aggregate

Natural available clean fine sand having fineness modulus 2.3 ,specific weight 2.631t/m^3, Absorption 9%-unit weight 1.721t/m^3 was used as fine sand.

Table 2: Sieve analyses of fine sand

Sieve No.	3/8"	No. 4	No. 8	No. 16	30	50	100		% pass
Sieve size (mm)	9.5	4.75	2.36	1.18	0.600	0.300	0.150		200
% Passing	100.0	99.5	97.3	87.5	60.6	27.9	1.6		
Limits									

Remarks

FM =2.3

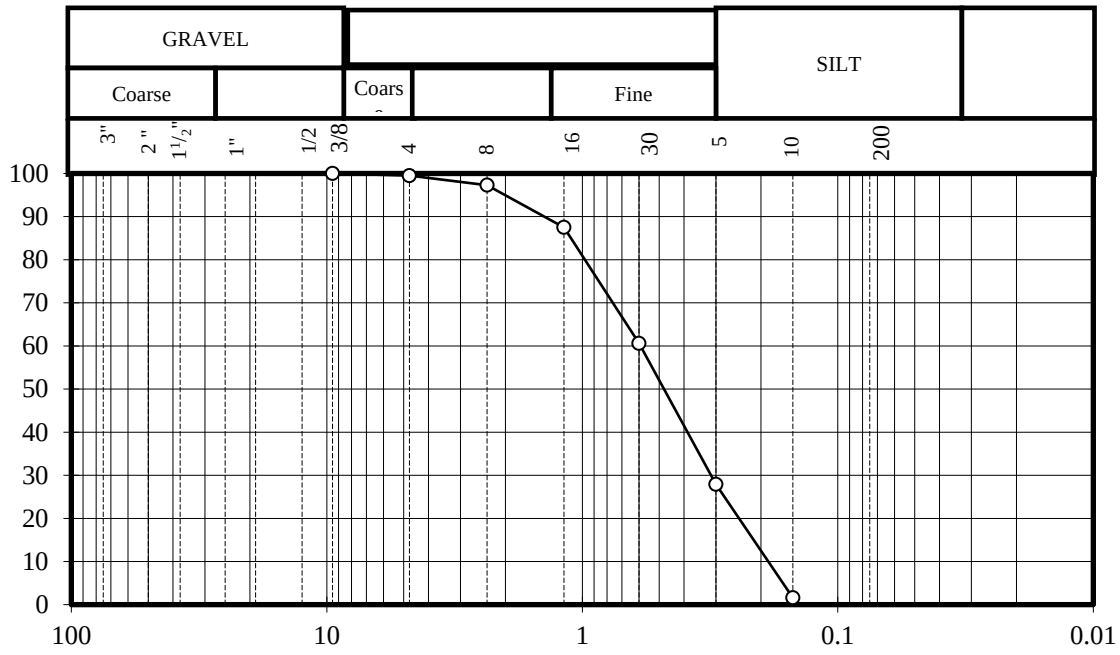

Fig. **1:** Sieve analysis of fine sand.

2.1.3 Coarse aggregate

Form about 75% of the concrete volume. Aggregates can be sand or crushed rock or recycled concrete rubbles, or other materials, aggregate is a dormant granular material such as sand, gravel and crushed rocks. It forms with water and cements the basic components of concrete. For a high-quality concrete mixture, the aggregates must be clean, hard, and strong, and the aggregate particles must be free of any absorbed chemicals or covered with any type of clay or any kind of fine material that can contribute to the deterioration of the condition and quality of the concrete Aggregates which constitute (60-70) % of the total concrete volume, can be divided into two categories, Fine aggregate It is generally composed of natural sand or fractured rocks so that the grains of this aggregate can pass through a sieve with holes of diameters (4.75 mm), Most of her sweetheart (95-100%) passes through a4.75 mm sieve, Coarse aggregates its grains are larger than (4.75 mm), but generally range from (4.75-150) mm, and it is also the group of granules, most of which are retained by (95-100) % on a 4.75 mm sieve.

Table 3: Physical Properties of Fine Aggregate

S. No.	Parameters	Results	
		size # 1	size # 2
1.	Specific Gravity	2.692	2.753
2.	unit weight	1.405	1.411
4.	Water Absorption (%)	2.1	1.4

Table 4: Granular gradient of Dolomite (5-25mm) combination of 50% dol. size # 1& combination of 50% dol. size # 2

sieve No.	1 1/2"	1"	3/4"	1/2"	3/8 "	No. 4	No. 8	No.16	% Pass 200
Sieve size (mm)	37.5	25.0	19.0	12.5	9.50	4.75	2.36	1.18	
% Passing	100.0	100.0	87.4	45.0	15.3	0.5	0.1		
Limits	100	95-100	---	25-60	---	0-10	0-5		

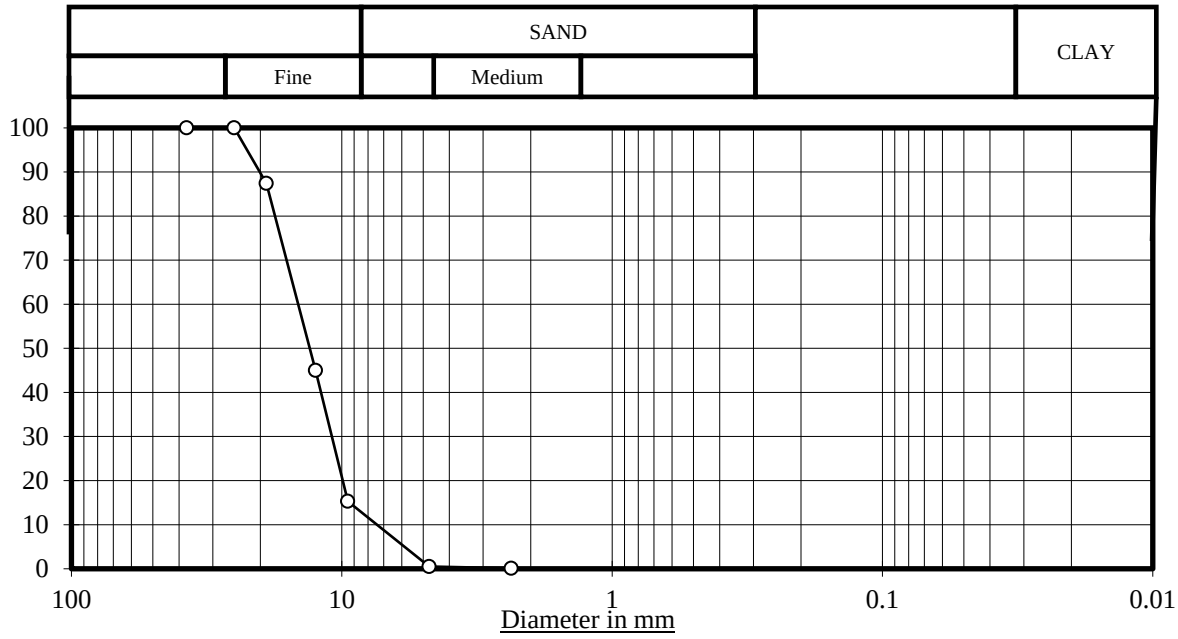

Fig 2: Granular gradient of Dolomite (5-25mm) combination of 50% dol. size # 1& combination of 50% dol. size # 2

2.1.4 Mixing water

The water used is fresh, clean, and free from impurities, ordinary drinking (tap**)** water and was taken from portable water supplies.

