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Study and Evaluation of bricks made from the local sand using sodium silicate as binder

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Abstract:

In this study, a mixture of (sand and sodium silicate (ratio 4:1) was composed , where sodium silicate is used as a binding agent, and put in an furnace at different temperatures ranging from (200-1000 ^{0}C). It was observed that the density and compressive strength with increasing temperature up to 800 ^{0}C degrees where the compressive strength at its maximum of 12 MPa.

the effect of the waste glass used in the mixture was studied by adding different rates. It was observed that the density of the models increases with increased rates of waste glass, but at a temperature of 800 ^{0} C noted that density decreases with the increase in the proportion of the mixture, while there was a clear increase in the strength of compression of the models with increased rates of waste glass . Also the process of sintering was studied was developed models that have the same ratio (sand (52%), waste glass (28%), sodium silicate (20%)) in an oven at a temperature of 800 were the physical properties (density, compressive strength and volume) with the change of time (4-20) hr the result show that the density decreases with increasing temperature and also increased volume. The compression strength, decreases with time but at 16 hr it reaches a maximum of more than(6 MPa).

Keyword: silica , waste glass, sodium silicate, compressive strength.

1-Introduction

The uses of silica sand depend on its mineralogy, chemistry and physical properties. It is mainly used for making glass and glass fiber, silicon carbide, sodium silicate, Portland cement, silicon alloys and metals, filter media in water treatment, sand paper and also for foundry sand, hydraulic fracturing, sand blasting, paint and a host of other applications . A major portion of silica sand produced is consumed by glass industry. Important types of glasses made are sheet, flat, bottle, wired and figured, vacuum, laboratory, fiber, shell, flint, ophthalmic, beads etc. There exist both physical and chemical specifications for each use. American Ceramic Society and US Bureau of Standards also give detailed chemical specifications for silica sand for making different types of glasses. After glass, perhaps, maximum standardization has been made for foundry applications. Silica sand is used in both foundry cores and moulds because of its resistance to thermal shocks. Physical properties of the sand is far more important here than the chemical.

Silica content of 85% is used in iron castings while for steel foundries it should be minimum 95%. Silica particle volume distribution and grain shape are very important for foundry Application.

Impurities usually present in the silica sand are free and coated iron oxides, clay, titania and smaller amounts of sodium, potassium and calcium minerals. The iron, being the most detrimental impurity, can be reduced by a number of physical, physico-chemical or chemical methods, the most appropriate method depends on the mineralogical forms and distribution of iron in the ore [1-4].

At present, the problem of protection of the environment from industrial and domestic Waste glass acquires particular importance. This is why different technologies for neutralization and utilization large-scale wastes are being developed. However, down to present time even such traditional of technologies as reception of bricks [5-10] are constantly modified. And usig a sodium silicate gel as alternative nucleating agent. Sodium silicate gel can reach inside the pores of porous 3D architectures to be used on tissue replacement and in tissue engineering scaffolding [11–13].

Objective of the study is the production of building bricks from the local sand quarries located in Zubair in Basrah through the formation of a mixture of sand and waste glass, using a binder (sodium silicate) and reduce the melting point of the sand.

That the reason for the study is to find alternatives to the product of mud bricks as well as the disposal of waste by recycling glass.

And get a replacement can be used in everyday life as well as reduce the cost and investment of the sand available in the province of Basra. As well as reducing the time required for their production.

2- Experimental parts

2-1 **Sand sifting**: The sand was taken from sand quarry located in the western of Basrah, Zubair and sifted sand with sieve (diameter 600 μm) washed with water (albadd's water) more than once to rid of salts and impurities and dust in the sand.

2-2 **Drying the sand**: The sand is dried in the oven at a temperature of 100 ^{0}C for a period of 4 hrs to rid of moisture.

2-3 **Mixing process**: the sand is mixed with the sodium silicate(in the ratio 4:1).

2-4 **Pour samples**: The samples are a good mix at the rate of mentioned in paragraph(2-3), and then poured into samples of (5 × 5 ×5) mm were prepared in accordance with ASTM C109 [14],shown the fig. (1).

2-5**The burning process**: The samples are burned in a furnace at different temperatures for a period of 4 hrs for each degree (from 200 ^{0}C until 1000^{0}C), and at each degree the physical properties were calculated (The density and the compression strength) . Shown in the fig.(2).

