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Geotechnical evaluation and the extent of the validity of the clayey rocks of Injana Formation (upper Miocene) in Al-Najaf, Al-Ashrif Governorate for the purposes of construction industry bricks

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Abstract : The research studied claystone of Injana Formation (upper Miocene) in the Najaf governorate in middle of Iraq,(ten) stations were taken and the search included several aspects field, laboratory, and office aspects In the field work information about the region were gathered and the stations were described and model work to conduct the required tests and laboratory analyses. The laboratory work included the geotechnical tests to evaluate the physical, engineering, chemical and mineralogical properties of claystone and determine .its suitability the mud brick used in the construction industry.

Physical tests showed that the percentage of clay is ranging from (50.2-83.9) and the percentage of silt is between (15.9-40.9) and while the sand is between (0-8%), the liquid limit ranges between (31-65), and the plastic limit between (17 -32),while the plastic index between (12-38), The Stikicy limit between (20-41), and the Rieke index between (3-9), The results of the liquid limit and plastic index that of the upper indicate the soil classification while., based on the Unified Soil Classification System (USCS), is type(CH) the clays high plasticity, and the lower layers are of the type (CL) and low Clays plasticity, The bulk density ranging from (1.8 to 1.2) gm / cm ^{3} and the specific gravity is between (2.7-2.81) ,while porosity value are between (31.91-47.89%), and that the cohesion values are between (25-70) ,while the values of internal friction angle are between(9 ° -37.5 °).

The results of the chemical analysis that showed the silicate content is the highest, followed by the, calcium, aluminum, iron, magnesium, potassium ,and sodium oxide sulfates. The X-rays diffraction (XRD)test showed the non-clay minerals, quartz, calcite, and feldspar,are dominant while minerals Montmorillinite, Illite and kaolinite are the dominant in the clay minerals.

The Claystone of Injana formation for the purposes of brick construction industry is evaluated by Adding by (10&15%) of sand, while the percentage the husk of rice added is (5&2.5%) in order to manufacture bricks with the best specifications in the physical, engineering and chemical properties (600) samples were prepared by using the semi-dry press method and heating, are temperatures (850°&1050°) in accordance with the buruing program that includes raising the temperature (5c°/ min) and three hours soaking time. The results showed a significant improvement of the samples when (10%) of sand and (2.5%) from the husks rice and added in terms of water absorption and uniaxial compressive strength and efflorescence (A) and type A is obtained when it is compared with the Iraqi standard (25 of 1993) and the American standard (C62-10 2010).
The study recommends estimating the reserves of claystone in the Injana formation and the economic evaluate of clays, and its show suitability as Quarries and the establishment of factories for the purposes of ceramic industries.
Keywords : Geotechnical Evaluation, Claystone, Injana Formation, Bricks.

1- Introduction

The various clays of sediment most commonly used in the industry where they are used in the bricks, ceramics, cement and paper industry, rubber and oil industry in the drilling of exploratory wells and oil refining and purification of fluids and other [1] Layering clay deposits are part of the sequences laminar geological formations that were deposited in the form of clay layers in flood plain or environment and exposed to natural and landfill compaction 'and when exposed to weathering become outcrops weak[2], and when mixed with water showing a certain plasticity[3,4].

2- Site of the Study Area

The study area is located in the Al-Najaf governorate some 5km west of Al-Najaf city,middle of Iraq. It is accurately determined by the longtiudes (44 ° 24 '30″ - 44 ° 12' 39″) E and latitude(31 ° 58 '12″ - 32 ° 03' 00″)N along the cliff, named locally Tar Najaf represents a sequences of Injan formation and Dibdiba formation figure(1).

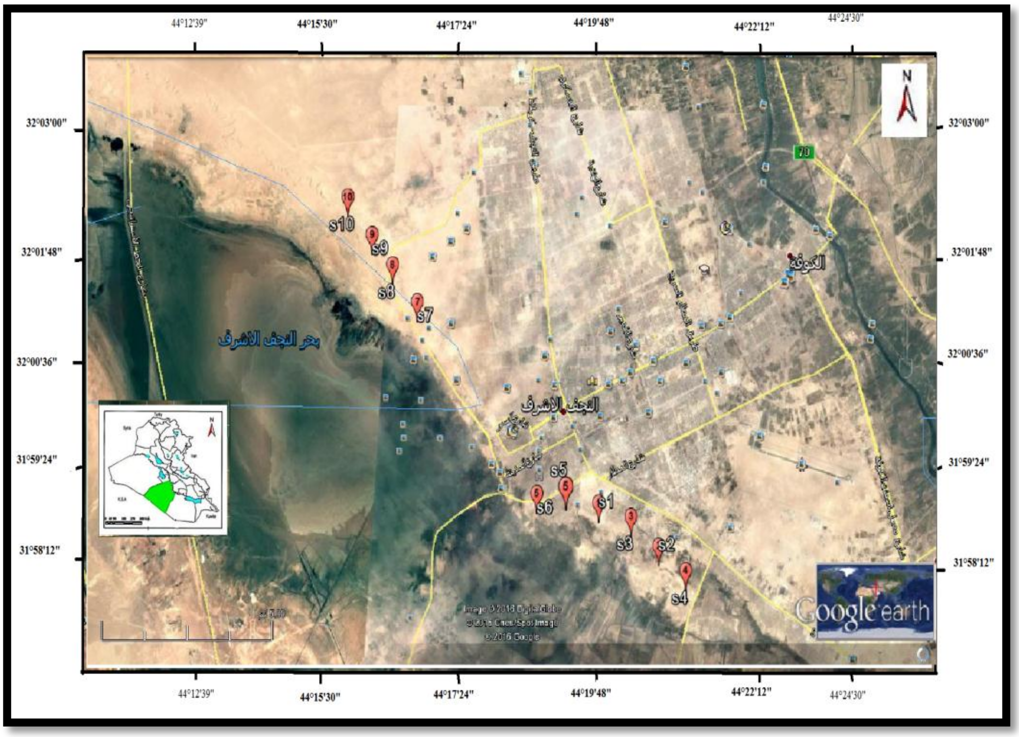


Figure (1)Location of the stations in the study area.

