Journal of Engineering and Sustainable Development

Vol. 23, No.06, November 2019
ISSN 2520-0917
https://doi.org/10.31272/jeasd.23.6.5

MANUFACTURING GREEN CEMENTING MATERIAL

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Received 18/10/2017 Accepted in revised form 31/1/2018 Published 1/ 11/2019

Abstract: Construction and Demolition (C&D) waste constitutes a major portion of total solid waste production in the world. The main purpose of this research is to study the effect of addition of waste Yellow Clay brick powder (CBP) on the behavior of cement mortar and concrete of Grade (C25) at both conditions; fresh and hardened on the mechanical properties of concrete through by using of different partial replacement of powdered brick with cement until 100 percent by weight (0% , 5% , 10% , 15% , 20% , 25% , 50% and 100%) to produce concrete and to reduce the impact on environment by consuming the material generally considered as waste product. The yellow clay brick was crushed and grinded manually and also sieve through 75µm sieve size in order to be fineness as cement. Cubes of size 150mm x 150mm x 150mm, Cylinders of size 300mm x 150mm and prisms of size 100mm x 100mm x 500mm were casted and tested, different ratios of waste CBP have been used to study its effect on the workability (slump flow), compressive strength and splitting tensile strength for 7, 14 and 28 days; and the modulus of rupture for 28 days. The results compared with the reference specimens and study the relationship between the mechanical properties of concrete.

Keywords: *Brick Dust, Waste clay bricks, Replacement, Construction and Demolition, Workability, Mechanical Strength.*

أنتاج المواد الخضراء الأسمنتية

الخلاصة: تشكل مخلفات البناء والهدم جزءا كبيرا من إجمالي إنتاج النفايات الصلبة في العالم. الهدف الرئيسي من هذا البحث هو دراسة تأثير إضافة مخلفات طابوق البناء الاصفر الطيني كمسحوق (CBP) على سلوك مونة الاسمنت والخرسانة ذات الصنف (C25) في مرحلة الخرسانة اللينة و في مرحلة الخرسانة المتصلبة وتأثيرها على الخواص الميكانيكية للخرسانة من خلال أستخدام مسحوق مخلفات الطابوق بنسب أستبدال مختلفة من وزن الأسمنت الى الاستبدال الكلي للأسمنت في الخلطة الخرسانية (0%, 5%, 10%, 15%, 20%, 25%, 50% الى 100%) لإنتاج خرسانة مستدامة وتقليل التأثير على البيئة من خلال استهلاك المواد التي تعتبر عموما مخلفات البناء. تم تكسير و سحق مخلفات طابوق البناء ومن ثم طحنها وأستخدام المسحوق العابر من الغربال 75µm من أجل أن تكون نعومة المسحوق كنعومة الاسمنت. مكعبات خرسانية حجم 150 ملم × 150 ملم × 150 ملم، اسطوانات خرسانية حجم 300 ملم × 150 ملم ومناشير حجم 100 ملم × 100 ملم × 500 ملم تم صبها واختبارها بأستخدام نسب مختلفة من مخلفات الطابوق الطيني (CBP) لدراسة تأثيرها على قابلية التشغيل، مقاومة الانضغاط وقوة الشد بعمر 7، 14 و 28 يوما؛ ومعامل الكسر بعمر 28 يوما. النتائج مقارنة مع العينات المرجعية ودراسة العلاقة بين الخواص الميكانيكية للخرسانة. تكمن أهمية البحث في أستخدام الفضلات الناتجة من الطابوق في أنتاج خرسانة عادية مما يساهم في تأمين البيئة من هذه المخلفات بالاضافة الى تقليص كميات السمنت المستخدمة في صناعة الخرسانة مما يقلل أيضا من أنبعاثات غاز CO_2 الناتج من تصنيع السمنت . أما الاضافة التي أسهم فيها هي أستخدام الفضلات كبديل عن السمنت وبنسبة تصل الى 10% مع حدوث أنخفاض بسيط في خواص الخرسانة مقارنة مع الخرسانة العادية . تكمن أهمية البحث في أستخدام الفضلات الناتجة من الطابوق في أنتاج خرسانة عادية مما يساهم في تأمين البيئة من هذه المخلفات بالاضافة الى تقليص كميات السمنت المستخدمة في صناعة الخرسانة مما يقلل أيضا من أنبعاثات غاز CO_2 الناتج من تصنيع السمنت . أما الاضافة التي أسهم فيها هي أستخدام الفضلات كبديل عن السمنت وبنسبة تصل الى 10% مع حدوث أنخفاض بسيط في خواص الخرسانة مقارنة مع الخرسانة العادية .

