Civil and Environmental Research
ISSN 2224-5790 (Paper) ISSN 2225-0514 (Online)
Vol.9, No.10, 2017

Effect of Recycling Waste Glass as Fine and Coarse Aggregate on Same Properties of Concrete

Asst.Lec. Jasim Jarallah Fahad AL- Kaabi
Al_Mustansiriya University, College of Engineering, Civil Department orcid.org/0000-0002-3529-047X

Abstract
This research aims to study the possibility of reuse of glass waste as a partial replacement in the first two cases, instead of fine aggregates and weight ratios (5%, 10%, 15%, and 20%) percent, in the second case a partial replacement of the coarse aggregates and the same proportions of the previous weight. The results showed that increasing the content of these wastes replaced by sand Resulted in a decrease in density and an increase in compressive strength at 28 days(16%,18%,27%,22%) respectively. The increase in splitting strength was 28 days (17%, 18.4%, 24.8%, 18%) respectively. The decrease in density was (1.5%,3%,4.4%,6%)respectively. The greatest effect was the compressive strength and splitting strength at 15% the replacement ratio. The results showed that increasing the content of these wastes replaced by gravel Resulted in a decrease in density and an increase in compressive strength at 28 days(12%,14%,16%,11%) respectively. The increase in splitting strength was 28 days (8.4%, 10.4%, 12%,8%) respectively. The decrease in density was(2.8%,4%,5.2%,6.4%)respectively. The greatest effect was the compressive strength and splitting strength at 15% the replacement ratio. The experimental results obtained from the modeling test showed that substituting the sand gave a higher density than replacing the gravel as well as compressive resistance and exhalation higher than gravel replacement.

Introduction
Many of the waste produced in cities today will remain in the environment for several years with the accumulation increasingly increasing with the escalating waste disposal crisis. One of the most successful solutions to this problem lies in waste recycling in useful products which generates a constant reduction of waste and reuse them. Many developed countries began to exploit and recycle waste and use it in the construction sector for the growth of this sector and its great need for construction materials. In this paper, the focus is on glass waste (bottles of gaseous gums and juices) Some of the researchers have studied the subject, for example,
1- **Dr. Haider K. Ammash** and others have studied the possibility of using glass waste and grinding it with a size greater than 5 mm in concrete. Glass waste was used as a partial replacement of sand (10%,20% 30% ,and 40%) in of the weight of the sand. The results of the study showed that with the increase in substitution, the resistance of tensile and tensile strength decreased by more than 20 and at 28 days, the erosion resistance decreased by 92 and 95 respectively. **(1)** .
2- **Gogg and Seri** also studied the effect of the use of glass waste powder in concrete on the permeability and the compressive and density resistance, where they concluded that the glass waste powder had a positive effect on increasing the operability, increasing compressive strength and low density **(2).**
3- **M. Iqbal Malik** and others**,** used glass waste as a partial replacement for sand used in concrete and (10%, 20% 30%, and 40%) of sand weight. Tensile strength,Durability, water absorption and density in 28 days. The study concluded that glass waste powder could be used as a partial replacement of sand and up to (30 %).**(3).**
4- **Tomas U. Ganiron**also conducted a pilot study on the impact of recycled glass waste and its use as a partial substitute for coarse aggregates In the concrete mix and studied the physical and mechanical properties. The study concluded that (5%) is the best and gives desirable results.**(4)**

The research aims to:
1. Recycle the glass waste and use it as a structural material in the concrete, a partial replacement of the sand or a partial replacement of the gravel.
2 - Study the effect of glass waste on the density of concrete, whether used instead of sand or gravel.
3- Study of the effect of glass residue on the resistance of compressive concrete in two cases (partial replacement of sand or partial replacement of gravel).
4 - Study the effect of glass waste on the resistance of concrete in two cases (a partial replacement of sand or gravel).
5 - Find the best proportion of the use of glass waste in concrete.

Search Plan
The research plan is based on the idea of recycling glass waste and using it as a aggregate in ordinary concrete in two cases. The first case is a partial replacement of the sand and a percentage of(5%, 10%, 15%,and 20%). 20 test cylinder to test the tensile strength 5 for each ratio and take the rate and calculated the density of each ratio

and take the rate in the same way, in addition to five reference cylinders without addition to the examination of compressive strength and five-millimeter to examine the tensile strength. The second case is a partial replacement of the gravel and a similar ratio of the number of cylinders tested to test the compressive strength, tensile strength and density. The mixing ratio of water / cement ratio was 0.5 for all mixtures.