3-Aims of the study

The aim of the study are following:-

1- To assess the geotechnical properties of the rocks through the claystone to identify the physical, chemical and engineering, mineralology characteristics to them.

2- To attempt to improve the quality of claystone and can be used as raw material in the manufacture of clay brick construction instead of the flood plain deposits and classification of brick according to Iraqi and international standard specifications.

4-(Geology of the study area):-

The exposed units from the older to the younger are:-

1 Injana formation(Upper Miocene) .

2 Dibdiba formation(Pliocene-Pleistocene) .

3- Quaternary sediments.

4-1 Injana Formation (U. Miocene): -

It is divided into two main units:-

(I) -Lower Clastic Unit: It consists of alternation of different clastic rocks (sandstone, siltstone, and claystone) or admixture of these rocks in different ratios. Thin beds of marly limestone are also recorded, two or three times up to 0.3 m in thickness, some Celestite-bearing beds are recorded in places[5]. Cementing materials are clay or carbonate. Some diagenetic processes occasionally led to fill the bedding planes and fractures by solution forming very thin veins of secondary gypsum. Generally, the sequence shows fining upwards cycles. The thickness of this unit reaches up to 25 m. The succession shows some lateral and vertical variations[5].

(II)-Upper Claystone Unit**:** It is informally named the Cave-Forming Claystone Unit .It consists of claystone, occasionally silty, brown to reddish brown, conchoidally fractured, massive, tough, cliff-forming, changes laterally or vertically to silty claystone. The thickness of this unit reaches 6.0 m or more in some places. It has wide geographic extension along both Tar Al-Najaf and Tar Al-Sayyed, for about 170 Km. This unit is highly jointed. It is overlain by highly permeable coarse grained sandstone of Dibdibba Formation. Some of these joints are enlarged gradually due to water erosion from the overlying beds forming a well-developed caves, which reach (1×2) m, or more[5] figure(2).

2- Dibdibba Formation (Pliocene – Pleistocene): It is widely exposed in the upper part of Tar Al-Sayyed forming the main plateau. The thickness ranges from one meter or less to more than 18m. Lithologically, the formation consists of sandstone and pebbly sandstone. The sandstone differs from place to another; the main color is brown but it could be gray, yellow and white or yellowish brown.

3- Quaternary Deposits: These deposits cover most of the study area which consist of aeolian deposits, valley filling sediments and colluvial sediments[6].

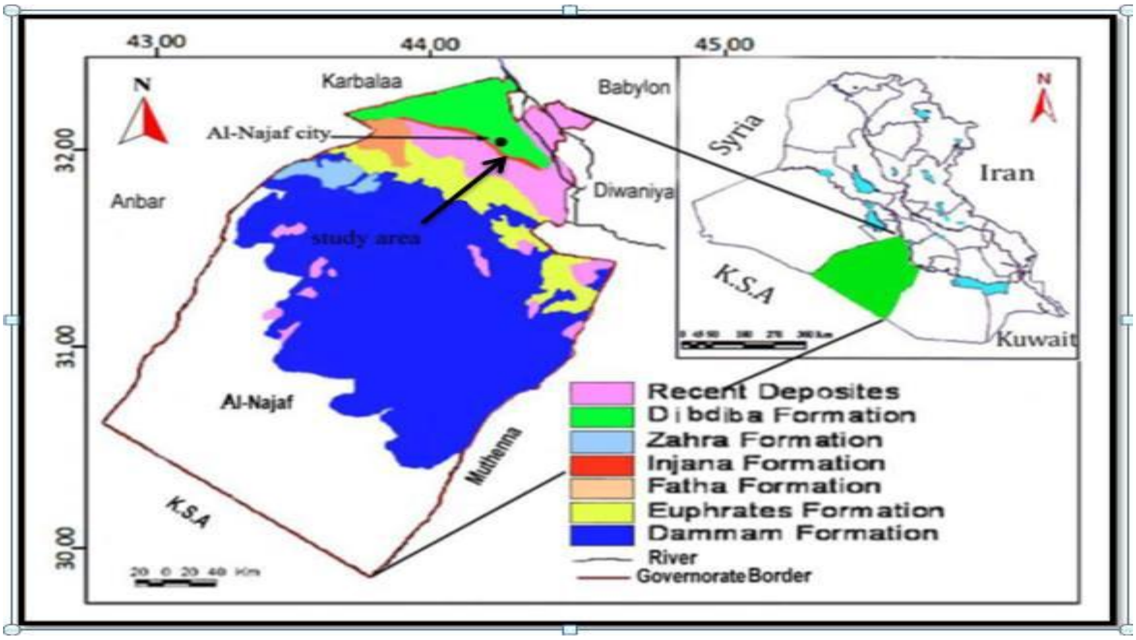


Figure (2) Show a geological map of the study area[7]

5-Methodology:-

5-Data Collection Stage:-

This stage included the collects information about the study area such as (papers, topographic maps and geological maps), in order to gain better Idea about the study area.

5-2Field work stage:

Field work is completed on the 28 of the month of August 2015 until the month of December 2015, as this included an engineering geological study detailed study area, which includes descriptions lithology ,determine the thickness of the layers of ten site (stations)using GPS device also has been chosen different rock samples depending on the variation lithology for the purpose of engineering geological tests and by fifteen samples of rock have kept in plastic bags after typing the information field on them, which has been described field of the of sandstone, claystone and siltstone and Marl interspersed with some veins of secondary gypsum, and for horizontal- sub-horizontal layers the Injana formation field descriptions show from the bottom to up of stations and layers of claystone as follows:

1-the clay stone gray to greenish and with a thickness ranging from (0.3-5.6 meters)in stations of the study area.