2-6 **Add Glass minutes**: the waste glass was added waste glass which drop 600 μm to a mixture of(sand and sodium silicate) at different percentages , table (1). and the cubs are formation in the same way and burned in furnace at different temperatures (from 200 ^{0}C until 1000 ^{0}C) to each grade 4 hrs and then the physical properties are calculated.

2-7 **The process of sintering**: In this step was selected percentage symbol A_7, which consists of the following ratio (52% of sand , 28% of the waste glass and 20% of sodium silicate) was Pour several samples of this ratio in the same way the previous paragraph (4). The samples put in a furnace at a temperature of 800 ^{0}C and measured physical properties after every 4 hrs and up to 20 hrs..

Where the models suffer from shrinkage and expansion, which affect the mechanical properties and occur as a result of this phenomenon to the metaphase transitions have interpreted this phenomenon by several theories [15,5,16] during the burning process at the temperature (100-200) ^{0}C . Still underdeveloped moisture after the drying process.

2-8 The physical and mechanical examination of the prepared samples:

A- Density of the sample:

the dimensions of the samples were measured by using vernier Caliper to calculate the size of the samples; the density was calculated using the following equation [17]:

$$\rho = \frac{m}{V}$$

where m is the mass of the samples in Kg.

V is the size of the samples in cm^3. as in tables (1, 2).

B- **Measurements of compressive strength:** the compressive strength was calculated by test mark Industries HUMBOLDT Machine, U.S.A. and applying the following equation [18]:

$$P = \frac{F}{A}$$

where P is the compressive strength, F is the force in Newton applied by the machine and A is the area of the samples in mm^2.

3- Results and discussion

Figure (3) shows the density of the mixture (silica and sodium silicate) differed with the temperature. It was observed that the density decreases with increased temperature. We have shown the density is high at the temperature 200^0 C and the temperature increases we noted that the density decreased but slowly, the temperature continues to 800 ^{0}C the density is decreases by very fast until the temperature 1000^0 C, the reason is due to an increases in temperature leads to increased in expansion volumetric, but between the temperature (700 - 1000) ^{0}C gets change largely due to the rapid increase of volume with increased temperature as in fig. (4) .

Fig.(5) we have observed that the compression strength by using device of the mixture used (sand and sodium silicate).It was observed that the compression strength at a temperature of 200^0 C be high up 9MPa and the compression strength decreases in the range of the temperature (800 - 1000) ^{0}C and after this range of temperature the compression strength increases by high up12MPa, The compression strength is decreases after the temperature 850 ^{0}C after than the compression strength is increases, and the reason can be explained in the metaphase Transformations of silica described in Table (2).

Then, calculated the density as a function of the percentage for waste glass and temperature different, the added consumer glass (waste glass) to the mixture (sand and sodium silicates) and the percentage shown in Table (2).

Figure (6) we have observed the behavior for the density with the percentage waste glass for temperature different :

The density of the samples increases with increased the percentage for waste glass at the temperature 200^0 C and also 400^0 C and 600^0 C, but the density of the samples decreases with increased the waste glass at 800^0 C , This can be explained increased the molten low density glass and increase the volume that leads to the decreased of density.

fig. (7) The compression strength of the mixture (sand, sodium silicates and waste glass) at temperature 1000 ^{0}C, the compression strength of the samples (A1, A2, A3, A4, A5) increases with the percentage of waste glass in the mixture increased and in a clear and explicit. This can be explained on the basis of the increasing interdependence between the sand particles due to the increases amount of molten waste glass resulting from the increased in percentage weighted glass.

The percentage of waste glass increases lead to a low degree of melted sand particles, leading to greater overlap between the sand particles.

After then, we have studies the sintering samples of the mixture consisting of 28% per waste glass and placed samples in the furnace at the temperature raising to 800 ^{0}C. The different of the density of samples is studies with time at the temperature 800 ^{0}C shown in Fig. (8). We have observed that the density decreases with the time reach the lowest value after 12 hrs and the temperature remained constant and the density increased after 16 hrs as well as 20 hrs.

Fig. (9) observe The volume different with the time at the temperature 800 ^{0}C change of time, the behavior of the volume is opposite to the behavior of density. The calculated compression were calculated for samples in same steps strength of the mixture as in Figure (10).