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1. Introduction

Cement and aggregate, which are the most important constituents used in concrete production, are the vital materials needed for the construction industry. This inevitably has led to a continuous and increasing demand of natural materials used for their production. Parallel to the need for the utilization of the natural resources emerges a growing concern for protecting the environment and a need to preserve natural resources, such as cement, by using alternative materials that are either recycled or discarded as a waste.

Reduction of Portland cement without reducing performance of concrete is very important for huge projects that need a lot of cement. Today, pozzolana and cementitious materials plays an important role in concrete. Wastes of industries and constructions which have pozzolanic or cementitious property, not only can reduce environmental pollution and energy consumption of construction industry, but also make it cheap.

According to some authors the best way for the construction industry to become a more sustainable one is by using wastes from other industries as building materials[1-3]. Portland cement clinker production consumes large amounts of energy (850 kcal per kg of clinker) and has a considerable environmental impact. This involves massive quarrying for raw materials (limestone, clay, etc.), as it takes 1.7 tones to produce 1 ton of clinker, as well as the emission of greenhouse and other gases (NOx, SO_2, CO_2) into the atmosphere. Around 850kg of CO_2 are emitted per ton of clinker produced[4]. Therefore, the replacement concrete by brick wastes represents a tremendous saving of energy and has important environmental benefits. Besides, it will also have a major effect on decreasing concrete costs, since the cost of cement represents more than 30 percent of the concrete cost.

The waste materials of clay bricks are usually come in different ways. Some are created in factories during and after the production process as a result of human mistakes, inappropriate materials, or a mistake in production process, some others are formed in transportation and distribution stage and finally a large part of waste materials are formed as a result of destroying buildings. The amount of waste materials may account to millions of tons annually.

Many researches were conducted to use waste clay brick materials in concrete industry, A.H.Swaroop. et.al.[5]; investigated the effectiveness on durability characteristics of concrete developed by using brick powder (BP) and quarry dust (QD) , In the backdrop of such a bleak atmosphere, there is large demand for alternative materials from waste. Secondary cementing materials like Brick Powder can be used to partially replace cement because of pozzolanic nature. Materials like quarry dust best suites to sand due to its physical and chemical properties, fineness etc. Also these materials are known to increase durability, resistance to sulphate attack and Alkali-Silica reaction(ASR). In their work, used different mixes of concrete considered are :

1. Conventional aggregate concrete (CCA)
2. Concrete made by replacing 10% cement BP…... (CBP10)
3. Concrete made by replacing 10% with BP and 10% QD…... (CB10Q10)

4. Concrete made by replacing 10% with BP and 15% QD…..(CB10Q15)
5. Concrete made by replacing 10% with BP and 20% QD…..(CB10Q20)
6. Concrete made by replacing 15% cement with BP..…(CBP15)
7. Concrete made by replacing 15% with BP and 10% QD…..(CB15Q10)
8. Concrete made by replacing 15% with BP and 20% QD…..(CB15Q20)
9. Concrete made by replacing 15% with BP and 30% QD…..(CB15Q30)

Their result showed that the brick powder (BP) and quarry dust (QD) For all types of mixes considered always an increase in strength is seen for both 7, 28 & 120 days curing.

M. Usha Rani, et al[6]; this study aimed to investigate the suitability of using crushed brick in concrete. Crushed brick originated from demolished masonry was crushed in the laboratory and added partial sand replacement. Three replacement levels, 15%,20% and 25%, were compared with the control. The tests on concrete showed that the mechanical properties (compressive, flexural and splitting tensile strengths) of concrete containing crushed brick were well comparable to those of the concrete without ground brick. The main focus of the research is to present additional information in the field of recycling clay masonry rubbles in order to explore the possible uses of these recyclable materials in structural applications.