2. claystone-brown to reddish-brown and with a thickness ranging from (0.3-3.5 meters) in stations of the study area.

From descriptions of field stations and the presence of sandstone layers where grians size from fine to coarse and the sandstone color from gray to gray-green and also sandstone brown and with different thicknesses shows a thicker in the formation. In addition to the siltstone with silty gray colour have different sizes in addition to the emergence of the sedimentary structures, which include the graded badding, cross-badding and clayballs.

5-3 (Laboratory Work Stage)

The performed laboratory tests in this stage includes:

5.3.1 (Geotechnical Tests)

5-3-1-1 (Physical tests)

It included (Grain size analysis [8],Atterberg limits, Stikicy limit, Rieke index according to [9], specific gravity, bulk density, porosity according to[10].

5-3-1-2 (Engineering test of claystone in study area)

It includes direct shear test and adopted in the present study which is named (consolidated –drained) (CD) according to [11].

5-3-1-3 (Geochemical tests of claystone in study area)

It Included tests of the percentages of chemical oxides ($Al2O3$, $Fe2O3$, MgO, CaO, $SiO2$, $SO3$) and Lost of ignation(L.O.I). The percentages of oxides, ($K2O$, $Na2O$) was extracted content by atomic absorption spectrum according to standard Iraqi specification[12].

5-3-1-4 (Mineralogical tests of claystone in study area)

X-ray diffraction test (XRD) to determine the type of mineral components of the clsystone in study area.

5-3-2 Preparing raw materials and materials used for industrial purposes

The clay and silt in the present study is the raw material for industrial purposes at this stage is prepared raw materials for forming processes bricks were crushing and grinding samples of cohesive clay by mill. on the study of the raw materials of the physical, chemical and engineering, metallurgical aspects have proposed the use of locally available additives quantities economic for the development and improvement of bricks specifications. Additives are sand is a natural material available and deployed in large quantities, especially in the Injana formation where he was washing and drying the sand and pass the sieve number(20) (0.85mm) that the fine sand ensures the interaction of silica with raw materials during incineration at high temperatures as he works to reduce the plasticity of claystone[13]. while used the husks of rice as other additives and raised a large resulting quantities form peeling rice for rice, which does not take advantage of them and put it into the environment as waste plants as it solid waste volatile air where they are get (200) kg per tone of rice.

5.3.3 Prepare mixtures

Due to the great similarity between the mineral and chemical composition of claystone, study area has been chosen (sixteen) distributed on the (eight) stations and numbering of selected samples for industrial purposes. It was selected raw material as it is after the milling and crushing of claystone of study area was chosen as the sand that comes down from a sieve No. (20) (0.85 mm) either rice husks were used as they are not being by any change.

5.3.4 Forming and drying of samples

Using two molds of the first timber with aspects of internal smooth measured (24.5, 11.7, 7.3) cm and for the purpose of comparing it with the dimensions of the bricks in place which according to [14]has been prepared (100 samples for this purpose where they were taken (3000) gm of one sample of claystone. The second mold is timber with inner-faceted smooth dimensions (7, 3.72, 2.5) cm to prepare more samples for the purpose of testing brick product were prepared (500) samples were taken (500) g of claystone per sample where conducted a manual mixing process for the purpose of homogeneity of the mixture and adopted the method of dry pressing after selecting the best ratio of water, namely, (7% - 8%) of the sample weight[15],then the manual mixing process continued after that and wrapped the dough with plastic bags for 72 hours to ferment well to ensure homogeneity and distribution of moisture content on all the components of the mixture before you start pressing as where samples by uniaxial compressive strength (Control). Where the use of pressure (250 kg / cm^2) that best compression was reached by a group of samples. samples drying at room temperature for 48 hours with monitoring their general appearance so that was not exposed to cracking or any deformation last[16], dried later in the electric kiln drying degree (110°) for 24 hours[17].

5.3.5 Burning stage

Samples were burning at two temperature (850&1050) ° includes raising the temperature at a rate (5° c / min) until reaching to the required degree of burning and soaking time much as three hours.

5.3.6 Tests of bricks Product

It is includes the following tests:

5-3-6-1 physical properties of bricks

It included the following tests (outer shape, color, linear and volumetric shrinkage according to[18], and water absorption, bulk density, apparent porosity according to[19].

5-3-6-2 Engineering tests of bricks

Which included the uniaxial compressive strength and it is calculated according to[20].

5-3-6-3 Chemical tests of bricks

That is included efflorescence test.

6. Results and discussion:

6-1 Geotechnical properties of claystone for Injana formation

After making the physical, engineering .chemical and mineralogical tests of the claystone of the study area and included the results in table (1),(2),figure(3) and figure (4).

The following tables show the results of tests for geotechnical evaluation Claystone:

Table 1 shows the results of physical and engineering properties of claystone for Injana formation