Conclusions:

In this study, was examined the possibility of producing brick building of sand local alternative to bricks currently used in the construction and factory of mud where it was getting bricks have high specifications by measuring the compressibility of any bear high strength and low density, cheap cost and easy composition of the materials available locally as well as for the disposal of waste glass and materials employed in the production of an important and essential in the construction .

Fig.(1): a) Shows the template used for pouring samples, b) Shows the samples

Fig.(2): Change color of samples with a high temperature

Table (1) : The percentage of composites of prepared samples waste glass of the mixture .

Sample	Sand%	Waste glass%	sodium silicates%
A1	76	4	20
A2	72	8	20
A3	68	12	20
A4	64	16	20
A5	60	20	20
A6	56	24	20
A7	52	28	20
A8	48	32	20
A9	44	36	20
A10	40	40	20

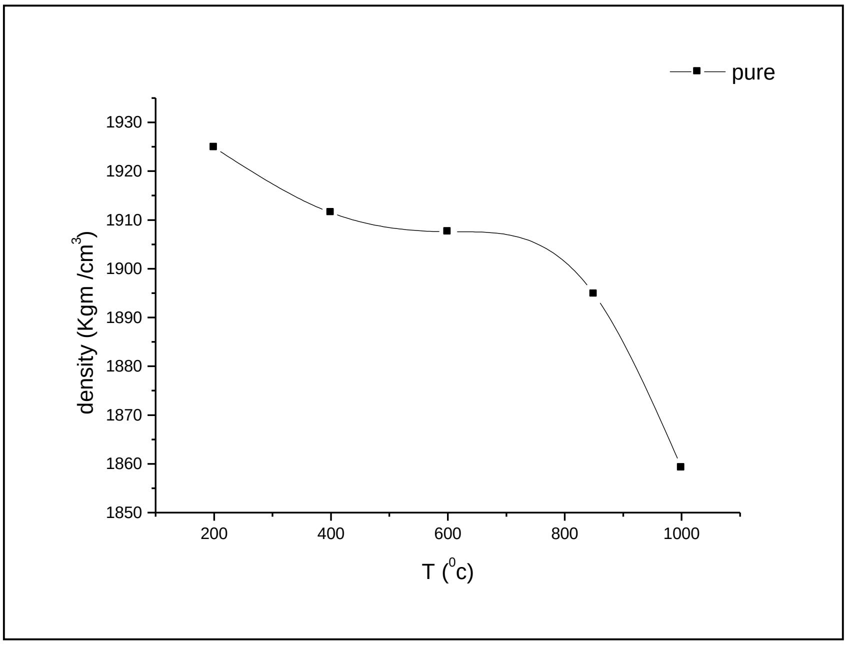

Fig.(3): Effect of temp. on the density of the prepared samples.

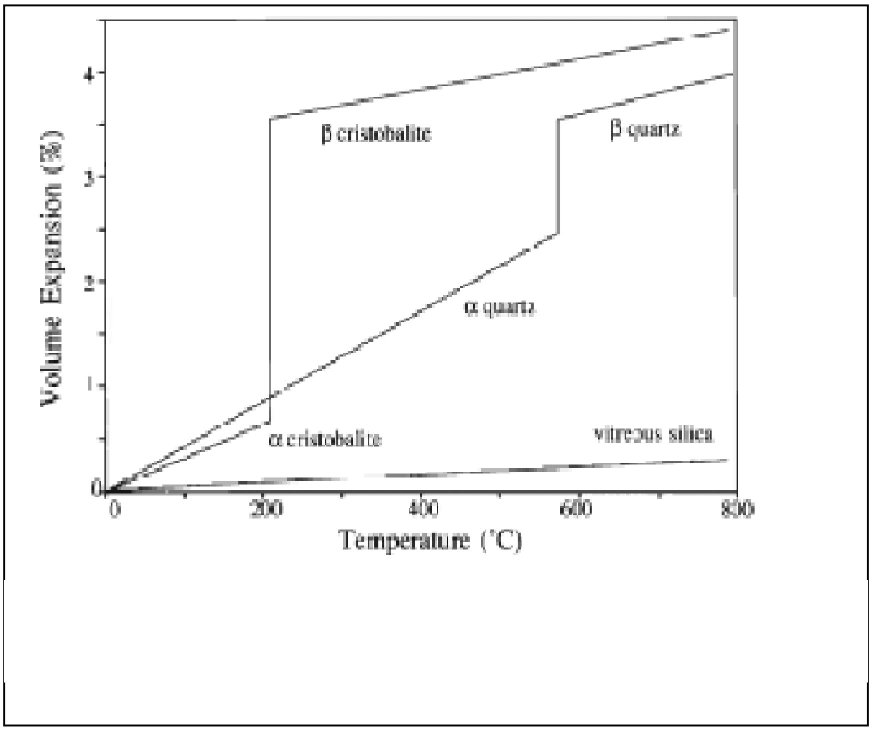

Fig.(4): volume thermal expansion of Various phases of silica [19].