2.1.5 Glass powder

Glass powder was obtained as glass waste from glass shops and a construction site in Cairo with clear white glass. The glass is a white transparent oxide-free type that has been crushed and milled from the transparent glass waste.

Fig. 3: Pictures of glass grinding machine.

Table 5: Physical Properties of Glass Powder.

S.No.	Physical Properties of Glass Powder Results	
1.	Specific Gravity fine Glass No.1	2.412
	Specific Gravity fine Glass No.2	2.525
2.	FinenessPassing75µm	99.5

2.2 MIX DESIGN

The design of the concrete mixture with a Caliber Cement of (350 and 450) kg / m3 without the use of any kind of additives consists of a mixture of 18 mixes.
The glass powder is a substitute for cement with a diameter of 75 microns and as a substitute for sand with a diameter of less than 2.5 mm Glass No.1 (size 0.5-1mm) and Glass No.2 (size 1-2.5mm). Dolomite (5-25mm) combination of 50% dol. size # 1& combination of 50% dol. size2#

1-A group
One reference mixture (AB) Reference (0) %.
Four mixtures A1-A2-A3-A4 content of 350 kg / m3 Substitution of glass powder as a replacement for cement with the same proportions (10-20-30-40) %
.
2-B group
Four mixtures B1-B2-B3-B4 350 kg / m3 Substitution of the glass mill as an alternative to sand with the same proportions (10-20-30-40) %.

3-C group
One reference mixture (CD) (0)%
Four mixtures of C1-C2-C3-C4 content of 450 kg / m3, the substitution of glass powder as a substitute for cement with the same proportions (10-20-30-40)% .

4-D group
Four mixtures of D1-D2-D3-D4 content of 450 kg / m3 Substitution of glass grind as a substitute for sand with the same proportions (10-20-30-40) %.

Table 6: Mix Proportions content of 350 kg / $m^{3.}$

w/c ratio	Quantity of Materials(kg)					
	Cement	Fine Aggregate	Coarse Aggregate		Water	Chemical Admixture
			Size#1	Size#1		
0.7	350	715	534	534	245	0

Table 7: Mix Proportions content of 450 kg / $m^{3.}$

w/c ratio	**Quantity of Materials(kg)**					
	Cement	**Fine Aggregate**	**Coarse Aggregate**		**Water**	**Chemical Admixture**
			Size#1	**Size#1**		
0.47	**450**	**685**	**534**	**534**	**213**	**0**

2.3 EXPERIMENTAL SET-UP

2.3.1 Replacing cement with glass powder of a mixture of concrete Caliber cement 350 and 450kg /m^3

2.3.1.1 glass powder and air volume

Subsequently, on a detailed study, we have obtained the following outcomes for the Tests air volume of Concrete shown in the **Table8** and **Fig .4.**

Table 8: glass powder and air volume.

Percentages glass powder	Proportion air volume	
	350 kg/m3	450kg/m3
0%	.90	1.6
10%	1.1	1.5
20%	0.9	1.9
30%	1.20	1.7
40%	1.0	1.2

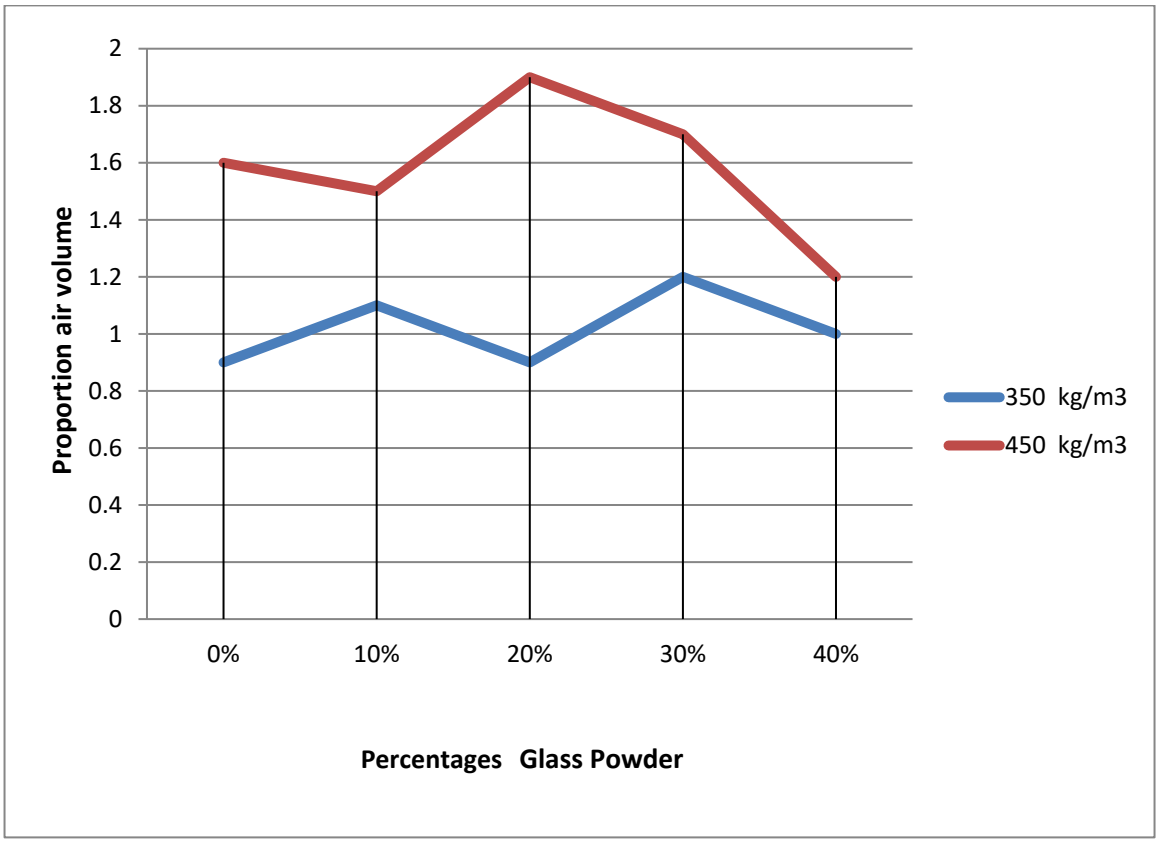

Fig. 4: The percentage of air change in the soft concrete mixture, according to mixture concrete Caliber cement 350 and 450kg /m^3

2.3.1.2 GLASS POWDER AND SLUMP

Subsequently, on a detailed study, we have obtained the following outcomes for the Test slump Concrete shown in **Table 9** and **Fig. 5.**

Table 9: Slump cone Abram.