NO	Stations	Clay%	Silt%	Sand%	USCS classification	L.L (Liquid Limit)	P.L (Plastic Limit)	P.I (Plasticity Index)	S.L (Stikicy Limit)	Ir (Rieke index)	Bulk density gm/cm^3	Specific Gravity	Porosity%	Cohesion(c) KN/m^2	Internal friction angle (°Ø)
1	1	72.6	23.8	2.9	CH	52	30	22	37	7	1.86	2.74	35.2	70	11.5°
2		50.2	40.9	8	CL	47	29	18	32	3	1.82	2.8	35.01	65	31°
3	3	76.2	22.5	0.3	CH	53	28	25	35	7	1.84	2.79	40.25	50	28.5°
4		67.7	29.5	2	CL	40	23	17	33	5	1.8	2.73	39.19	40	9°
5	4	81.0	18.1	0.1	CH	55	28	27	36	8	1.83	2.79	40.40	35	27°
6		57.9	35.4	5.9	CL	46	27	19	33	6	1.81	2.8	33.09	30	32.5°
7	6	76.2	22.5	0.3	CH	61	23	38	30	7	2.10	2.71	38.09	50	10°
8		61.7	32.1	5.3	CL	40	22	18	25	3	1.8	2.75	38.55	40	17.5°
9	7	60	31.5	7	CH	57	32	25	35	3	2.03	2.75	36.99	49	15.5°
10		59.8	32.7	6.7	CL	35	23	12	29	6	1.89	2.7	35.72	25	31°
11	8	83.9	15.2	0	CH	63	31	32	39	8	2	2.8	35.43	50	19.5°
12		60.6	31.5	7	CL	31	17	14	20	3	1.86	2.77	39.33	45	23.5°
13	9	64.0	31	4.1	CH	62	32	30	41	9	1.8	2.74	34.01	45	26°
14		59.1	34.9	5	CL	49	27	22	33	6	1.87	2.81	35.09	35	37.5°
15	10	72.8	24.2	2.1	CH	65	30	35	39	9	1.81	2.76	47.89	70	16°
16		54	39	6.1	CL	49	28	21	34	6	1.88	2.73	41.84	35	32°
Average		66.10625	29.05	3.925		50.3125	26.875	23.4375	33.1875	6	1.875	2.760625	37.88	45.875	23°
Range		83.9-50.2	40.9-15.2	8-0		65-31	32-17	38-12	41-20	9-3	2.1-1.8	2.81-2.7	47.89-33.09	70-25	37.5°-9°

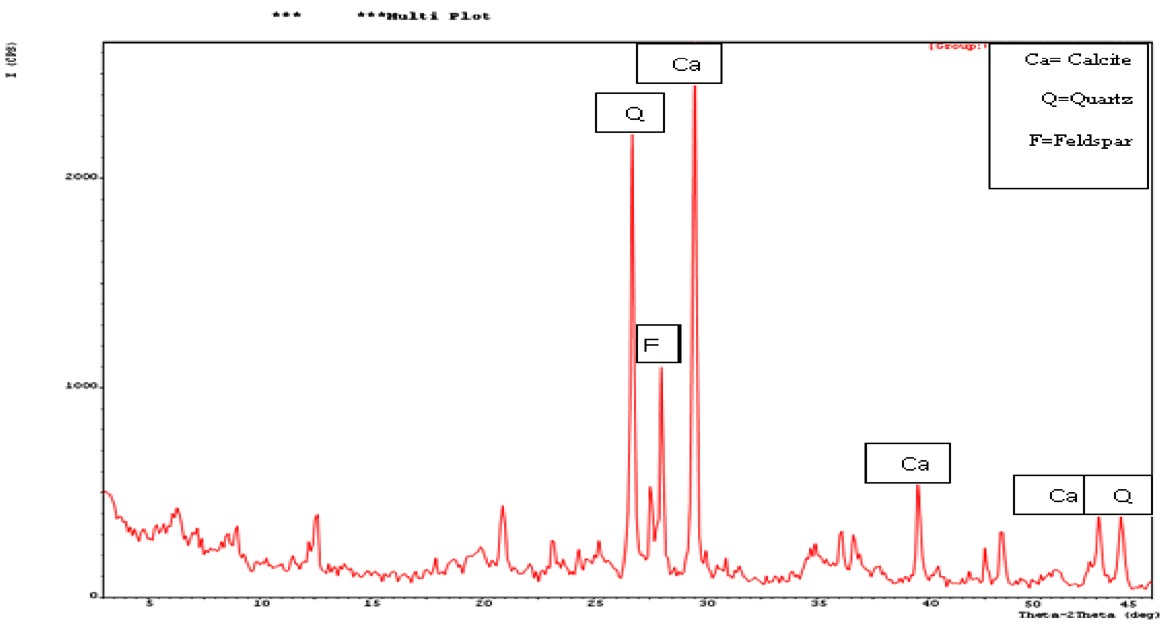
The results of grain size analysis of rocks for the Injana formation showed the claystone percentage is higher than those of siltstone and sandstone percentage the maximum value of clay percentage (83.9%) table(1) is in station (No.8) and minimum value (%50.2) in the station (No1.) . The average clay percentage is(%66.1).