Table (2) : the metaphase of silica [20].

Form	S.G	Temp(^{0}C)	To	S.G.	C.E
α- Quartz	2.65	573	B_1-Quartz	2.60	2.4
α- tridmite	2.32	117	β_1-Tridmite	2.32	0
β- tridmite	2.32	163	β_2-Tridmite	2.32	0
α -Cristobalite	2.32	220	β- Cristobalite	2.21	5.6
β_1-Quartz	2.60	870	Tridmite	2.32	12.7
β_2-Tridmite	2.32	1470	Cristobalite	2.21	5
β_1- Cristobalite	2.21	1128	Vitreous silica	2.21	0
α- Quartz	2.65	-----	Vitreous silica	2.21	20
β_1-Quartz	2.60	-----	Vitreous silica	2.21	17
β_1-Tridmite	----	-----	Vitreous silica	2.21	5
Quartz	----	1470	Liquid silica	-----	-----
Tridmite	----	1670	Liquid silica	-----	-----
Cristobalite	----	1710	Liquid silica	-----	-----
α-Quartz	2.65	------	α- tridmite	2.32	14.2
α-Quartz	2.65	------	α -Cristobalite	2.32	14.2

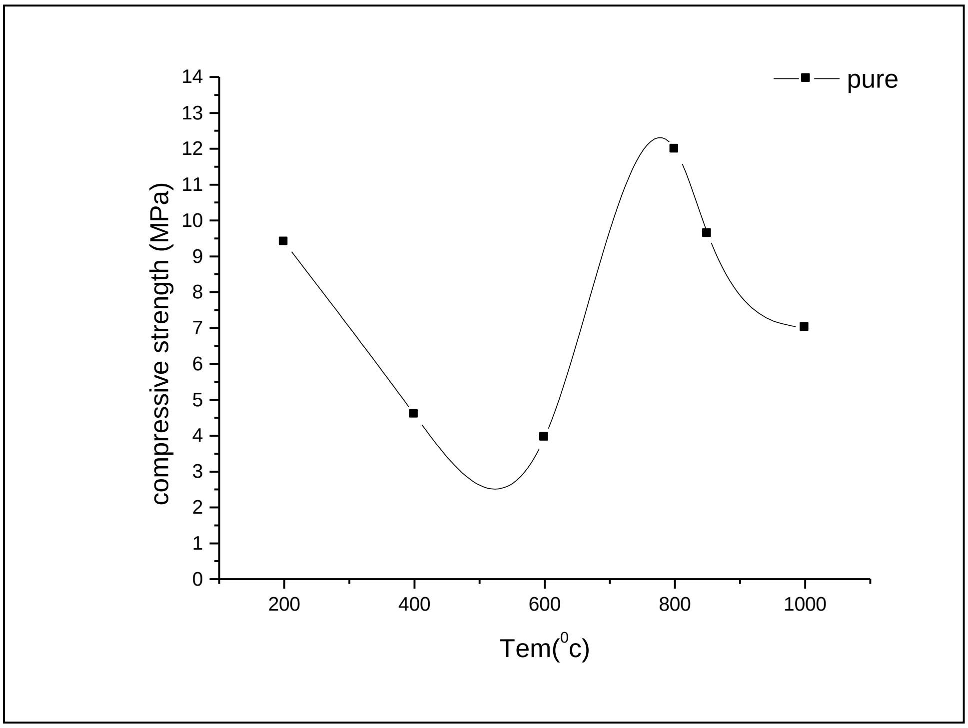

Fig.(5): Represent the compressive strength different with the temperature .