SLUMP	MIDDLE SLUMP (CM)	
	350kg/m3	450kg/m3
0%	13	10
10%	15.5	10
20%	15	9
30%	17	15
40%	20	14

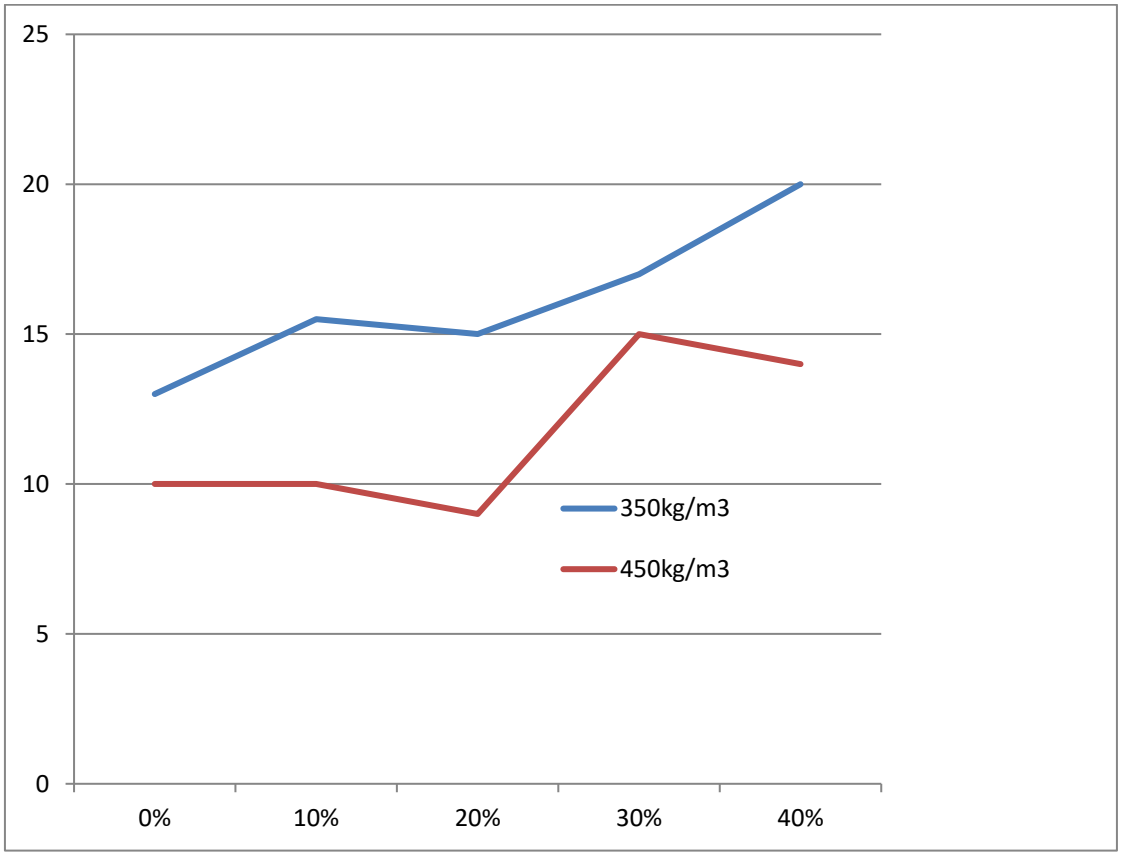

Fig.5: Slump values of concretes with varying amounts of glass powder of mixture concrete Caliber cement 350 and 450kg /m3

2.3.1.3 Soft concrete density

Subsequently, on a detailed study, we have obtained the following outcomes for the Tests of soft concrete density Concrete shown in **Table 10 and Fig. 6**

Table 10: The density of the concrete mixture in soft concrete
Changes as the amount of cement in the mixture change

Percentages glass powder	Soft concrete density t/m3	
	350kg/m^3	450kg/m^3
0%	2.41	2.413
10%	2.390	2.411
20%	2.40	2.383
30%	2.294	2.351
40%	2.365	2.355

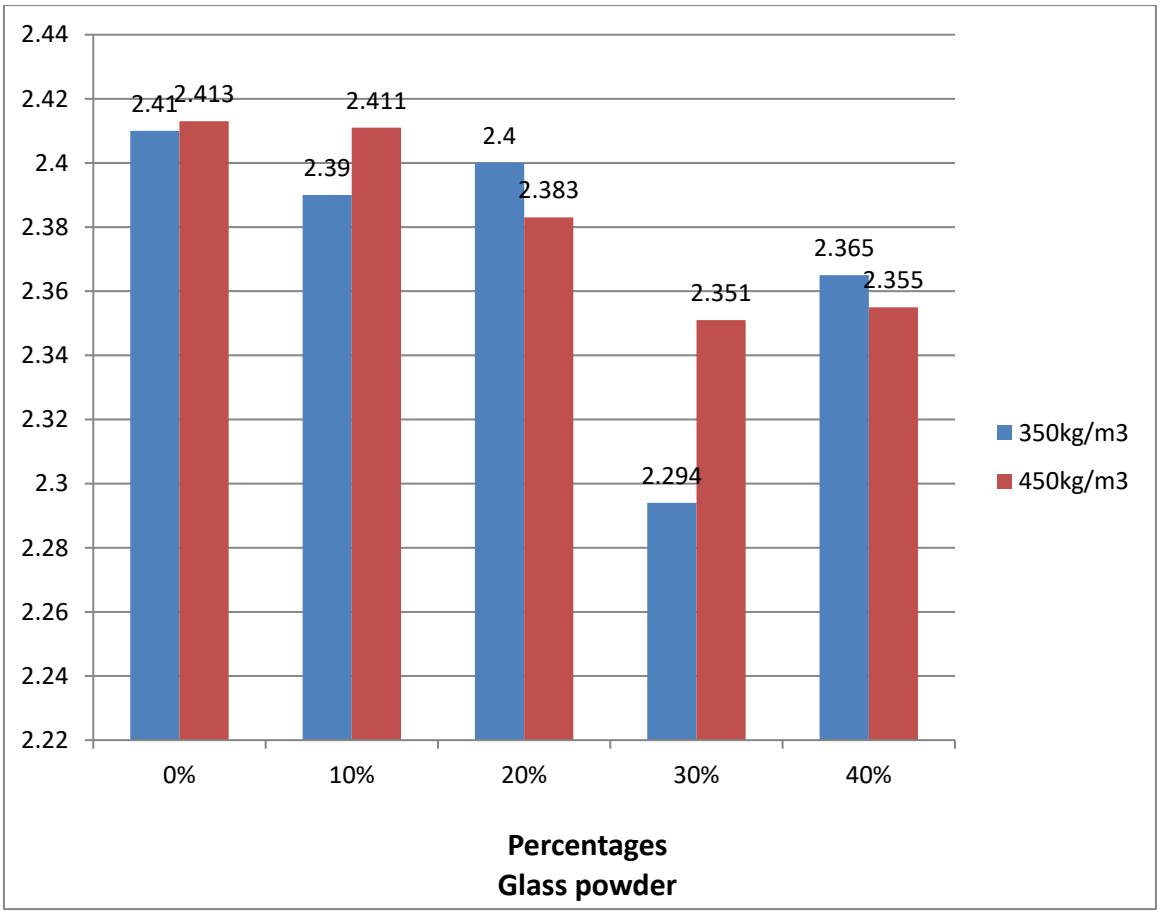

Figure 6: Change in the density of the concrete mixture with increased replacement ratios and change in the amount of cement.