The bulk density for claystone of Injana formation (table 1) ranging from the maximum value of (2.1) gm/cm^{3}in station (No.6) to the minimum value (1.8%) gm/cm^3 in the station (No.9) and the average is (1.9)gm/cm^3. The specific gravity for claystone of Injana formation (table 1) ranging from the maximum value of (2.81) in station (No.9) to the minimum value (2.7%) in the station (No.7) and the average is (2.76).The bulk density and specific gravity are of the index properties that are used in the evaluation and classification of rocks Since the specific gravity of claystone of study area depends on the rate of the specific gravity of minerals constituent[21,22]. Notes that the increased of claystone percentage have increased value of specific gravity this due to of types of clay minerals that have been distinguish by XRD, Which included the following minerals(Kaolinite , Illite and Montimorillonite). Figure(4) . The porosity for claystone of Injana formation (table 1) ranging from the maximum value of (47.89) in station (No.10) to the minimum value (33.09%) in the station (No.4) and the average is (37.88).The porosity values depend on the size, shape of grains ,mineral crystals, degree of grading and the nature of packing[23] .The Liquid limit(L.L) for claystone of Injana formation (table 1) ranging from the maximum value of (65) in station (No.10) to the minimum value (31%) in the station (No.8) and the average is (50.3).While the plastic limit (P.L) for claystone of Injana formation (table 1) ranging from the maximum value of (32) in station (No.9,7) to the minimum value (17%) in the station (No.8) and the average is (26.8),as well as the plasticity index (P.I)) for claystone of Injana formation (table 1) ranging from the maximum value of (38) in station (No.6) to the minimum value (12%) in the station (No.7) and the average is (23.43).The plasticity index (P.I) of claystone where classified according to[24,25] that is (plastic-high plastic) and classification of clays depending on(USCS) that (CH) of the upper layers and(CL) to the lower layers. The Stikicy limit (S.L)) for claystone of Injana formation (table 1) ranging from the maximum value of (41) in station (No.9) to the minimum value (20%) in the station (No.8) and the average is (33.2).While the Rieke index(R.I) for claystone of Injana formation (table 1) ranging from the maximum value of (9) in station (No.10) to the minimum value (3%) in the station (No.8,6,7,3) and the average is (6)and that the value of Stikicy limit refelect the water required for testing and the average value since whenever increasing plastic materials increase the value of stickicy limit and vice versa ,as well as the effect of quality of clay minerals type and non-clay for physical propertieswhat the value of Ricke index whenever they are less than(10) increased the validity of claystone for ceramic and bricks industry.The results of slow direct shear test(CD) for claystone of Injana formation for cohesion(c) are shown in (table 1) ranging from the maximum value of (70)KN/m^2 in station (No.1,10) to the minimum value (25%)KN/m^2 in the station (No.7) and the average is (45.9)KN/m$^{2.}$ While the internal friction angle (Ø°) ranging from the maximum value of (37.5°) in station (No.9) to the minimum value (9°)in the station (No.3) and the average is (23°).The low values of (Ø°) due to the the increasing of clay percentage because these causing sliding and decreasing the strength[26,27] From table(2) The Silica values for claystone of Injana formation ranges from the maximum value of (42.29 %) in station (No.7) to the minimum value (35.66%) in the station (No.8) and the average is (38.72%)where the highest value of Silica ratios compared to the other oxides due to enter as a main component within the crystal structure of clay minerals. The Alumina values for claystone of Injana formation ranges from the maximum value of (14.74%) in station (No.3) to the minimum value (8.86%) in the station (No.3) and the average is (12.02%) the low ratios of Alumina in study area due to the high proportion of carbonate in the rock of study area either increase compared with other oxides the essential ingredient for crystalline minerals structures of clay minerals and feldspar[28].The Calcium oxide values for claystone of Injana formation ranges from the maximum value of (21.61%) in station (No.3) to the minimum value (13.42%) in the station (No.4) and the average is (16.26%)and the high ratios of calcium oxide as contribute of carbonate and gypsum rocks found in nearby from Injana formation. The Iron oxide values for claystone of Injana formation ranges from the maximum value of (7.2 %) in station (No.10) to the minimum value (4%) in the station (No.8) and the average is (5.2%)this ratio refelects the presence in crystalline of illite minerals or may solve the aluminum in montimorillonite mineral adsorbed on the surfaces of clay minerals[29].The magnesium oxide values for claystone of Injana formation ranges from the maximum value of (8.65 %) in station (No.9) to the minimum value (3.8%) in the station (No.1) and the average is (5.32%)the value of magnesium oxide is high because they enter within crystal structure of clay minerals including montimorillonite .The soduim oxide values for claystone of Injana formation ranges from the maximum value of (1.34%) in station (No.3) to the minimum value (0.19%) in the station (No.7) and the average is (0.62%),while the potassium oxide values for claystone of Injana formation ranges from the maximum value of (1.89%) in station (No.3) to the minimum value (0.22%) in the station (No.9) and the average is (0.64%) and the low values of sodium and potassium oxide

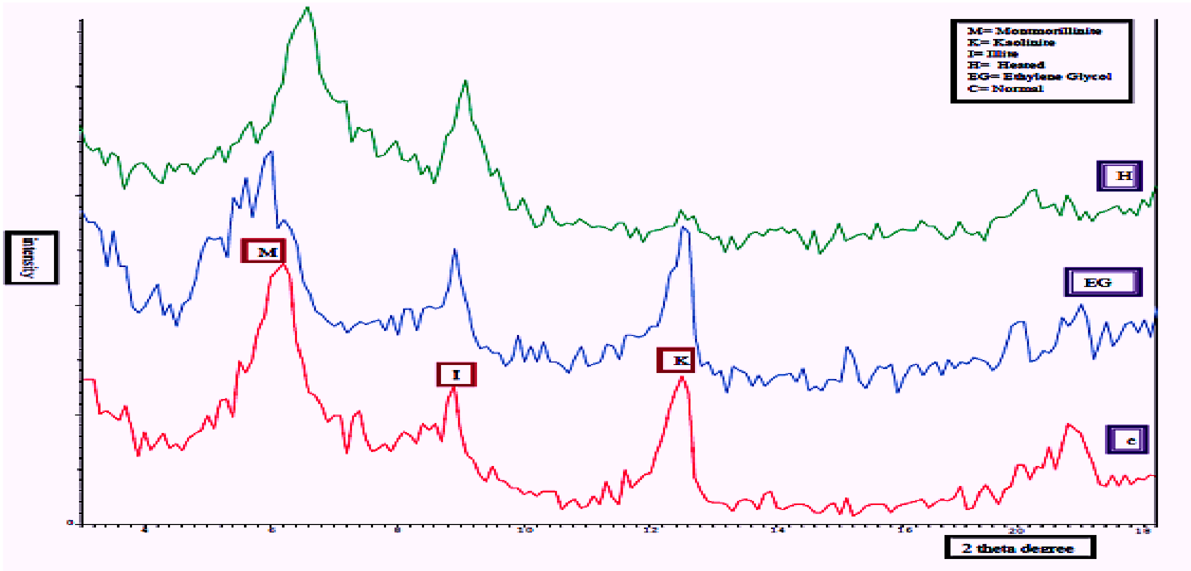
Due to adsorption potassium ratio on the surfaces of clay minerals have been more of sodium adsorbed[30].As the ratio of sulphates were few either missing burn high percentage is due to several reasons, including the evaporation of molecular water within the crystal structure of clay minerals.Results of(XRD) of the rock of study area indicated to the presence of the following minerals(Quartz, Calcite, Feldspar, Montimorillonite, Illitte and Kaolinite) figures(3,4).