Materials

1-Portland cement: is local, the first type that corresponds to the Iraqi specifications No. 5/1984, and was manufactured in cement factories in Najaf**.(5)**

2 - Coarse aggregate: The maximum amount of coarse aggregate (14) mm is used in this study. Classification of coarse aggregates conforms to the requirements of Iraqi specifications No. (45) for the year 1984**.(6)**

3- Fine aggregate: Local fine aggregate was used in the Akheider quarry with a maximum size of 4.75 mm which is within the requirements of Iraqi specifications No. (45) for the year 1984**.(6)**

4 - Glass waste which comes from recycling glass waste for empty bottles used for gaseous gums and juices. The Iraqi specifications for fine aggregates in case of use as fine aggregates and meets the requirements of Iraqi specifications for coarse aggregate in the case of use a coarse aggregate s.

5 - Mix Concrete mixtures containing 1.5: 3 (0.5) (cement, sand, pebbles) were applied to the cement respectively. The use of partial replacement of fine sand and gravel with glass waste and ratios (5, 10) , 15, 20) and reference blends without any replacement for comparison results..

Density

The density is(defined as the ratio of the mass of a substance to its total volume, we mean the volume of the material, including the open and closed pores). This is the property(expresses the weight of one cubic meter of matter (kg / m3))**(7).** The importance of this property is necessary in the conduct of structural calculations and according to loads and is linked to other properties such as compressive resistance, thermal insulation, sound and other important mechanical properties of the material. For these reasons, the density is necessary for each structural material. Also reduce the density material is one of the things that contribute to reducing the cost of foundation in this research, the use and recycling of glass waste was used as a partial replacement in two cases the first instead of partial sand and by(5%, 10%, 15% ,and 20%)results showed a decrease in density when replacing sand with glass waste as in table (1)and percentage(1.5%, 3%, 4.4%, and 6% respectively),with an increase in compressive strength except for 20%.This is a good structural thing . The results showed that the decrease in density is more pronounced when gravel is replaced by sand substitutes (2.8% ,4%, 5.2%,and 6.4%), respectively, observed the figures (2) and (3). For the same ratios, the researcher believes that the reason for the low density is normal because the specific weight and density of glass waste is less than Specific weight And the density of sand or gravel used in concrete, where the specific weight of glass waste is about 2.11 while the sand up to 2.61 and the density of glass waste is up to 2430 kg / m while the density of sand up to 2576 kg / m.

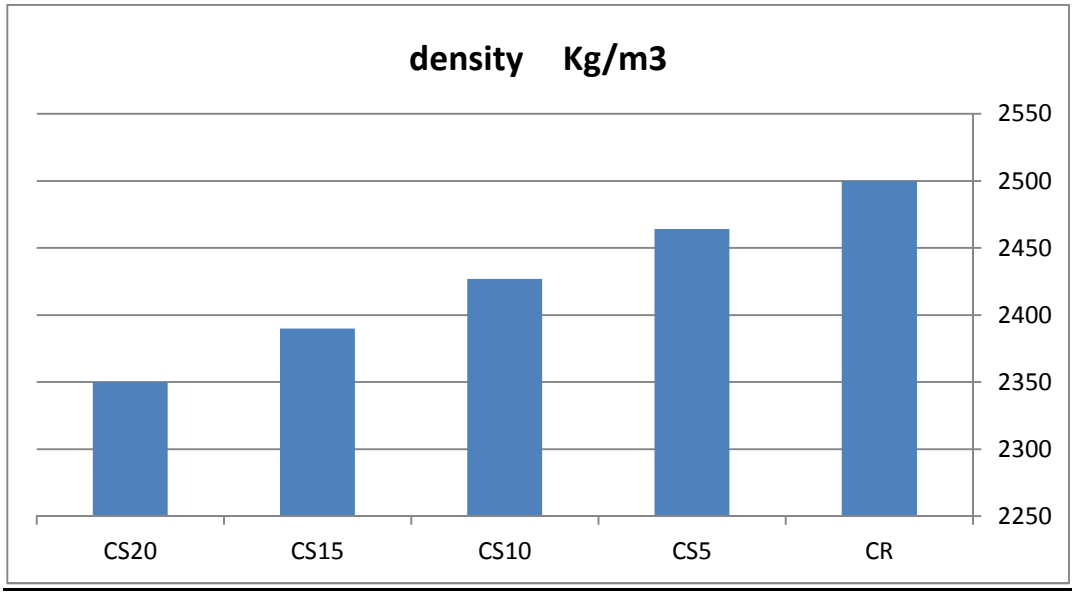
Table (1)shows the percentage of substitution for sand ,gravel and density per group as well as decrease in density as a percentage