A.Naceria, et al.[7]; showed that the quantity of pozzalanic admixture (waste brick) of cement manufactured is the principal parameter who influences on the variation of the physic-chemical properties of the cement tested.

This paper presents a preliminary study on the assessment of the pozzolanic activity of waste bricks powder as well as its potential use in concrete as a partial replacement of cement. A series of tests were conducted to study the pozzolanic activity and the compressive strength tests were to monitor the strength development of the concrete at different ages containing from 5 to 100 percent bricks powder as cement replacement. The other objective is to reduce the cost of construction but also helps to reduce the impact on environment by consuming the material generally considered as waste product.

2. Experimental Program

2.1. Materials Used

2.1.1 Cement

Ordinary Portland cement (OPC) type (I) manufactured at northern cement factory Bazin, Al-Sulaimaniya / Iraq with the trademark of (Al-mass) has been used in this investigation. It was stored in dry place to minimize the effect of humidity on cement properties and it was tested by National Center for Construction Laboratories (NCCL) / Central Baghdad Laboratory. Tables (1) and (2) show the chemical composition and main compounds, and physical properties of the cement used throughout this work respectively. The test results show that the used cement conforms to the requirements of the Iraqi Standard Specification (I.O.S No.5/1984-Type I)[8].

Table (1) Chemical Composition and main compounds of Al-mass ordinary Portland cement used throughout this work.

Oxide Composition	% by weight	Limits of Iraqi specification No.5:1984[8]
Silica Dioxide (SiO_2)	21.61	-
Lime (CaO)	64.23	-
Magnesia Oxide (MgO)	2.28	<5.0
Iron Oxide (Fe_2O_3)	3.30	-
Alumina Trioxide (Al_2O_3)	4.97	-
Sulphate (SO_3)	2.65	<2.8
Loss on ignition (L.O.I)	1.90	<4.0
Insoluble residue (I.R)	0.85	<1.5
Time saturation factor (L.S.F)	0.909	0.66 – 1.02
Main Compounds (Bogue´s equation) %by weight of cement		
Tricalcium Silicate (C_3S)	51.510	-
Dicalcium Silicate (C_2S)	23.182	-
Tricalcium Aluminate (C_3A)	7.593	-
Tetracalcium Alumino-Ferrite (C_4AF)	10.032	-

Table (2) Physical Properties of Al-mass Ordinary Portland Cement used throughout this work

Physical Properties	Test result	Limits of Iraqi specification No.5:1984[8]
Fineness (m^2/kg) by Blaine method	335	≥ 230
Setting time (Vicat´s method)		
Initial setting (min)	150	≥ 45 min
Final setting (hrs.)	4:40	≤ 10 hrs
Compressive strength for cement mortar cube (70.7)mm at, MN/m^2		
3 days	30.0	> 15
7 days	39.5	> 23
Soundness using Auto clave%	0.03	< 0.8

2.1.2 Clay brick powder

The waste clay bricks (WCBs) used in the investigation were taken from the demolished building. The WCBs were converted into the same size of aggregates, then, the products were placed inside the impact crusher, after that, ground and softening the products to different average particle size were converted into fine powder. After grinding, which has been sieved and grains passing through 75micron was the primary material used, Fig.(1 & 2). The waste clay bricks types used derived from a variety of sources in Iraq, and are referred to as Yellow Clay Brick (YCB). The chemical compositions of Yellow clay brick powder (YCBP) was analyzed and results obtained are reported in Table 3.