Table 2 show the results of chemical tests of the claystone for Injana formation

NO	Stations	SiO_2	Fe_2O_3	MgO	CaO	Al_2O_3	SO_3	K_2O	Na_2O	L.O.I	Total
1	1	39.8	5.2	3.8	18.98	12.75	0.04	0.28	1.08	17.7	99.63
2		35.96	4.4	5.39	14.38	14.74	0.05	1.89	0.54	22.3	99.65
3	3	38.31	4.12	4.25	19.0	8.86	0.03	0.58	1.34	23.14	99.63
4		37.09	4.08	5.33	21.61	10.30	0.02	1.13	0.32	20.01	99.89
5	4	41.56	4.32	5.62	13.42	13.12	0.05	0.28	0.42	21.2	99.99
6		38.18	6.16	4.16	13.8	12.14	0.04	1.54	0.3	23.66	99.98
7	6	42.29	5.01	4.30	16.02	12.88	0.04	0.22	0.91	17.44	99.11
8		35.95	5.72	4.2	15.1	13.40	0.02	0.34	0.42	24.00	99.15
9	7	40.19	4.32	5.20	16.18	12.72	0.01	1.012	0.19	20.00	99.822
10		38.62	6.8	6.12	15.93	10.24	0.03	0.34	0.24	21.06	99.38
11	8	35.66	4	5.4	18.04	11.12	0.01	0.28	0.78	24.00	99.29
12		37.13	5.8	3.89	15.63	13.12	0.04	0.24	0.76	22.65	99.26
13	9	40.48	5.13	8.65	13.93	10.69	0.02	0.28	0.98	19.66	99.82
14		37.03	5.9	6.3	18.07	14.02	0.01	0.22	0.26	17.02	98.83
15	10	40.67	7.2	6.6	14.12	10.76	0.05	1.36	0.62	18.25	99.63
16		40.71	5.4	5.93	15.95	11.57	0.04	0.24	0.82	18.95	99.61
Average		38.72688	5.2225	5.32125	16.26	12.02688	0.03125	0.6395	0.62375	20.69	99.542
Range		42.29-35.66	7.2-4	8.65-3.8	21.61-13.42	14.74-8.86	0.05-0.01	1.89-0.22	1.34-0.19	24-17.02	99.99-98.83



(Figure 3) X-ray diffraction of the rock sample (1) for station (1)



(Figure 4) X-ray diffraction of clay fractions of Injana formation samples (1) station (1)

6-2 Geotechnical properties of bricks:-

After geotechnical evaluation for claystone of study area where is the drying of bricks and were burning at temperatures(850° and 1050°)respectively including at rate(5c°/min) until reaching to the required degree of burning and soaking time much as three hours tables(3,4).

Table 3 shows the results of the evaluation of the bricks produced in degrees of burns (850 °) to mix raw material

NO	Stations	Levels	raw material	linear shrinkage %	volumetric shrinkage %	porosity %	bulk density gm/cm^3	absorption %	compressive KN/m^2	efflorescence
1	Stations 1	Upper	**850°**	1.42	4.311	30.39	1.517	20.97	16.604	sprightly
2		Lower		1.38	5.166	29.96	1.534	23.018	15.27	sprightly
3	Stations 3	Upper		1.29	5.638	29.476	1.559	19.81	20.51	sprightly
4		Lower		1.68	3.812	29.21	1.576	22.48	16.02	sprightly
5	Stations 5	Upper		2.32	4.840	35.60	1.383	28.282	10.81	sprightly
6		Lower		1.71	3.791	32.86	1.434	24.99	12.68	sprightly
7	Stations 7	Upper		2.08	3.681	30.32	1.489	15.77	20.72	sprightly
8		Lower		1.45	5.691	27.45	1.461	23.142	14.06	sprightly
9	Stations 9	Upper		2.31	4.591	29.78	1.481	24.066	13.51	sprightly
10		Lower		1.88	3.542	29.63	1.672	25.225	15.03	sprightly
11	Stations 11	Upper		1.76	5.312	28.99	1.541	24.381	13.21	sprightly
12		Lower		2.54	6.01	34.49	1.576	28.484	10.58	sprightly
13	Stations 13	Upper		2.49	5.891	32.62	1.567	22.01	13.172	sprightly
14		Lower		2.92	4.061	30.13	1.594	24.484	12.762	sprightly
15	Stations 15	Upper		1.98	5.592	33.93	1.55	28.44	10.23	sprightly
16		Lower		1.97	3.982	28.09	1.462	19.09	15.95	sprightly
Range		Upper		1.29-2.49	3.681-5.891	28.99-35.6	1.383-1.567	15.77-28.44	10.33-20.72	
		Lower		1.38-2.92	3.545-6.01	27.45-34.49	1.434-1.672	19.09-28.484	10.58-16.02	
Average		Upper		1.956	4.982	31.388	1.511	22.966	14.846	
		Lower		1.941	4.507	30.228	1.539	23.864	14,044	

Table 4 shows the results of the evaluation of the bricks produced in degrees of burns (1050°) to mix raw material