Batch number	Types	Waste Glass Ratio by Weight of Gravel and Fine (%)	Density Kg/m^3	Reduction in Density (%)
	CR	-	2500	-
1	CS5	5%	2464	1.5
2	CS10	10%	2427	3
3	CS15	15%	2390	4.4
4	CS20	20%	2350	6.0
1	CC5	5%	2432	2.8
2	CC10	10%	2400	4.0
3	CC15	15%	2370	5.2
4	CC20	20%	2340	6.4

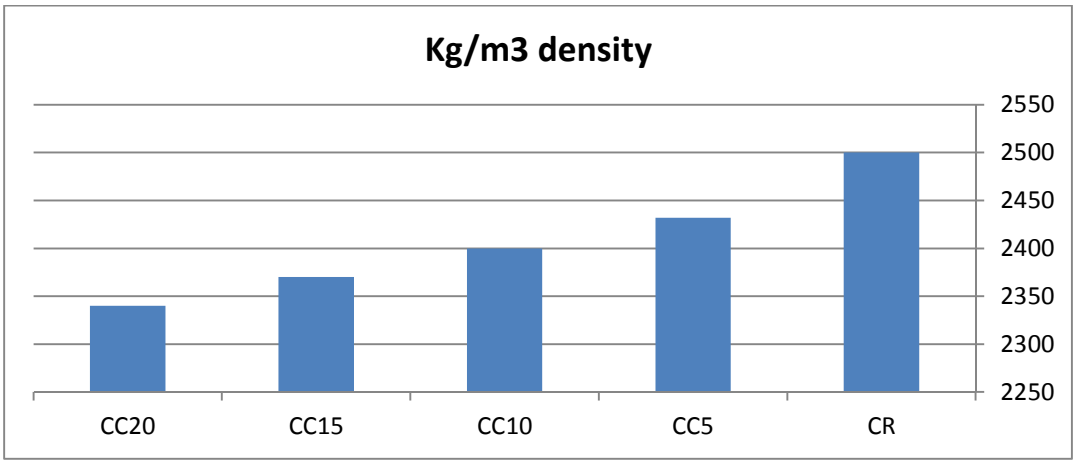
CR: Reference concrete

CS 5 : A partial Weight Replacement of Sand with Percentage of 5%

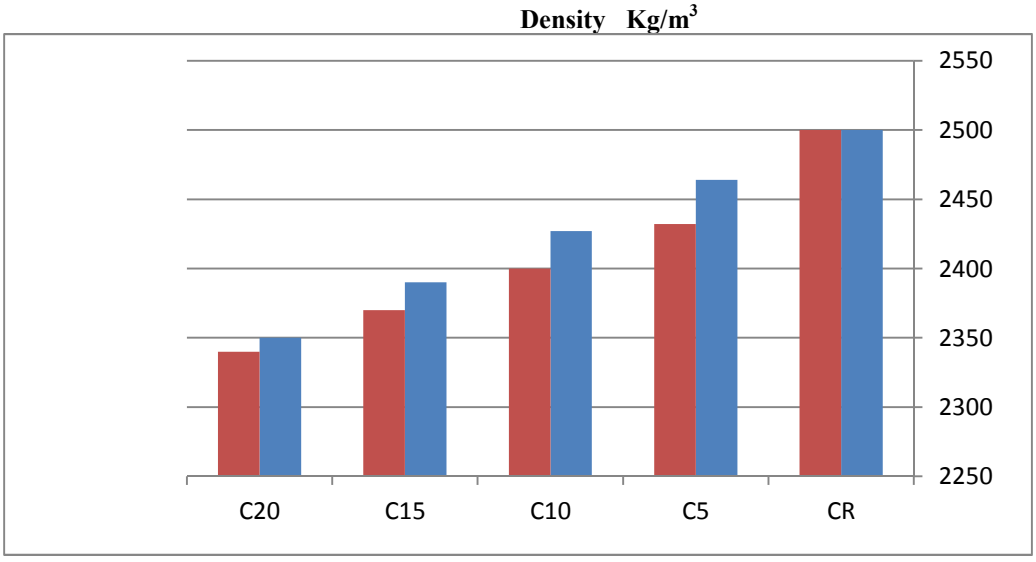
CC 5: A partial Weight Replacement of Gravel with Percentage of 5%



A figure (1) shows low density when substituting sand for glass waste.



A figure (2) shows low density when substituting gravel for glass waste.