Plate 1. Step's of crushing and grounding the WCBs

Plate 2. Step's of sieving and grains passing through 75µm

Table (3): The chemical composition of CBP* (wt.%)

Composition	YCBP
SiO_2	40.60 %
Al_2O_3	12.00 %
Fe_2O_3	4.93 %
CaO	28.10 %
Na_2O	1.30 %
K_2O	0.87 %
MgO	5.16 %
TiO_2	0.56 %
P_2O_5	0.17 %
SO_3	5.31 %
L.O.I	1.21 %

* The chemical composition tests were made by the Central Laboratories Department for Iraq Geological Survey

2.1.3 Fine Aggregate

From Al-Ukhaider region, Karbalaa-Iraq, natural sand is used in this study which has fineness modulus of (3.18) and specific gravity (2.63). The grading of the fine aggregate was checked according to Iraqi Standard Specification (No.45: 1984)[9]. Table (4) show the sieve analysis and the grading curve of fine aggregate. Table (5) shows the physical properties of the fine aggregate that are performed by National Center for Construction Laboratories (NCCL) / Central Baghdad Laboratory.

Table (4) Sieve analysis of fine aggregate (Zone 2)

Sieve size mm (I.S.S No.23)[10]	% passing by weight	Limits of Iraqi standard specification No. 45:1984[9] (Zone 2)
10	100	100
4.75	92	90-100
2.36	75	75-100
1.18	56	55-90
0.6	38	35-59
0.3	16	8-30
0.15	5	0-10
Pan	0	-

Table (5) Physical properties of fine aggregate

Physical properties	Test result	Limit of Iraqi specification No.45:1984[9]
Specific gravity	2.63	-
Sulphate content as SO_3	0.194%	0.5% (max)
Fineness modulus	3.18	
Fine materials passing from sieve (75µm)	2.2%	5% (max)
Dry rodded density kg/m^3	1715	-
Absorption	2%	
Moisture content	1.4	

2.1.4 Coarse Aggregate

Natural crushed coarse aggregate of maximum size 10 mm was used in this research. It was brought from AL–Badrah region. The gradation, specific gravity, density and sulphate content were tested. The properties of natural coarse aggregate used are show in Tables (6,7). The results demonstrate that the grading and sulphate content of the coarse aggregate conform to the requirements of Iraqi Standard No. 45/1984[9] and it was tested by National Center for Construction Laboratories (NCCL) / Central Baghdad Laboratory

Table (6) Sieve analysis of natural coarse aggregate

Sieve size mm	% passing by weight	Limits of Iraqi standard specification No. 45:1984[9]
20	100	100
14	99	90-100
10	86	50-85
5	4.1	0-10
2.36	-	-

Table (7) Physical properties of natural coarse aggregate

Physical properties	Test result	Limit of Iraqi specification No.45:1984[9]
Specific gravity	2.65	-
Sulphate content as SO_3	0.034%	≤ 0.1%
Fine materials passing from sieve (75μm)	0.4	-
Compacted bulk density kg/m^3	1575	-
Absorption	0.7%	-

2.1.5 Water

The water used in the mix preparation and curing the specimens of concrete for 7,14 and 28 days was potable water from the water-supply network system (tap water).

2.2. Concrete Mix Design

A reference mix was made with ordinary Portland cement (a concrete without waste brick powder material), and proportioned according to the ACI 211.1-91[11] . The specified minimum compressive strength at 28 days for this mix was 25 MPa. (M25). Many trail mixes were adopted to check the required properties and accurate amount of W/B ratio. In order to achieve the scope of this study, eight types of Green binding concrete mixes were used in the present research as listed in Table (8). The variables used in these mixes were type of pozzolana material. At the beginning of the mixture design, binder content 400 kg/m^3, fine aggregate content was 600 kg/m^3, coarse aggregate content was 1200 kg/m^3 and water content was 200 l/m^3. The proportion of these components by weight is (1:1.5:3) and w/c ratio is (0.5) were chosen as constant. Concrete mixes were made with waste bricks powder replacing 5, 10, 15, 20, 25, 50 and 100 percent by weight of the cement as pozzolana and with the same amount of aggregates and water as in the reference. The value of cement and waste bricks powder is shown in Table 8.