2.3.1.4 The density of the solid concrete

Subsequently, on a detailed study we have obtained the following outcomes for the density of the solid concrete shown in the(**Table11and Table12**) and (**Fig. 7 and Fig. 8**).

Table 11: Concrete density with samples (Caliber Cement 350 kg/m^3)

Percentages glass powder	solid concrete density t/m3	
	7day	28day
0%	2.44	2.47
10%	2.42	2.45
20%	2.41	2.41
30%	2.38	2.41
40%	2.41	2.41

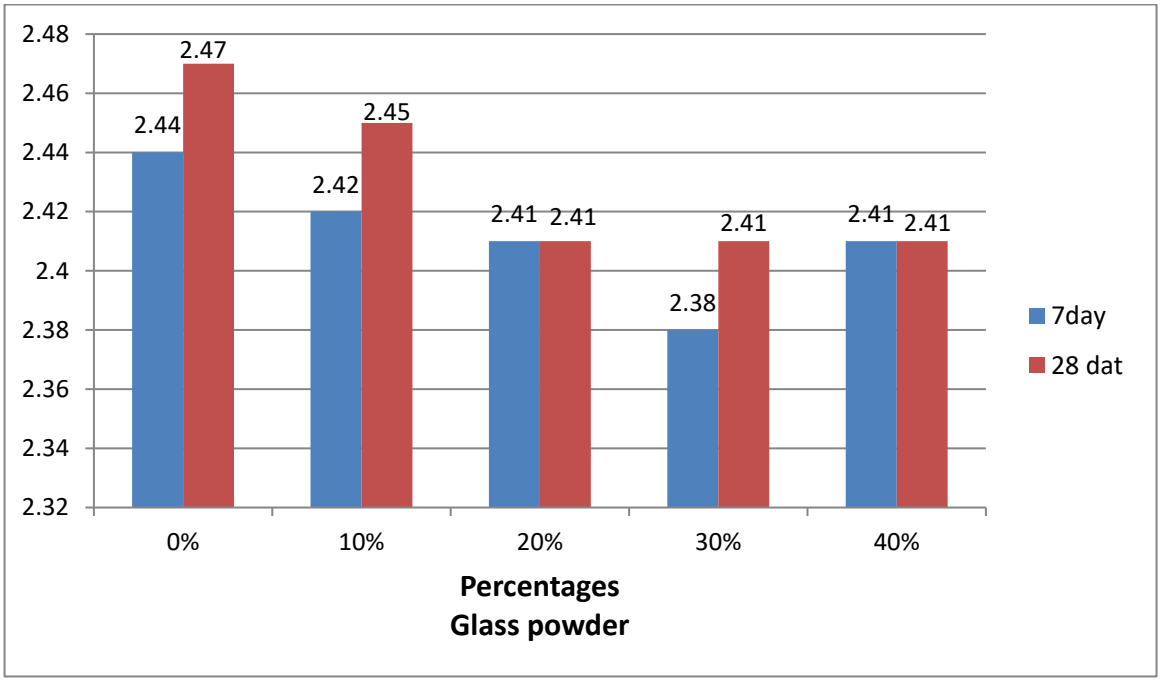

Fig. 7: Change the density of concrete with the age of samples(Calibre 350kg/m^3).

Table 12: Concrete density with samples(Caliber Cement 450 kg/m^3)

Percentages glass powder	solid concrete density t/m3	
	7day	28day
0%	2.50	2.49
10%	2.42	2.47
20%	2.42	2.45
30%	2.42	2.45
40%	2.41	2.43

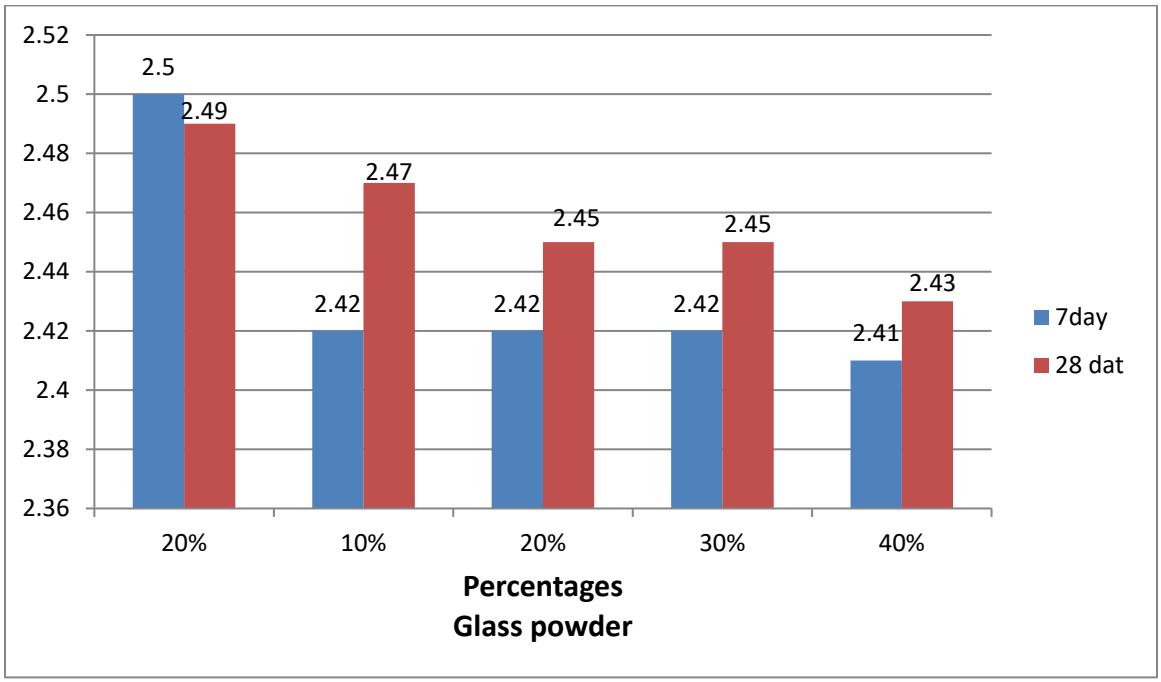

Fig. 7: Change the density of concrete with the age of(Caliber Cement 450 kg/m^3)

2.3.1.5 Compressive Strength Test

Subsequently, on a detailed study, we have obtained the following outcomes for the Cubic compressive strength shown in (**Table 13** and **Table 14**) and (**Fig. 9** and **Fig. 10**)

Table 13: Concrete pressure resistance test results with increasing proportions of replacement with glass powder of mixture (Caliber Cement 350 kg /m^2)