A figure (3) shows a comparison between density when replacing sand and gravelwithglass waste.

Compressive Strength

Compressive Strength (the most important properties of hardened concrete is the quality and strength of concrete compressive Strength. is the mother resistance of hardened concrete as most properties improve and increase with compressive strength.) This test determines the stress compressive of the concrete after 28 days. The molds are lubricated for each set of models prior to the casting process and for each compressive strength level of 28 days, with iron cylinders of 150 x 300 mm were used for compressive strength testing according to the standard C39ASTM 86 **(8).** This research shows that when fine aggregate is replaced by (5%, 10%, 15% ,and 20%) of glass waste showed that compressive strength increased by(16%, 18%, 27% and 22%), respectively. These results are considered satisfactory and good with low observed density. As the percentage of glass residues increased, the compressive resistance increased to an optimal rate of(15%), where the resistance increased by (27%) and, then the increases of the replaced glass waste did not give the increase similar in resistance. The researcher believes that the reason for the increase in resistance is due to the form of granular glass residues, which are angular shape, which gave stronger cohesion with cement mortar shown table(2) observed the figures, No.(4, 5, and 6).

Table (2) shows the percentage of substitution for sand, gravel and Compressive Strength per group as well as decrease in Compressive Strengthas a percentage.

Batch number	Types	Waste Glass Ratio by Weight of Gravel and Fine (%)	Average Cylindrical Compressive Strength$fc`$ (MPa)	Reduction in Compressive Strength (%)
	CR	-	22	-
1	CS5	5%	25.6	16
2	CS10	10%	26	18
3	CS15	15%	28	27
4	CS20	20%	26.9	22
1	CC5	5%	24.7	12
2	CC10	10%	25.2	14
3	CC15	15%	25.5	16
4	CC20	20%	24.5	11

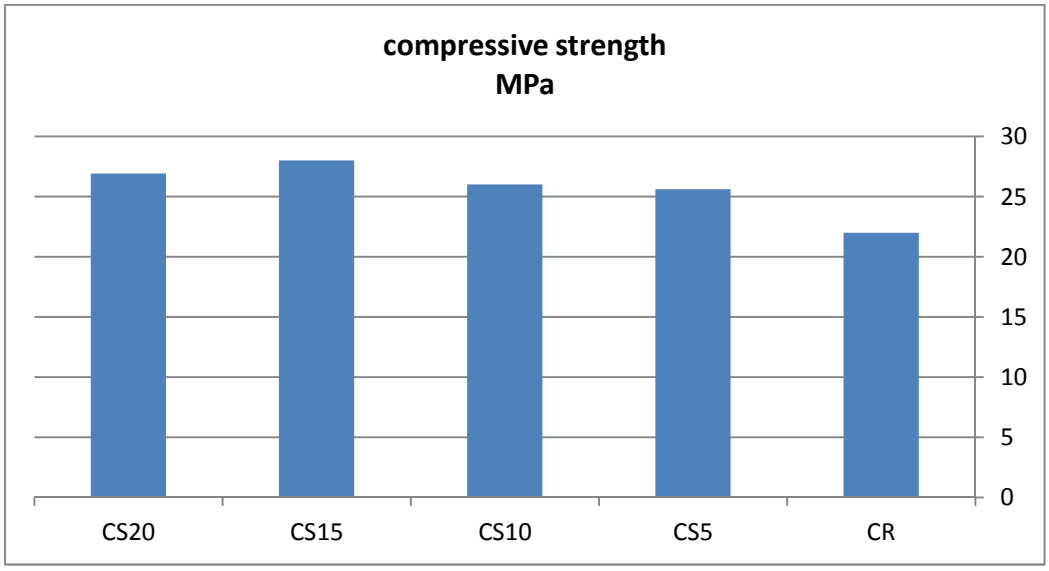


Figure (4) shows the increase in compressive strength when replacing sand with glass waste.

It is also observed that when the coarse gravel is replaced by (5%, 10%, 15% ,and 20%)glass waste, the same gradient has increased compressive strength for (12%, 14%, 16% and 11%) percent respectively. These results are satisfactory and acceptable with a decrease in density. The proportion of glass residues increases compressive strength up to the optimal ratio of(15%) as the resistance increased by (16%) and then the increase in the replacement glass waste did not give the corresponding increase in resistance. The researcher believes that the reason for the increase in resistance is due to the form of glass waste granules where they have an angular shape and the surface area is larger, gave stronger cohesion with cement mortar showntable 2 and look at Figure (5) .