Table (8) Samples name and composition

Abbreviation	Cementitious materials percent		Cementitious materials weight (kg/m^3)	
	Cement	Pozzolana	Cement	Pozzolana
C	100	0	400	0
CBP5	95	5	380	20
CBP10	90	10	360	40
CBP15	85	15	340	60
CBP20	80	20	320	80
CBP25	75	25	300	100
CBP50	50	50	200	200
CBP100	0	100	0	400

The concrete mixtures were mixed in accordance with ASTM C192. And workability of the fresh concrete was measured with a standard slump cone, slump test fulfilled according to ASTM C143[12]. The interior of the drum was initially washed with water to prevent absorption. The coarse and fine aggregate were mixed first, followed by addition of the cement and pozzolan (YCBP), and water containing required amount.

With each mix, control specimens are prepared to determine the mechanical properties of the hardened concrete at 7,14 and 28 days. Control specimens involve 9 cubes (150×150×150)mm for compressive strength measurement, 21 cylinders (150×300)mm for compressive strength measurement, splitting tensile strength, and modulus of elasticity and 1 prism (100×100×500)mm for flexural strength (modulus of rupture).

Table (9) shows specimens, number of specimens and types of test used for these specimens in order to determine the properties of the hardened concrete.

Table (9) Specimen and Type of Testing

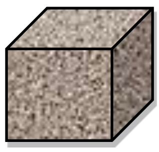
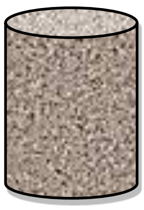
Specimen	Total Number of specimen for each test	Test	Standards of Test
 *Cube:(150×150×150)mm*	72	Cube Compression Strength	B.S: 1881: part 116[13]
 *Cylinder:(150×300)mm*	72	Cylindrical Compression Strength	ASTM C39-01[14]
 *Cylinder:(150×300)mm*	72	Splitting Tensile Strength	ASTM C496-04[15]
 *Prism:(100×100×500)mm*	8	Modulus of Rupture	ASTM C78-02[16]

Plate 3. Control Specimens

3. Fresh and Hardened Properties Tests of SC-YCBP:

The different tests were conducted in the laboratories as shown in below. It consists of mixing of concrete by partial and fully replacing cement with proportions (by weight) of waste yellow clay brick powder (YCBP) added to concrete mixtures were as follows: 0% (for the control mix), 5%, 10%, 15%, 20%, 25%, 50% and 100% Concrete samples are tested, to evaluate the concrete fresh and harden properties like Workability, Compressive strength, Split tensile strength and Flexural strength requirements.

3.1 Workability of Concrete (Slump Test)

Slump cone test was conducted to measurement of concrete's workability, or fluidity. A slump test is a method used to determine the consistency of concrete. The consistency, or stiffness, indicates how much water has been used in the mix. The slump test result is a measure of the behavior of a compacted inverted cone of concrete under the action of gravity. It measures the consistency or the wetness of concrete.
The workability of all concrete mixer was measured immediately after mixing in accordance with test method of ASTM C143/ C143M [12]

Table (10) Measured values of Concrete Workability

MIx	% of YCBP replacement	Slump value (cm)
NC-OPC	0	11.1
SC-YCBP5	5	9.5
SC-YCBP10	10	8.4
SC-YCBP15	15	7.7
SC-YCBP20	20	6.5
SC-YCBP25	25	5.1
SC-YCBP50	50	3.5
SC-YCBP100	100	2.4

Figure (4) shows the relationship between the waste yellow clay brick powder and the slump test value of the Green concrete mix. According to the results obtained, replacing (5%, 10%, 15%, 20%, 25%, 50% and 100%) from the cement weight in the Green concrete with YCBP causes to decrease its workability of fresh concrete about (14.41%, 24.32%, 30.63%, 41.44%, 54.05%, 68.46%, 78.37%) respectively.