The percentage	compressive strength	
	350kg/m^3	
	7day	28 days
0%	218.1	326.7
10%	178.7	261.7
20%	135.3	221.8
30%	100.8	179.9

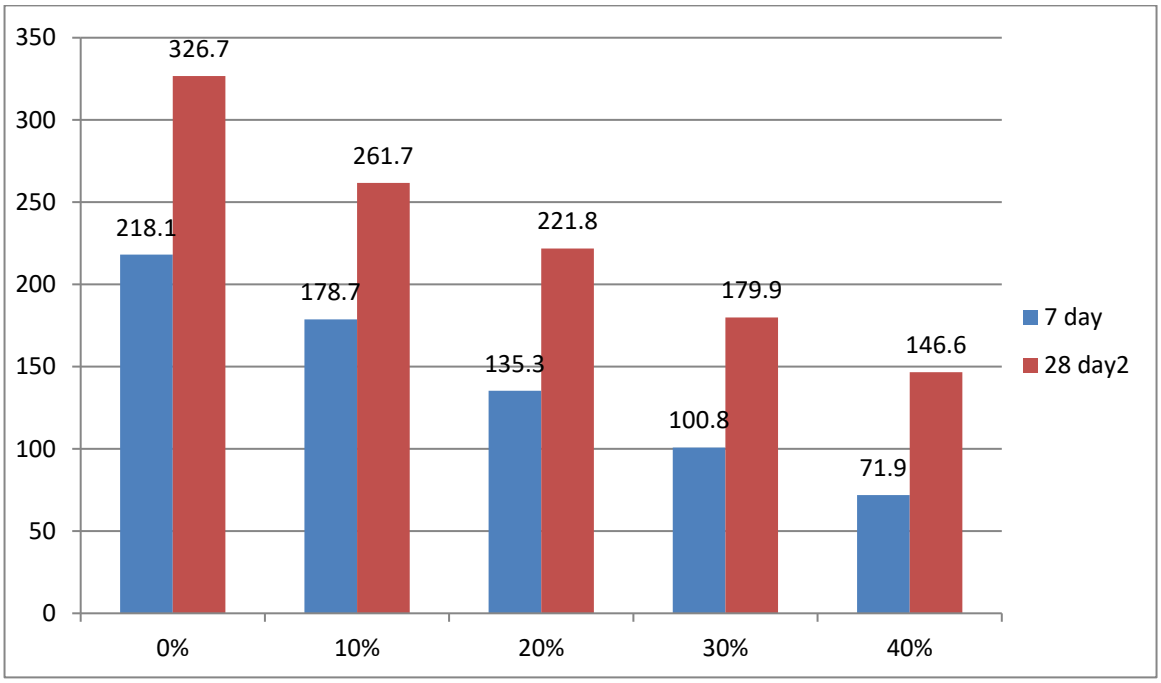

Fig. 8: Relative decrease in concrete resistance with increasing proportions of replacement with glass powder *of* mixture (Caliber 350 kg /m^3)

Table 14: compressive strength test results with increasing proportions of Replacement with glass powder of mixture (Caliber Cement 450 kg /m^3)

The percentage	compressive strength	
	450kg/m^3	
	7day	28 days
0%	278.9	420
10%	260.4	410.3
20%	208.7	342.4
30%	179.5	268
40%	146.5	252.3

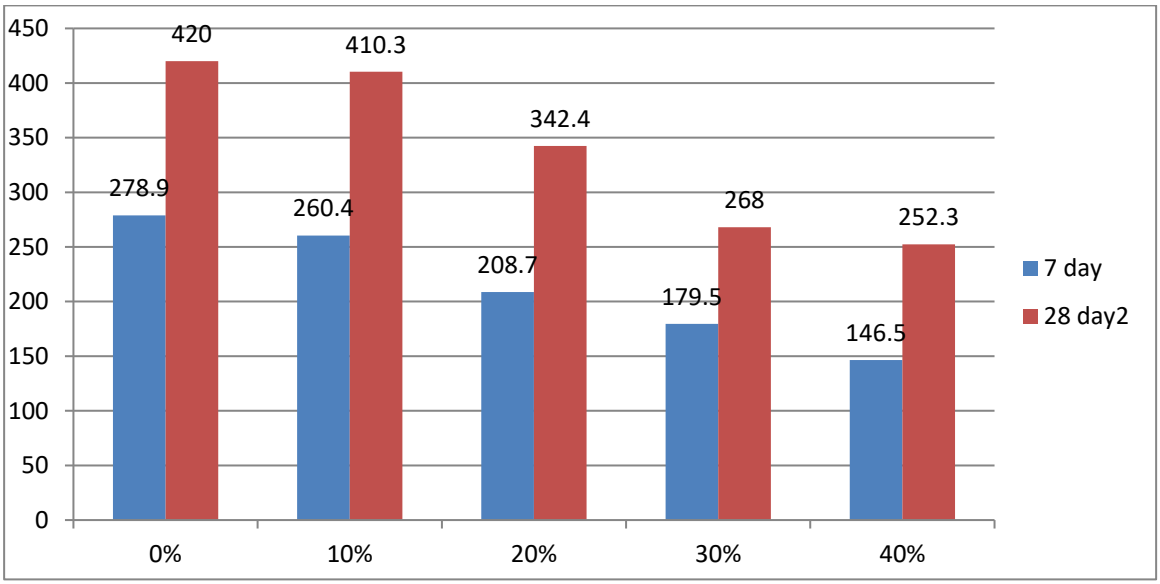

Fig. 9: Relative decrease in concrete resistance with increasing proportions of replacement with glass powder of mixture (Caliber Cement 450 kg /m^3)

2.3.2 replacing sand with glass powder of a mixture of concrete calibre cement 350 and 450kg/m^3

2.3.2.1 glass powder and air volume

Subsequently, on the detailed study, we have obtained the following outcomes for the Tests air volume of Concrete shown in **Table 15** and **Fig. 11**.

Table 15: glass powder and air volume.

Percentages glass powder	Proportion air volume	
	350 kg/m^3	450kg/m^3
0%	.90	1.6
10%	1.1	1.8
20%	1.20	1.5
30%	1.60	1.5
40%	1.0	1.5