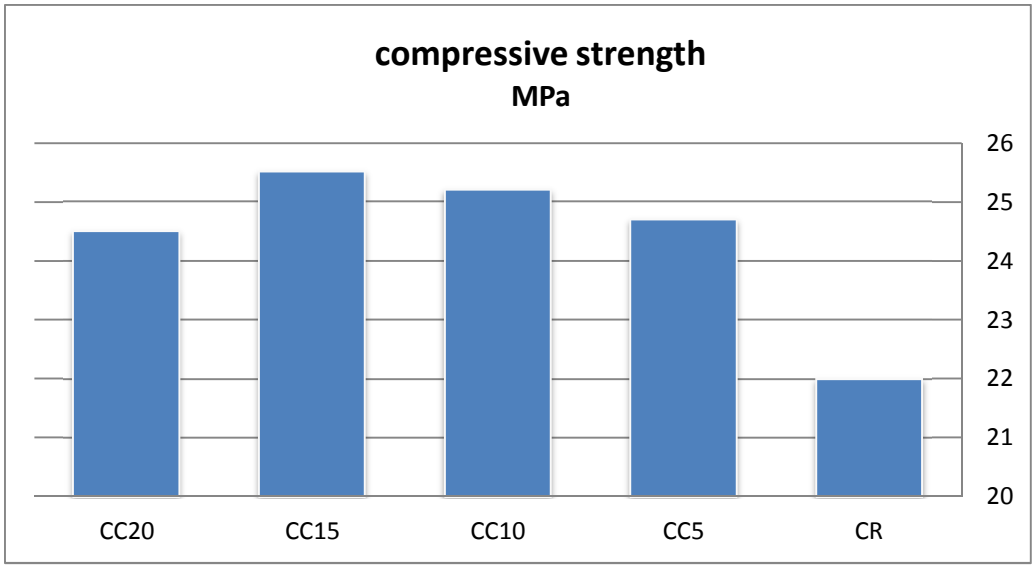


Figure (5) shows the increase in compressive strength when replacing gravel g with glass waste.

The results show that when comparing the fine sand substrate replacement ratios with the same replacement ratios for the coarse gravel, the replacement of the sand gave a higher resistance than replacing the gravel. The researcher believes that the reason is that fine grinding reduced the air gaps, and the small size of making the mortar cover the grain better and thus increased density and reflect positively on the resistance. Table(1), (2) shows this and figure(6) illustrates this as well.

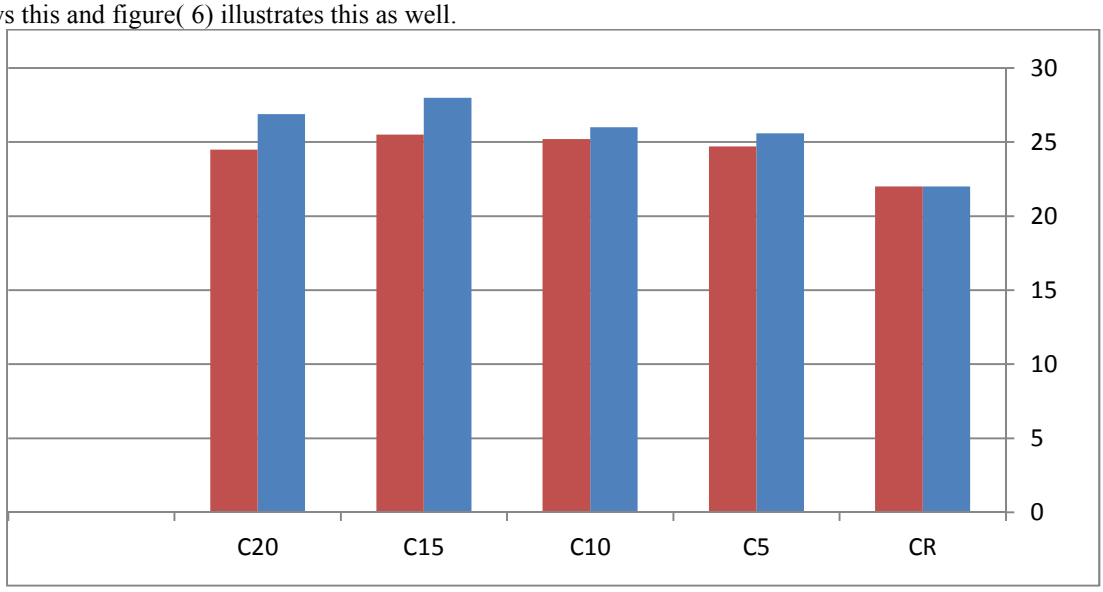


Figure (6) shows the comparison between compressive strength when replacing sand and gravel with glass waste of the same proportions.