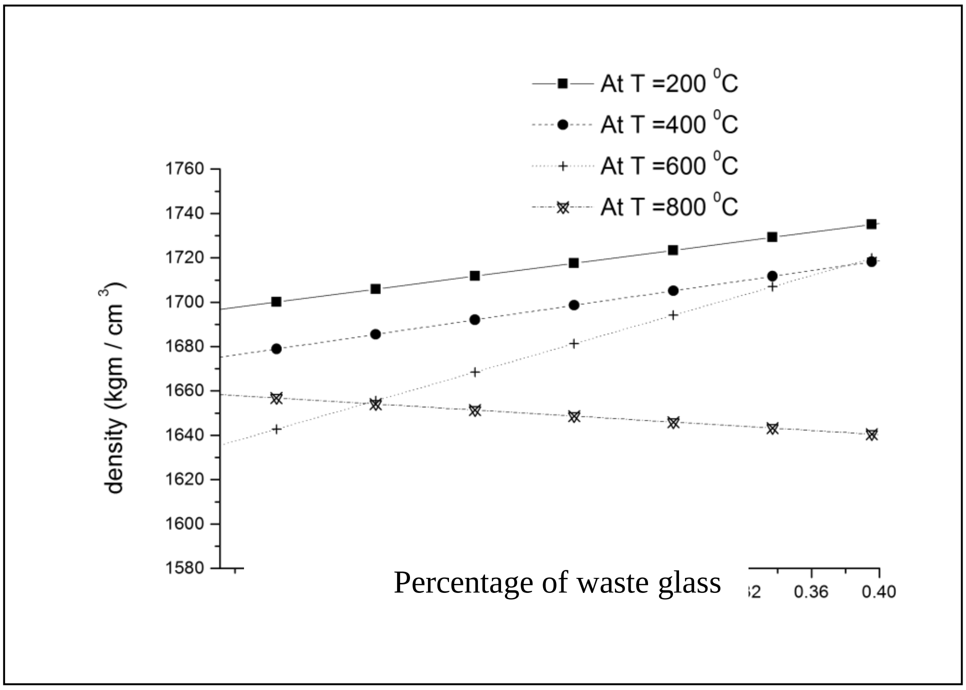

Fig.(6):Represent the density different with Percentage of waste glass and temperature.

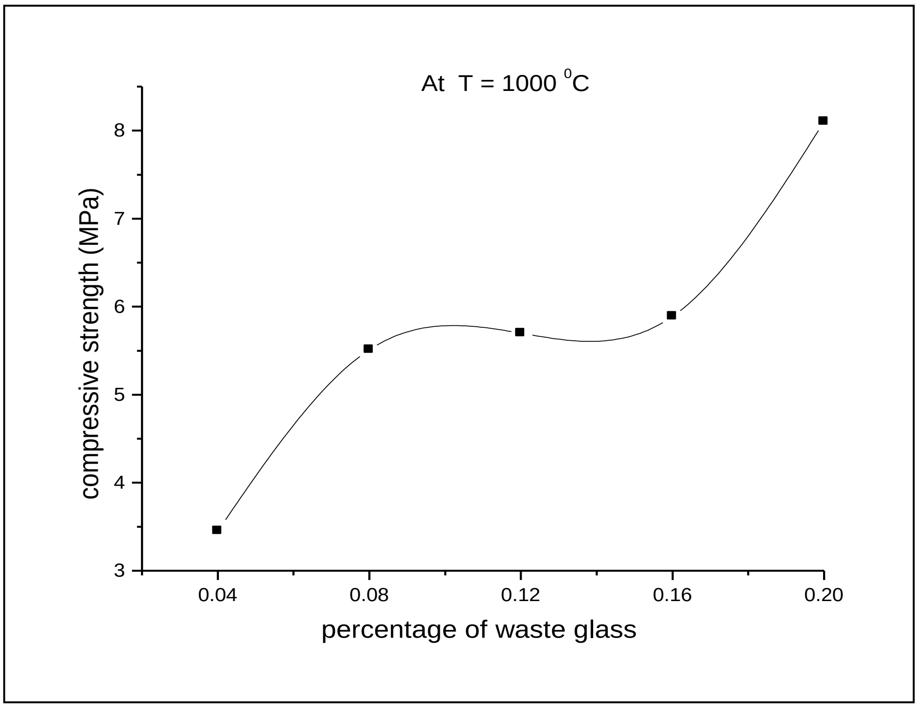

Fig.(7):Represent the compression strength different with Percentage of waste glass At T=1000^{0}C .