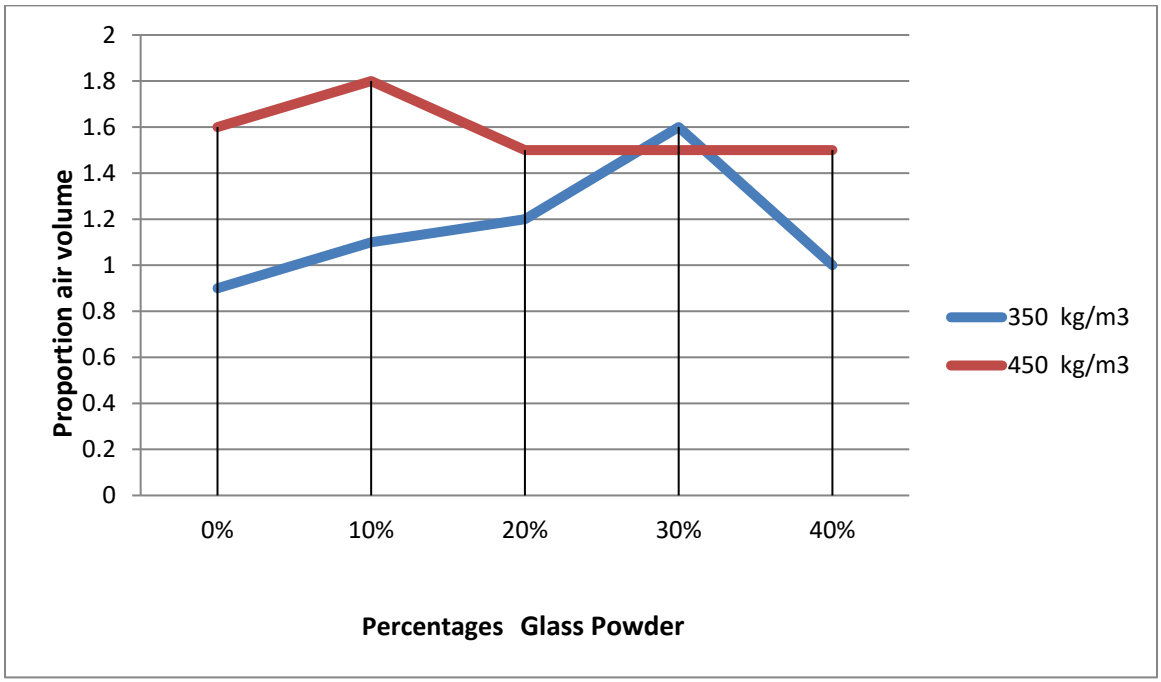

Fig. 10: the percentage of air change in the soft concrete mixture according to replacing sand with glass powder of mixture concrete Caliber cement 350 and 450kg /$m^{3.}$

2.3.2.2 GLASS POWDER AND SLUMP

Subsequently, on the detailed study, we have obtained the following outcomes for the Tests slump of Concrete shown in **Table 16** and **Fig. 12.**

Table 16: Slump cone Abram

SLUMP	MIDDLE SLUMP (CM)	
	350kg/m3	450kg/m3
0%	13	10
10%	14.5	10
20%	14	10
30%	16	10
40%	16	11

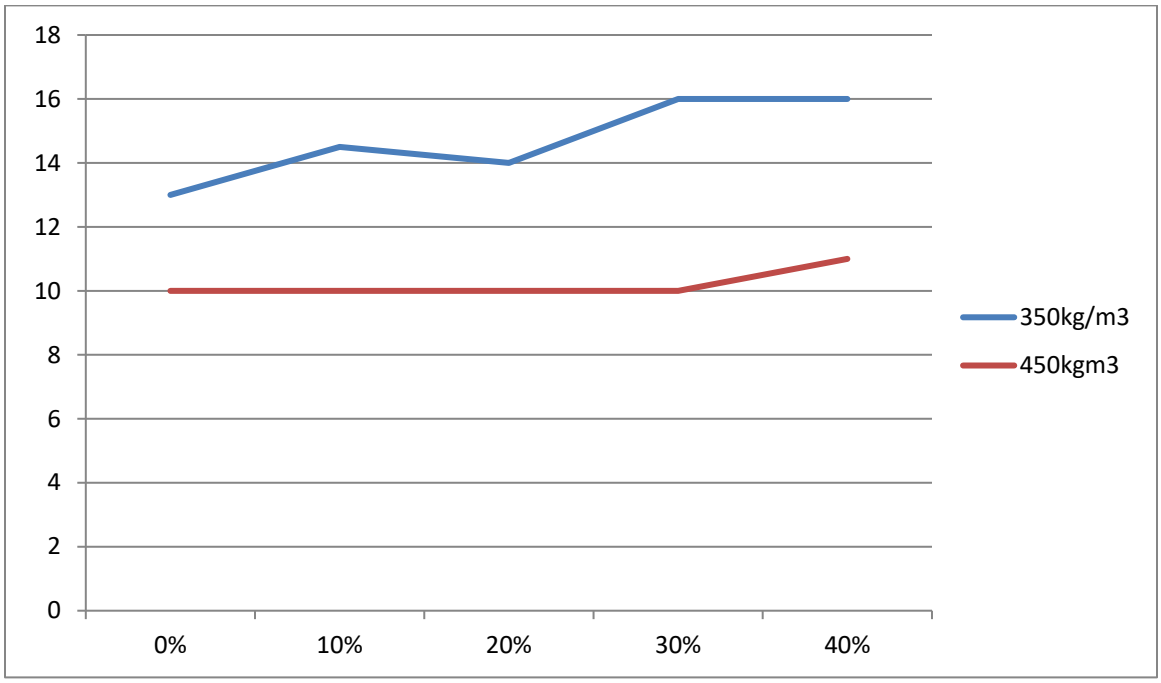

Fig. 11: Slump values of concretes with varying amounts of glass powder of mixture concrete Caliber cement 350 and 450kg /m^3

2.3.2.3 Soft concrete density

Subsequently, on the detailed study, we have obtained the following outcomes for the Tests Soft Concrete shown in **Table 17** and **Fig. 13**.

Table 17: The density of the concrete mixture in soft concrete
Changes as the amount of cement in the mixture change

:

Percentages glass powder	Soft concrete density t/m^3	
	350kg/m^3	450kg/m^3
0%	2.410	2.413
10%	2.391	2.410
20%	2.391	2.397
30%	2.371	2.397
40%	2.232	2.347