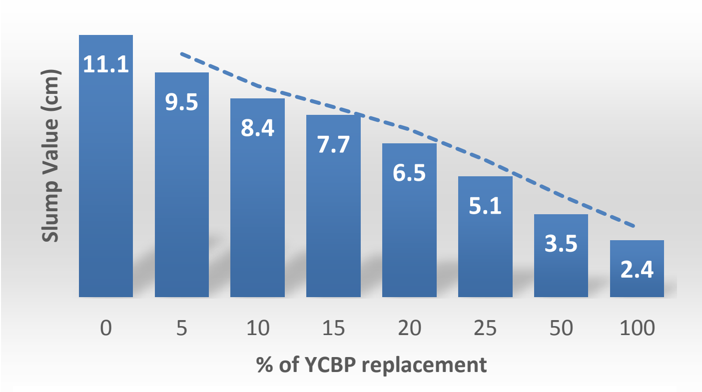


Figure 4 Slump value with %of YCBP replacement

3.2 Compressive Strength Test:

Standard cubes (150) mm are used according to (B.S 1881: part116[13]), are casting and testing to determine the compressive strength at 28 days. The machine used in the test is hydraulic compression machine of 2000 kN capacity. The average of three specimens at age of 28 days is used to determine the compressive strength for the NC as well as the partial and fully replacement mixes, as shown in figure (5)

Table (11) Average compressive strength in ages 7,14 and 28 days

	Compressive strength (MPa)		
% of YCBP replacement	7 days	14 days	28 days
0	20.5	24.26	30.11
5	17.47	22.14	28.1
10	16.46	21.54	27.9
15	14.8	20.83	26.47
20	13.7	19.3	24.1
25	12.31	17.9	22.8
50	9.9	14.8	17.28
100	3.7	5.82	6.4

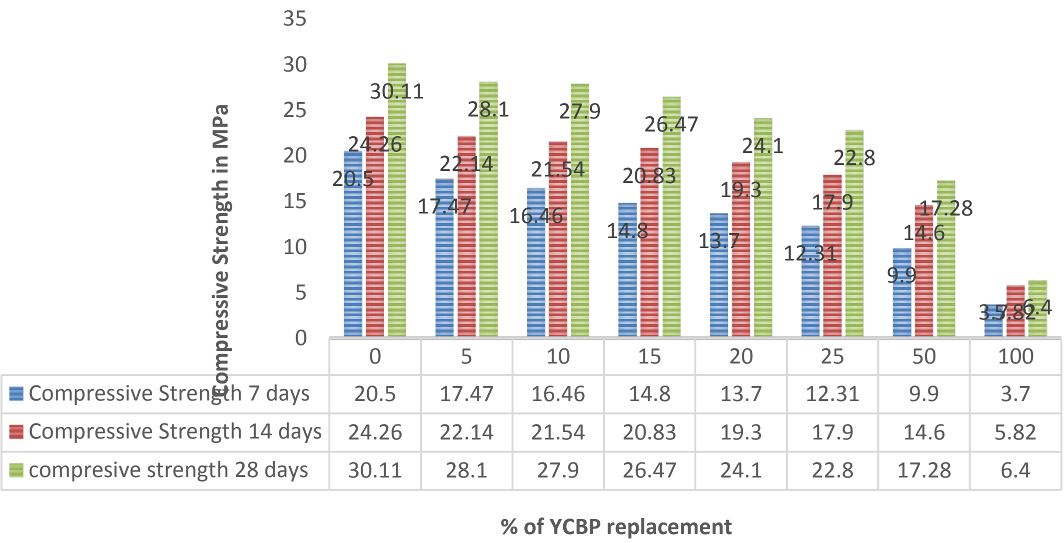


Figure (5) Average compressive strength with % of YCBP replacement

Figure (5) shows the relationship between compressive strength for OPC-NC (reference mix) and the weight replacement ratio of OPC by waste yellow clay brick powder.

According to the results obtained, the results show, that the average of compressive strength of samples decrease (14.78, 19.71, 27.8, 33.17, 39.95, 51.71 and 81.95) percent in 7 days curing, but this rate has drop to (6.67, 7.34, 12.09, 19.96, 24.27, 42.61 and 78.74) percent in 28 days curing respectively for replacing (5%, 10%, 15%, 20%, 25%, 50% and 100%) from the cement weight in the concrete mix by YCBP.