NO	Stations	Levels	raw material	linear shrinkage %	volumetric shrinkage %	porosity %	bulk density gm/cm^3	absorption %	compressive KN/m^2	Efflorescence
1	Stations 1	Upper	**1050**	1.831	2.98	28.619	1.575	22.03	18.98	Sprightly
2		Lower		2.632	4.641	29.062	1.617	20.05	15.33	Sprightly
3	Stations 3	Upper		1.976	5.583	28.354	1.692	16.29	13.09	Sprightly
4		Lower		2.061	5.443	27.33	1.610	21.95	15.35	Sprightly
5	Stations 5	Upper		2.53	4.637	27.94	1.556	17.99	20.51	Sprightly
6		Lower		1.98	3.27	26.70	1.631	23.09	15.61	Sprightly
7	Stations 7	Upper		2.223	5.105	26.639	1.635	24.99	14.89	Sprightly
8		Lower		1.79	4.424	24.461	1.786	16.89	20.13	Sprightly
9	Stations 9	Upper		2.09	3.324	28.78	1.568	15.61	22.51	Sprightly
10		Lower		1.553	4.636	30.15	1.585	19.89	13.13	Sprightly
11	Stations 11	Upper		1.837	5.598	29.39	1.634	20.55	17.89	Sprightly
12		Lower		2.522	3.675	33.613	1.679	28.98	10.59	Sprightly
13	Stations 13	Upper		1.787	2.813	29.705	1.658	19.09	22.13	Sprightly
14		Lower		1.53	4.532	27.59	1.705	21.65	23.023	Sprightly
15	Stations 15	Upper		2.05	3.017	28.321	1.627	20.01	20.501	Sprightly
16		Lower		1.92	4.283	30.135	1.723	26.03	15.551	Sprightly
Range		Upper		1.787-2.53	2.813-5.598	26.639-29.705	1.556-1.692	15.61-24.99	13.09-22.51	
		Lower		1.53-2.632	3.27-5.443	24.461-33.613	1.585-1.786	16.89-28.98	10.59-23.023	
Average		Upper		2.041	4.1321	28.469	1.6181	19.57	18.8126	
		Lower		1.999	4.363	28.6130	1.667	22.316	16.0892	

6-2-1 Study the effect of additive on the properties of bricks product:-

After making the geotechnical tests of the brick,treated brick additives(sand and rice husks) and included the results in tables(5,6,7,8,9,10,11,12).

Table 5 shows the results of the evaluation of the bricks produced in degrees of burns (850 °) to mix raw material and sand 10%

NO	Stations	Levels	raw material and sand 10%	linear shrinkage %	volumetric shrinkage %	porosity%	bulk density gm/cm^3	absorption %	compressive KN/m^2	Efflorescence
1	Stations 1	Upper	**850**	1.39	2.54	26.25	1.59	18.5	20.89	Sprightly
2		Lower		1.48	3.02	28.489	1.48	16.8	23.38	Sprightly
3	Stations 3	Upper		2.09	2.98	30.743	1.501	17.2	20.32	Sprightly
4		Lower		1.813	2.51	26.45	1.43	25.4	15.52	Sprightly
5	Stations 5	Upper		1.604	3.129	26.972	1.61	16.1	25.31	Sprightly
6		Lower		1.389	3.161	22.421	1.62	25.8	15.13	Sprightly
7	Stations 7	Upper		1.891	3.675	27.407	1.45	19.6	22.20	Sprightly
8		Lower		1.56	4.235	27.002	1.52	26.6	12.6	Sprightly
9	Stations 9	Upper		1.789	2.56	25.28	1.68	17.1	19.94	sprightly
10		Lower		1.621	2.68	28.817	1.49	17.6	23.34	sprightly
11	Stations 11	Upper		1.506	3.89	27.453	1.732	20.9	13.85	sprightly
12		Lower		1.308	4.19	30.731	1.751	23.11	15.66	sprightly
13	Stations 13	Upper		1.721	2.98	27.513	1.521	24.8	14.9	sprightly
14		Lower		1.822	4.523	29.51	1.499	17.8	24.44	sprightly
15	Stations 15	Upper		2.01	3.87	26.12	1.598	20.3	21.7	sprightly
16		Lower		1.91	4.27	27.98	1.621	23.4	14.39	sprightly
Range		Upper		2.09-1.39	2.54-3.89	25.28-30.743	1.45-1.732	16.1-24.8	13.85-25.31	
		Lower		1.308-1.91	2.51-4.523	22.421-30.731	1.43-1.751	16.8-26.6	12.6-24.44	
Average		Upper		1.7501	3.203	27.217	1.585	19.312	19.419	
		Lower		1.6128	3.574	27.675	1.551	22.064	18.058	

Table 6 shows the results of the evaluation of the bricks produced in degrees of burns (1050°) to mix raw material and sand 10%

NO	Stations	Levels	raw material and sand 10%	linear shrinkage %	volumetric shrinkage %	porosity %	bulk density gm/cm^3	absorption%	compressive KN/m^2	Efflorescence
1	Stations 1	Upper	**1050**	1.399	5.344	23,86	1.839	15.32	30.09	Sprightly
2		Lower		1.751	3.423	31.76	1.487	14.21	28.08	Sprightly
3	Stations 3	Upper		1.704	3.876	32.16	1.543	18.54	20.12	Sprightly
4		Lower		1.823	3.261	23.71	1.898	26.98	14.24	Sprightly
5	Stations 5	Upper		1.757	4.847	22.05	1.607	20.25	21.09	Sprightly
6		Lower		1.350	2.626	21.98	1.68	25.71	12.35	Sprightly
7	Stations 7	Upper		1.571	3.115	30.89	1.76	16.35	27.61	Sprightly
8		Lower		1.823	4.264	25.91	1.728	24.73	15.19	Sprightly
9	Stations 9	Upper		1.390	4.179	22.51	1.514	18.91	24.16	Sprightly
10		Lower		1.288	5.113	29.91	1.75	16.02	23.45	Sprightly
11	Stations 11	Upper		1.751	2.796	30.13	1.54	23.06	15.05	sprightly
12		Lower		1.851	4.793	24.32	1.53	17.76	28.19	sprightly
13	Stations 13	Upper		1.921	3.141	21.39	1.58	22.41	14.15	sprightly
14		Lower		1.780	4.934	29.05	1.499	15.91	27.12	sprightly
15	Stations 15	Upper		1.870	3.812	25.13	2.33	16.69	30.11	sprightly
16		Lower		1.833	3.892	26.13	1.56	24.51	15.22	sprightly
Range		Upper		1.39-1.921	2.796-5.344	21.39-32.16	1.514-2.33	15.32-23.06	14.15-30.11	
		Lower		1.288-1.851	2.626-5.113	21.98-31.76	1.487-1.898	14.21-26.98	12.35-28.19	
Average		Upper		1.6703	3.888	26.323	1.7141	18.941	22.798	
		Lower		1.687	4.038	26.596	1.6415	20.729	20.48	