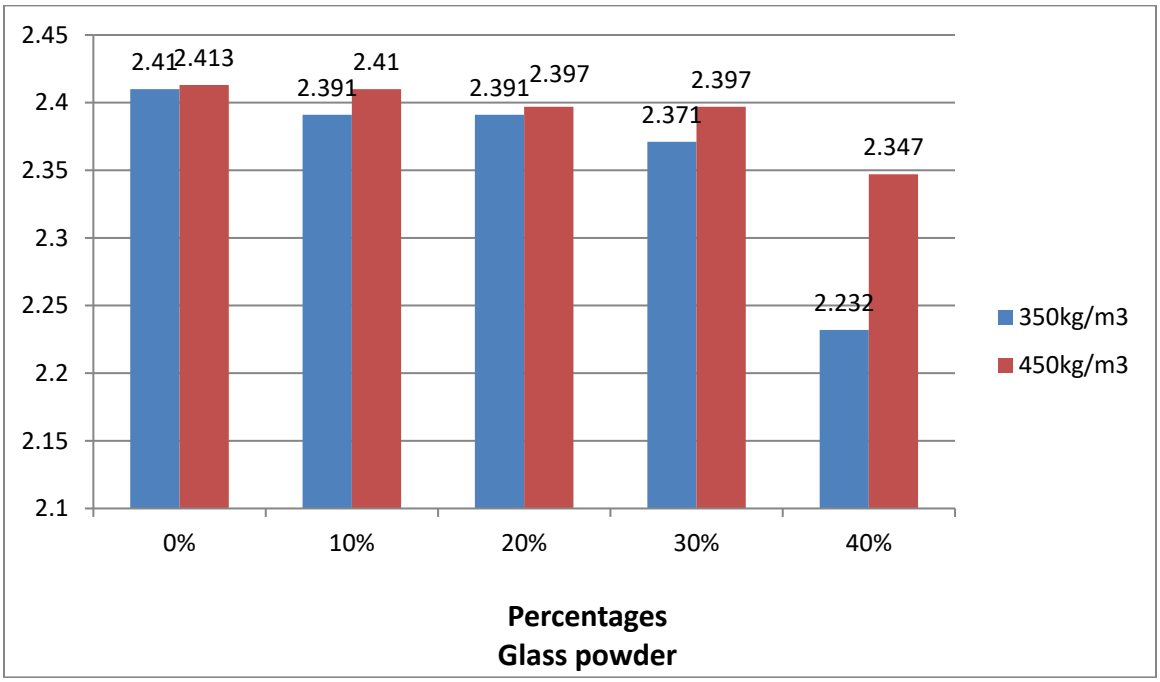

Fig. 12: Change in the density of the concrete mixture with increased replacement ratios and change in the amount of cement.

2.3.2.4 The density of the solid concrete

Subsequently, on the detailed study, we have obtained the following outcomes for the Tests The density of the solid Concrete is shown in (**Table 18 and Table 19**) and (**Fig.** 14 and **Fig. 15**).

Table 18: Concrete density with samples (Calibre cement 350 kg/m^3)

Percentages glass powder	solid concrete density t/m^3	
	7day	28day
0%	2.44	2.47
10%	2.41	2.39
20%	2.45	2.43
30%	2.44	2.41
40%	2.41	2.46

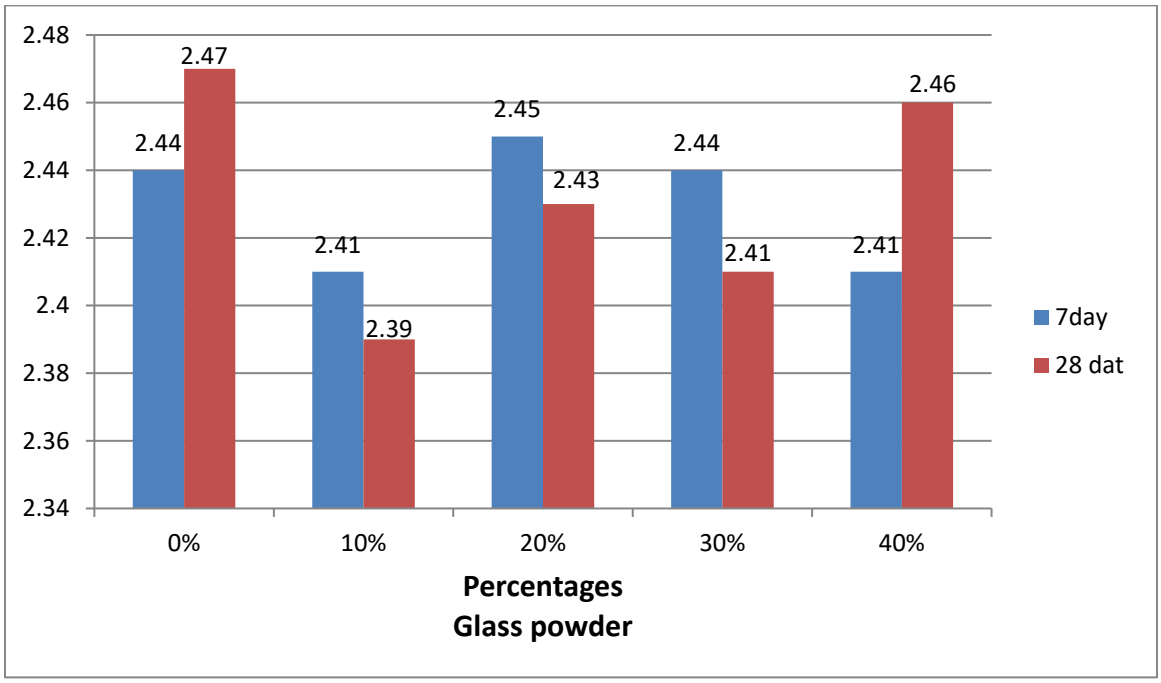

Fig. 13: Change the density of concrete with the age of samples mix cement (Caliber cement 350kg/m^3)

Table 19: Concrete density with samples (Calibre cement 450 kg/m^3)

Percentages glass powder	solid concrete density t/m^3	
	7day	28day
0%	2.5	2.49
10%	2.44	2.45
20%	2.45	2.46
30%	2.42	2.47
40%	2.41	2.47

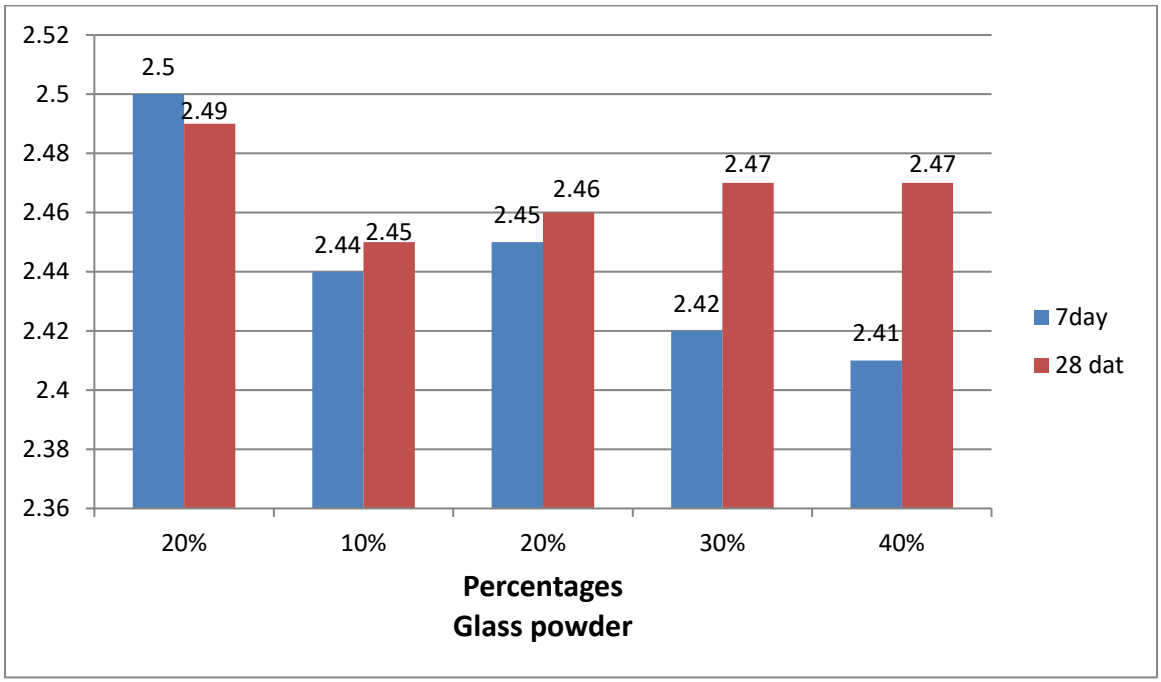

Fig. 14: Change the density of concrete with the age of the sample's mix cement(Caliber cement 450kg/m^3)

2.3.2.5 Compressive Strength Test

Subsequently, on a detailed study, we have obtained the following outcomes for the Test Compressive Strength Tests for the solid Concrete shown in (**Table 20** and **Table 21**). (**Fig. 16** and **Fig. 17**).