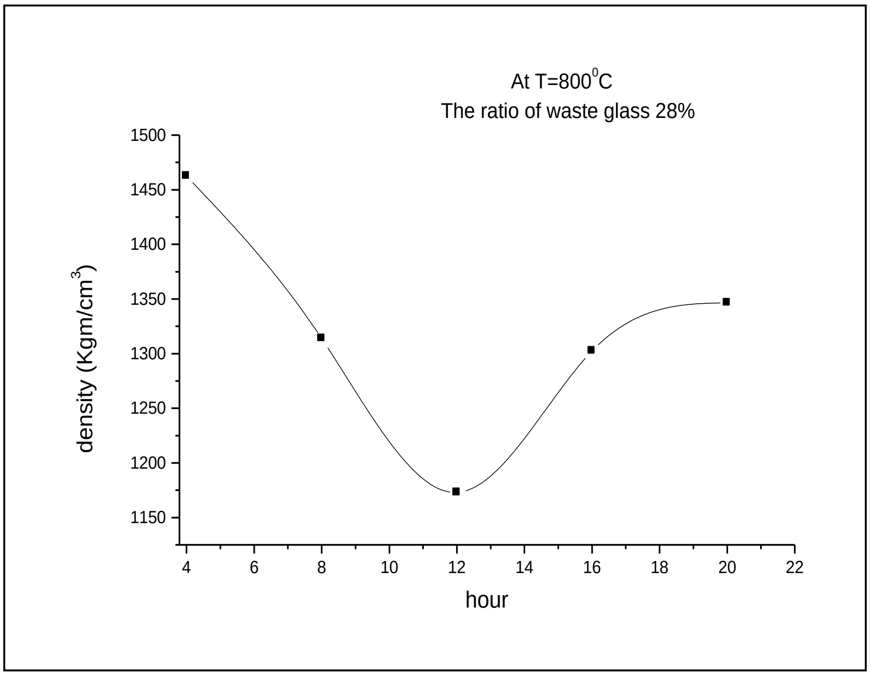

Fig.(8):Represent the density different with The Time At T=800^{0}C and the ratio of waste glass (28%)

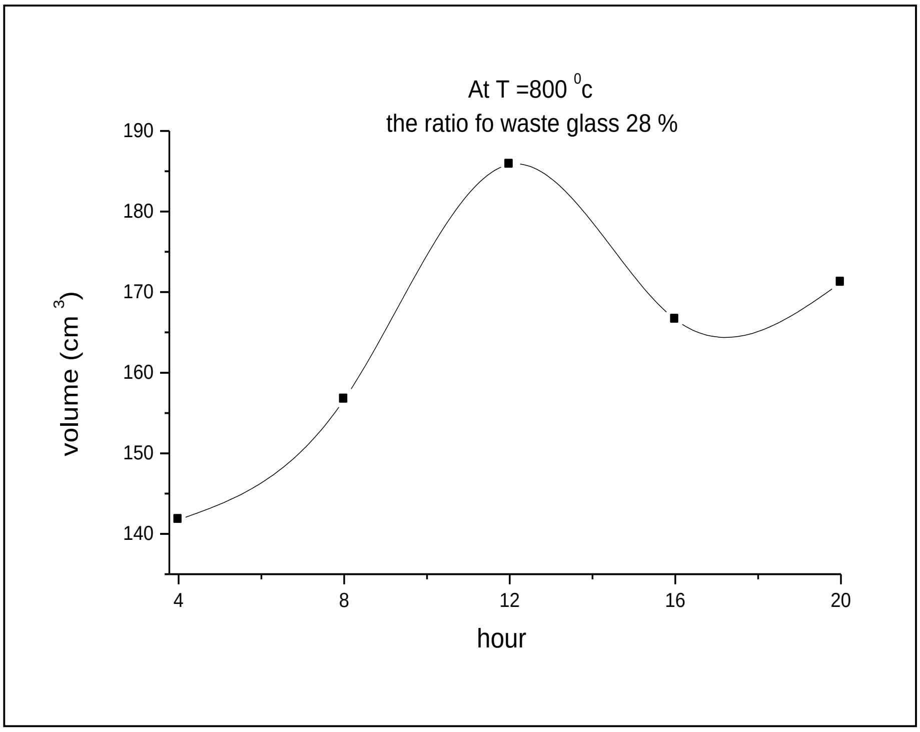

Fig.(9):Represent the volume different the Time At T=800^{0}C and the percentage of waste glass (28%)with