3.3 Splitting Tensile Strength Test

The splitting tensile strength test was carried out according to the ASTM C496/C496M[15]. Cylinders with the dimensions of d=150mm, h=300mm were prepared according to ASTM C192. This test is carried out by placing a cylinder specimen horizontally between the loading surfaces on a hydraulic compression testing machine of 2000 kN capacity and the load is applied until failure of cylinder along the vertical diameter as shown in figure (6). Three cylinders were tested for each batch at the age of 7, 14 and 28 days, and an average value of the splitting tensile strength was obtained, as shown in table (12), by using the following equation:

$$f_{sp} = \frac{2P}{\pi d L} \qquad (1)$$

where:

f_{sp}= Splitting tensile strength (MPa)
P = Maximum applied load (N)
d = Diameter of the cylinder (mm)
L = Length of the cylinder (mm).

Table (12) Average splitting tensile strength in ages 7,14 and 28 days

% of YCBP replacement	Splitting tensile strength (MPa)		
	7 days	14 days	28 days
0	2.19	2.83	3.28
5	1.84	2.59	2.91
10	1.62	2.28	2.66
15	1.49	1.98	2.47
20	1.06	1.42	2.01
25	0.93	1.31	1.68
50	0.77	0.89	1.10
100	0.55	0.68	0.78

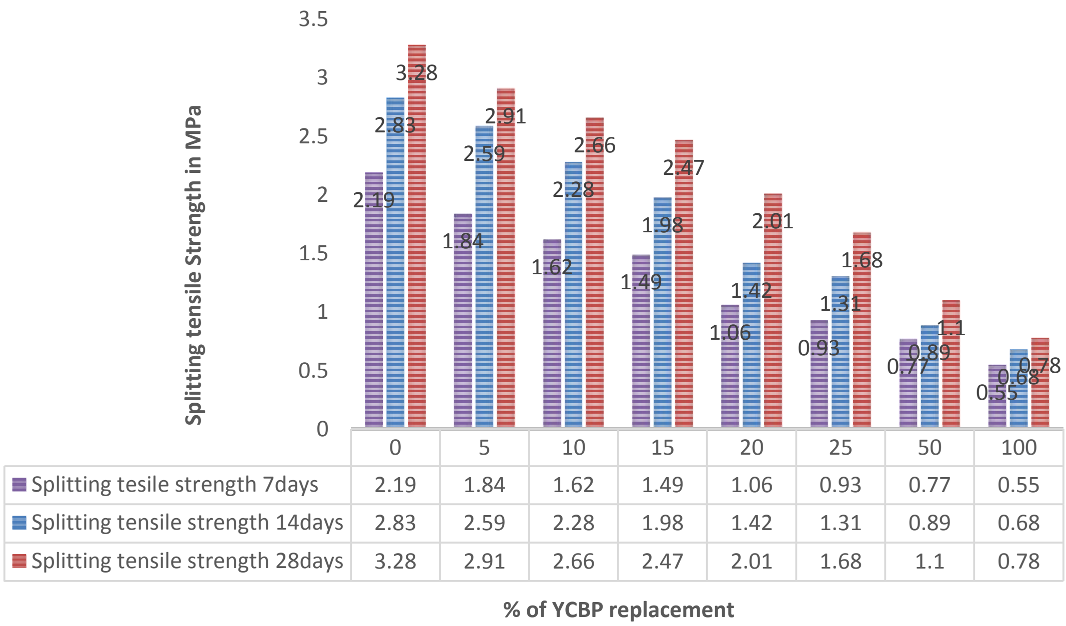


Figure (6) : Average splitting tensile strength with % of YCBP

From Table (12) and Fig.(6), the reduction of splitting tensile strength with presence of YCBP due to the effect of bond strength between the cement and YCBP in the concrete matrix and the weakness of yellow clay brick which entirely made up of concrete.