Table 20: Relative decrease in concrete resistance with increasing proportions of replacement with glass powder of mixture (Calibre cement 350 kg/m^3)

the percentage is in per cent	compressive strength	
	350kg/m^3	
	7day	28 days
0%	218.10	326.7
10%	160.10	324.9
20%	199.7	297.2
30%	184.4	286.6?
40%	152.8	232.10

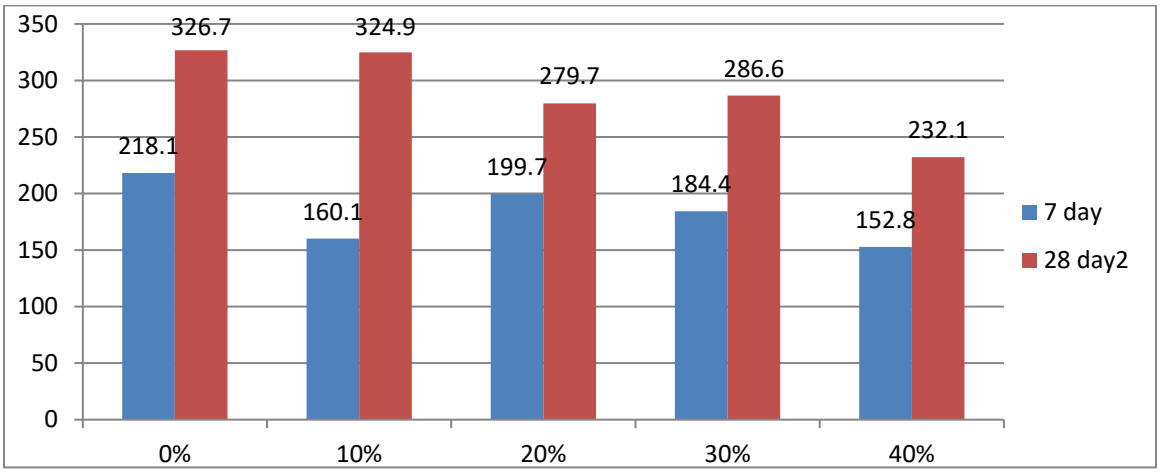

Fig. 15: Relative decrease in concrete resistance with increasing proportions of replacement with glass powder of mixture (Calibre cement 350 kg /m^3)

Table 21: Relative decrease in concrete resistance with an increase proportions of replacement with glass powder of mixture (Calibre cement 450 kg/m^3)

the percentage is in per cent	Cracking cubes	
	450kg/m3	
	7day	28 days
0%	278.9	420
10%	289.9	421.1
20%	280.3	414.6
30%	262.4	408.2
40%	269.1	361.7

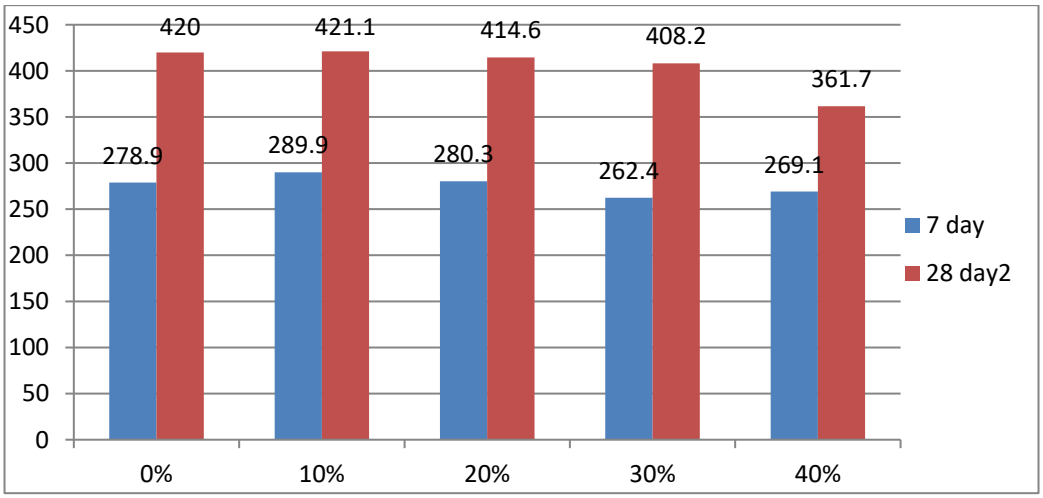

Fig. 16: Relative decrease in concrete resistance with increasing proportions of replacement with glass powder of mixture (Calibre cement 450 kg /m^3)

SUMMARY AND CONCLUSIONS

In this research study, the effect of replacing cement and sand with cement content (350-450) kg/m^3 on the soft concrete mixture and hardened concrete by glass waste powder was studied. Based on the results and observations of the pilot work carried out, the following conclusions were singled out:

1) It can be said that the results of the slump and the size of the voids are due to the mechanism of glass powder work.
2) The concrete mixture shows content of 350 kg/m^3 a marked improvement in workability by increasing the proportions of cement replacement by the glass and appears in the value of slump at the replacement rate of 40% The value of slump was .20 mm compared to the reference mixture the value of 13 mm, also the concrete mixture content of 450 kg / m shows an improvement in workability and this is shown in the replacement ratio of 30% The value of slump was 15 mm compared to the reference mixture The value of slump was 10 mm.
3) Replacement of fine glass with sand the mixture shows the content of 350 kg/m^3 Improvement in the value of slump at the replacement rate of 30% The value of slump was 16 mm compared to the reference mixture The value of slump was 13mm, also the mixture content of 450 kg / m^3 shows a slight improvement in a slump when replacing 40% The value of slump was 11mm compared to the reference mixture The value of slump was 10mm.
4) The decrease in the resistance of the concrete mixture when replaced with cement and sand is due to the decrease in density, increase in surface area and decrease in the amount of cement that needs an additional amount of water, which greatly affects the cement hydration reaction.
5) Glass powder and fine glass can interact with the results of cement components. This appears in the improvement of cement resistance when replaced with sand by 10%, where the resistance improved by an increase of 0.3%.
6) The results of the tests showed the inherent properties of the granules of the glass mill, such as surface tension, lack of absorption and low angle of the interior All these properties need extensive and in-depth studies that can help in the production of concrete mixtures with high efficiency.

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