Pictures Advice shown the scan used in the search.

Tensile Strength

The Splitting Tensile Strengthtest is (a strong pull of a reverse pull on the ends of the model to be examined, causing tensile stresses in the material and increasing the length of the model on the side parallel to the mounted force). **(9)** The Splitting tensile strength of the concrete is important because it greatly affects the size of cracks (10 - 15%) of the compressive strength is achieved in two ways:

1-Resistanceto tensile bending or the so calledmodulus of rupture.

2-Examination of Splitting tensile, which was conducted in this research and where examines a cylinder with a height of 30 and a diameter of 15 cm and break it in the compression device by putting pressure on it when its horizontal axis is horizontal and tensile stress is obtained from the low of elasticity theory using the following equation:

$$Cft=2p/\pi\ L\ d$$

(L) The length of the cylinder

(d) The diameter of the cylinder

((Cft) The Splitting Tensile stress (10)

The results of this research showed a positive increase in tensile strength, with a partial increase in sand substitutions with glass defects up to(15%), which is the best ratio. In use, more than that, the decrease in tensile strength has been shown.

The increase in tensile strength, The sand was (18.4%, 24.8%, 18.8% and 17%) percent respectively.The results of this study showed a positive increase in resistance with increased partial replacement of the gravel with glass irregularities up to (15%), which is the best ratio as in the previous case. When using more than that, the decrease in tensile strength began to appear. Replace the sand with a note that the tensile strength when substituting the sand was higher than the replacement of the gravel. The percentage increase in the partial replacement of the gravel was (8.4%, 12%, 10.4% and 8.4%) respectively, the equivalent of Table (3) and Figures(7, 8,and 9) respectively that the increase in tensile strength when replacing the partial sand and gravel with glass waste normal condition reason to increase the resistance and compression as the relationship between the tensile and compression resistance is a direct relationship and rely on..

$0.5\sqrt{\hat{f}c}$ الى $0.67\sqrt{\hat{f}c}$ In normal concrete.**(11)**

Table (3) shows the percentage of substitution for sand, gravel and Splitting Tensile Strength per group as well as decrease i Splitting Tensile Strength per n as a percentage.

Batch number	Types	Waste Glass Ratio by Weight of Gravel and Fine (%)	Average Cylindrical Splitting Tensile Strength (MPa)	Increasing in Splitting Tensile Strength (%)
	CR	-	2.5	-
1	CS5	5%	2.93	17
2	CS10	10%	2.96	18.4
3	CS15	15%	3.12	24.8
4	CS20	20%	2.96	18.4
1	CC5	5%	2.71	8.4
2	CC10	10%	2.76	10.4
3	CC15	15%	2.8	12
4	CC20	20%	2.7	8

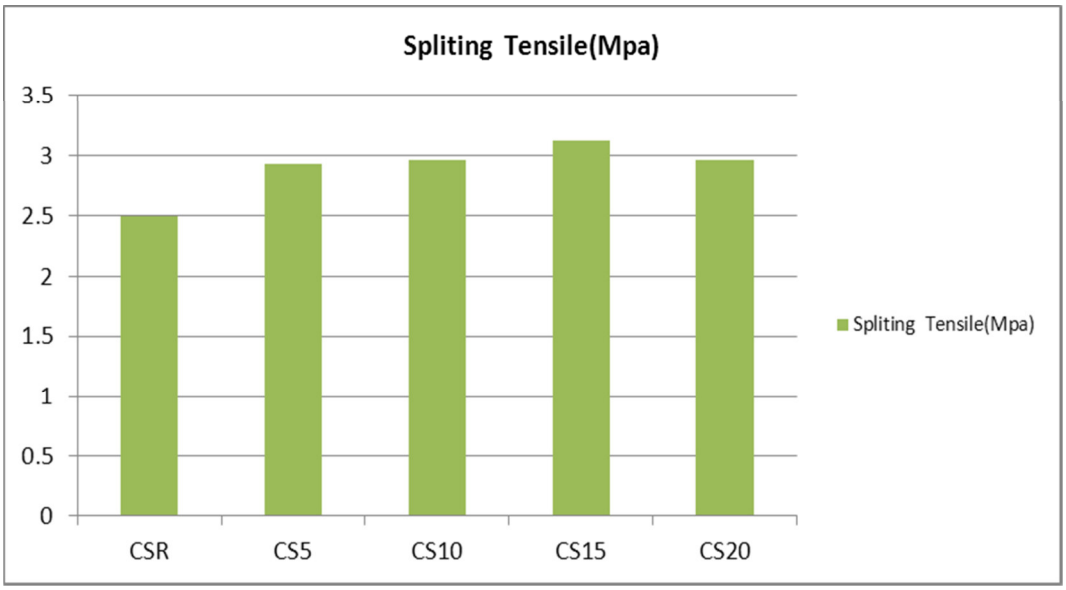


Figure (5) shows the increase inSplitting Tensile Strength when replacing sand with glass waste.