3.4 Modulus of Rupture Test:

The flexural strength (modulus of rupture) test is performed according to ASTM C78-02[16] on prismatic specimens of (100×100×500)mm were cured in water and tested at 28 days, with four point loading using a hydraulic testing machine (ELE) of 50 kN capacity, the results as shown in table (13) and fig.(7)

The modulus of rupture is calculated, as follows:

$$f_r = \frac{PL}{bh^2} \quad (2)$$

where:

f_r= modulus of rupture (MPa)
P= maximum applied load (N)
L= distance between the support
(span length) (mm)
b= width of prism (mm)
h= depth of prism (mm)

Table (13): Modulus of Rupture value in MPa

% of YCBP replacement	Modulus of Rupture MPa
0	4.64
5	4.32
10	4.45
15	4.14
20	3.78
25	3.33
50	2.29
100	0.87

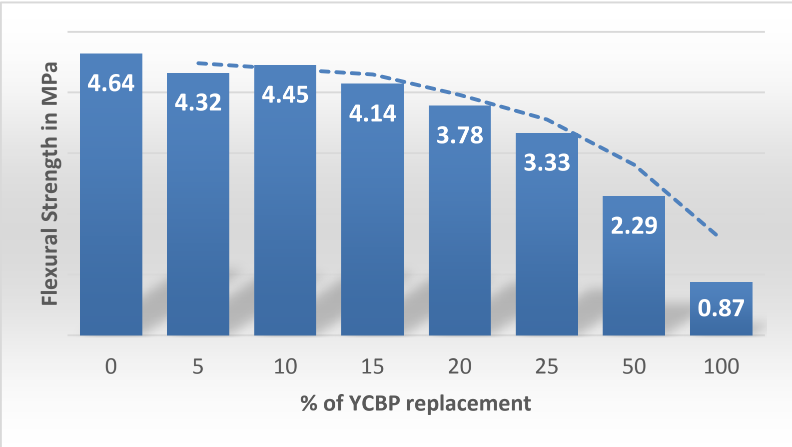


Figure (7) : Modulus of rupture with % of YCBP replacement

Table (13) and figure (7) shows a comparison of the flexural tensile strength for normal concrete mix and the type of concrete included yellow clay brick powder mixes. The comparison between flexural strength values for sustainable concrete with YCBP with a combination of normal concrete, shows that the flexural strength of the YCBP concrete specimen is more decreased. This is attributed to the lower tensile strength of YCBP and the weaker bond between YCBP and cement matrix.

4. Conclusions

Based on the results obtained from experimental work for normal and sustainable concrete with (YCBP), in this study that waste bricks can be used until 100 percent as a replacement of cement in concrete, besides to their corresponding cubes, cylinders and prisms specimens, the conclusions can be illustrated below:

1. Replacing (5%, 10%, 15%, 20%, 25%, 50% and 100%) from the cement weight in the mortar with yellow powder of the waste of clay bricks (YCBP) causes to decrease its workability of fresh concrete about (14.41%, 24.32%, 30.63%, 41.44%, 54.05%, 68.46%, 78.37%) respectively as compared with reference mix.
2. The results show, that the average of compressive strength of samples decrease (14.78, 19.71, 27.80, 33.17, 39.95, 51.71 and 81.95) percent in 7 days curing, but this rate has drop to (6.67, 7.34, 12.09, 19.96, 24.27, 42.61 and 78.74) percent in 28 days curing respectively for replacing (5%, 10%, 15%, 20%, 25%, 50% and 100%) from the cement weight. The results shows that there is slight decrease in compressive strength of the mixes (5%, 10% and 15%) as compared with reference mix.
3. Replacing (5%, 10%, 15%, 20%, 25%, 50% and 100%) from the cement weight in the concrete mix with (YCBP), the average of splitting tensile strength of samples decrease (16.02, 26.03, 32.18, 51.75, 57.21, 64.95 and 74.96) percent in 7 days curing, but this rate has drop to (11.28, 18.90, 24.69, 38.71, 48.78, 66.46 and 76.21) percent in 28 days curing respectively. The results also shows the same trend as mentioned above in point (2) especially in samples tested at 28days.
4. Replacing (5%, 10%, 15%, 20%, 25%, 50% and 100%) from the cement weight in the concrete mix with (YCBP), the modulus of rupture of samples decrease (6.79, 3.88, 10.67, 18.44, 28.15, 50.48 and 81.07) percent in 28 days curing respectively, the result show, when replacing (5% - 15%) from the cement weight, the value of the modulus of rupture test is nearly close to the normal concrete.

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