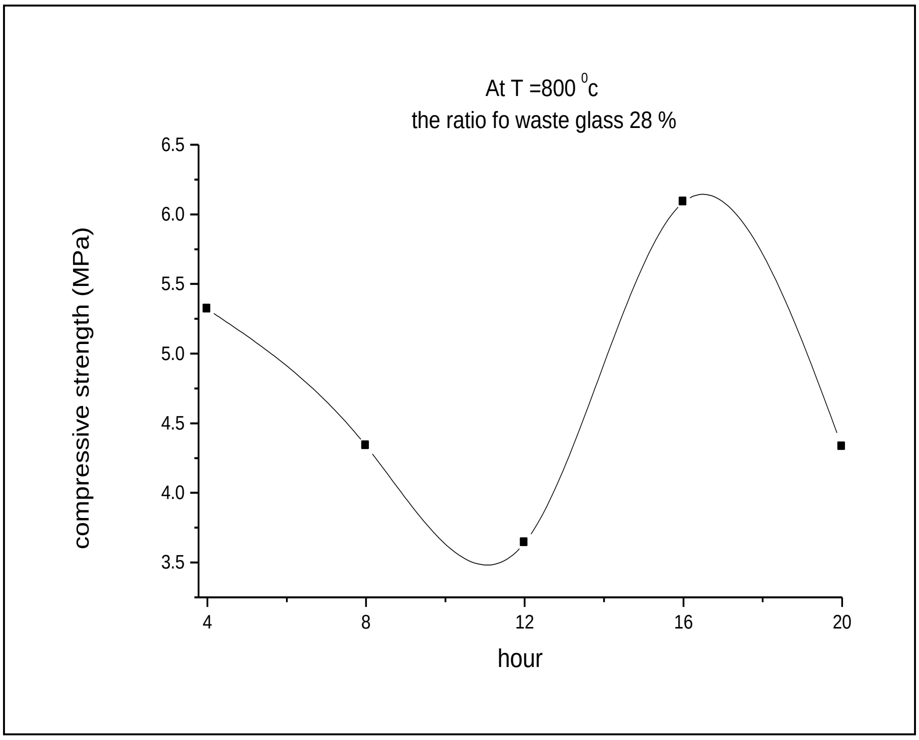

Fig.(10):Represent the compression strength different with the Time At T=800^{0}C and the percentage of waste glass (28%)

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دراسة وتقييم طابوق البناء مصنع من الرمال المحلية باستخدام سيليكات الصوديوم كرابط

تاريخ الاستلام : 2012\5\27 **تاريخ القبول :2013\11\27**

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الخلاصة :-

في هذه الدراسة ، تم عمل خليط متكون من (الرمل و سليكات الصوديوم (بنسب 1:4) حيث استعملت سليكات الصوديوم كمادة رابطة ووضع الخليط في فرن عند درجات حرارة مختلفة تتراوح ^{0}C (200-1000) حيث لوحظ نقصان الكثافة وقوة الانضغاط بزيادة درجة الحرارة حتى درجة ^{0}C 800 حيث تكون مقاومة الانضغاط أعلى ما يمكن وتصل إلى 12 MPa.

درس تأثير إضافة نفايات الزجاج إلى الخليط وبنسب مختلفة حيث لوحظ زيادة الكثافة للنماذج مع زيادة نسب نفايات الزجاج ولكن عند درجة حرارة ^{0}C 800 نلاحظ نقصان الكثافة مع زيادة نسبة الخليط بينما سجلت زيادة في قوة الانضغاط للنماذج مع زيادة نسب نفايات الزجاج وبشكل واضح ، بعد ذلك درست عملية التلبيد حيث وضعت النماذج التي لها نفس النسبة (الرمل (52%)، نفايات الزجاج (28 %) ، سليكات الصوديوم (% 20)) في فرن عند درجة حرارة^{0}C 800 وتم دراسة الخواص (الكثافة ومقاومة الانضغاط والحجم) مع تغير الزمن hr (20 -4) حيث لاحظنا إن الكثافة تقل مع زيادة درجة الحرارة وكذلك نلاحظ زيادة الحجم ، أما قوة الانضغاط فأنه تقل مع الزمن ولكن عند 16 hr تصل أكثر من 6 MPa.

الكلمات المفتاحية: السيليكا، نفايات الزجاج، سيليكات الصوديوم، قوة الضغط.