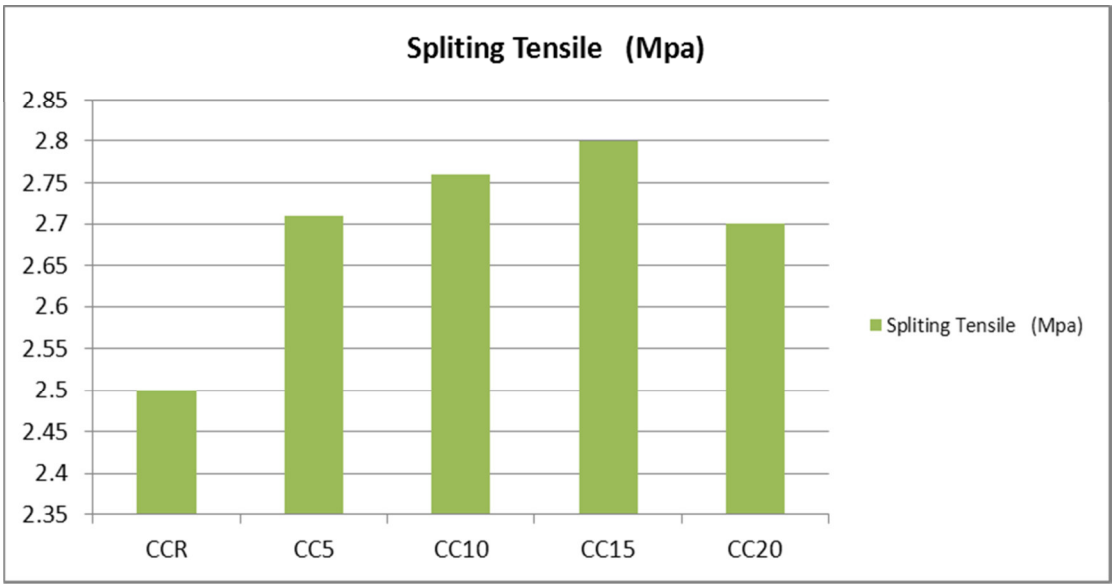


Figure (6) shows the increase in Splitting Tensile Strengthwhen replacinggravel with glass waste.

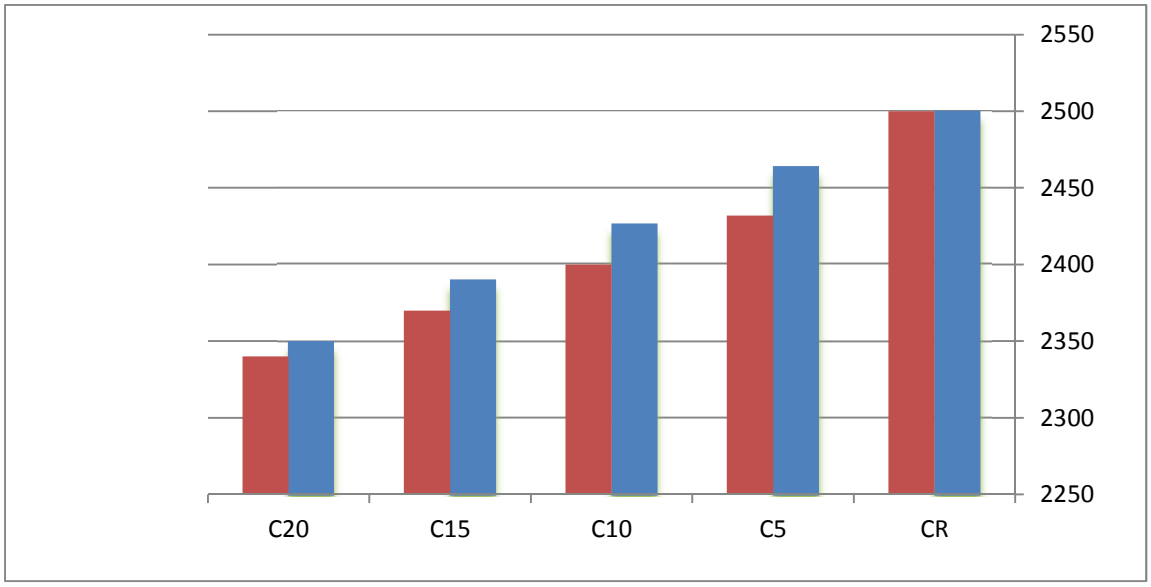


Figure (7) shows the comparison between Splitting Tensile strength when replacing sand and gravel with glass waste of the same proportions.

Conclusions

In this practical study, some important conclusions were reached which can be summarized in the following points:

1-The effect of recycle glass waste on the density of the concrete was positive as the density of the concrete decreased with the increase of partial replacement of sand (5%, 10% 15% and 20%). The results showed a decrease in density (1.5.3%, 4.4% and 6%) respectively.

2-The effect of recycle waste on the density of the concrete was also positive as the density of the concrete decreased with the increase in the partial replacement of the gravel (5%, 10%, 15%, and 20%). Where the results showed that the decline in density is more pronounced, when replacing the gravel, when replacing sand and proportions (2.8%, 4%, 5.2% and 6.4%), respectively.

3-The results showed that when partial replacement of sand by (5%, 10%, 15%,and 20%) glass waste that the compressive strength increased for (16%, 18%,27%,and 22%) respectively. These results were observed with a decrease in density. As the percentage of glass waste increased, the compressive strength increased to an optimal rate of (15%). The increase in replacement glass waste does not give the same increase in strength. It is also noticed that when the gravel is replaced by (5%, 10%, 15%, and 20%) glass waste that the compressive strength increased for (12%, 14%, 16% and 11% respectively). As the percentage of glass waste increased, compressive strength increased to an optimal ratio of (15%)where it increased for (16%)

4-The results of this research showed a positive increase in tensile strength with the increase of partial replacement of sand with glass irregularities up to (15%) which is the best ratio and when using a percentage more than that began to decrease in tensile strength shows that the increase in tensile strength as ratio (17%, 18.4%, 24.8%,and 18%) respectively. The results showed a positive increase in tensile strength with a partial increase in the replacement of the gravel with glass waste (15%), which is the best ratio as in the previous case and when using more than that, the decrease in tensile strength began .It similar to the case of replacing the sand with the note that the tensile strength when replacing the sand is higher than the replacement of gravel, and the percentage increase, when replacing the partial of the gravel is 8.4%,10.4%,12%,and 8.4%) respectively.(

5-This study gives positive results and encourages recycling industry glass waste and use in construction engineering, especially that this study is few in our countries.

References

(1)-Dr. Haider K. Ammash and others **"***Usingof Using Waste Glass as fine aggregate in concrete"* .Al-Qadisiya Journal for Engineering Sciences Vol. 2 No. 2009.

(2)- Gogg and Seri "*Performance of Using Waste Glass Powder In Concrete As Replacement Of Cement***".**American Journal of Engineering Research (AJER) e-ISSN : 2320-0847 p- ISSN : 2320-0936, Vol. 2 Issue-12, pp-175-181 2013.

(3)-M. Iqbal Malik, Muzafar Bashir, Sajad Ahmad, Tabish Tariq, Umar Chowdhary "*Study of Concrete Involving Use of Waste Glass as Partial Replacement of Fine Aggregates*". IOSR Journal of Engineering (IOSRJEN) e-ISSN: 2250-3021, p-ISSN: 2278-8719 Vol. 3, Issue 7, ||V6 ||, PP 08-13,(July. 2013).

(4)-Tomas U. Ganiron Jr "*The Effect of Waste Glass Bottles as an Alternative Coarse Aggregate in Concrete Mixture*". International journal of ICT –aided Architecture and Civil Engineernig Vol.1.No.2, PP1-10.(2014)

5- المواصفات العراقية رقم 5 / 1984

6- المواصفات العراقية رقم 45 لسنة 1984

7- الكودات العربية الموحدة لتصميم وتنفيذ المباني (العزل الحراري)2003

8- The standard C39ASTM 86

9-كتاب فحص المواد الانشائية **يوسف الدواف** الطبعة الثالثة1972

10- كتاب تصميم المباني الخرسانية المسلحة بموجب الكود الامريكي **الدكتور المهندس علاء التميمي**1999

11- كتاب تصميم المباني الخرسانية المسلحة بموجب الكود الامريكي مدرس **جمال عبد الواحد فرحان الظاهر** 2005