Table 7 shows the results of the evaluation of the bricks produced in degrees of burns (850 °) to mix raw material and sand 15%

NO	Stations	Levels	raw material and sand 15%	linear shrinkage %	volumetric shrinkage %	porosity %	bulk density gm/cm^3	absorption %	compressive KN/m^2	efflorescence
1	Stations 1	Upper	**850**	0.65	3.14	26.02	1.657	22.02	20.51	sprightly
2		Lower		0.63	3.156	26.23	1.593	24.21	13.641	sprightly
3	Stations 3	Upper		0.39	2.318	27.69	1.631	18.05	22.72	sprightly
4		Lower		0.79	4.351	27.98	1.985	24.21	14.84	sprightly
5	Stations 5	Upper		0.73	3.514	28.54	1.744	18.91	23.95	sprightly
6		Lower		0.72	2.725	22.99	1.451	16.98	21.88	sprightly
7	Stations 7	Upper		0.91	2.044	20.04	1.653	25.81	15.54	sprightly
8		Lower		0.82	2.192	25.54	1.721	26.85	13.31	sprightly
9	Stations 9	Upper		0.79	4.012	26.09	1.503	21.98	24.23	sprightly
10		Lower		0.89	2.89	20.05	1.435	16.99	19.09	sprightly
11	Stations 11	Upper		0.71	2.981	23.98	1.693	23.05	15.05	sprightly
12		Lower		0.77	3.061	28.52	1.423	26.89	14.61	sprightly
13	Stations 13	Upper		0.90	2.99	22.95	1.951	20.12	22.95	sprightly
14		Lower		0.64	3.081	28.63	1.703	19.99	24.33	sprightly
15	Stations 15	Upper		0.91	4.51	27.94	1.931	24.22	15.12	sprightly
16		Lower		0.68	3.081	23.01	1.536	23.59	14.09	sprightly
Range		Upper		0.39-0.91	2.044-4.51	20.04-28.54	1.503-1.951	18.05-25.81	15.05-24.23	
		Lower		0.63-0.89	2.192-4.351	20.05-28.63	1.423-1.985	16.98-26.89	13.31-24.33	
Average		Upper		0.749	3.188	25.406	1.7203	21.77	20.009	
		Lower		0.743	3.0671	25.369	1.606	22.464	16.974	

Table 8 shows the results of the evaluation of the bricks produced in degrees of burns (1050 °) to mix raw material and sand 15%

NO	Stations	Levels	raw material and sand 15%	linear shrinkage %	volumetric shrinkage %	porosity %	bulk density gm/cm^3	absorption%	compressive KN/m^2	efflorescence
1	Stations 1	Upper	**1050**	0.94	2.182	24.928	1.811	19.6	21.79	sprightly
2		Lower		0.44	2.161	27.830	1.66	26.5	12.32	sprightly
3	Stations 3	Upper		0	3.196	30.655	1.71	18.3	27.01	sprightly
4		Lower		0.65	2.570	31.605	1.64	17.8	22.75	sprightly
5	Stations 5	Upper		0.39	3.577	30.492	1.67	25.6	13.32	sprightly
6		Lower		0.83	3.768	26.584	1.69	20.9	22.7	sprightly
7	Stations 7	Upper		0.75	2.269	23.570	1.62	20.8	24.65	sprightly
8		Lower		0.58	2.891	25.968	1.65	23.2	15.35	sprightly
9	Stations 9	Upper		0.49	2.469	22.671	1.79	18.7	22.41	sprightly
10		Lower		0.25	3.425	23.713	1.83	26.6	12.01	sprightly
11	Stations 11	Upper		0.95	2.998	23.631	1.69	19.01	20.69	sprightly
12		Lower		0.73	3.261	22.121	1.83	24.4	15.73	sprightly
13	Stations 13	Upper		0.63	2.847	22.52	1.63	26.34	12.61	sprightly
14		Lower		0.551	2.626	35.73	1.73	19.4	27.73	sprightly
15	Stations 15	Upper		0.39	3.625	24.641	1.85	20.51	23.85	sprightly
16		Lower		0.299	2.828	28.58	1.654	23.55	14.4	sprightly
Range		Upper		0-0.95	2.182-3.625	22.52-30.655	1.62-1.82	18.3-26.34	12.61-27.01	
		Lower		0.25-0.83	2.161-3.768	22.121-35.73	1.64-1.83	26.6-17.8	12.01-27.73	
Average		Upper		0.568	2.895	25.389	1.7214	21.108	20.791	
		Lower		0.541	2.941	27.766	1.711	22.794	17.874	

Table 9 shows the results of the evaluation of the bricks produced in degrees of burns (850 °) of the raw material mixture and rice husks 2.5%

NO	Stations	Levels	raw material mixture and rice husks 2.5%	linear shrinkage %	volumetric shrinkage %	porosity%	bulk density gm/cm^3	absorption %	compressive KN/m^2	Efflorescence
1	Stations 1	Upper	**850**	0.758	2.079	28.03	1.39	18.01	25.01	Sprightly
2		Lower		0.785	2.623	25.86	1.01	12.31	28.05	Sprightly
3	Stations 3	Upper		1.305	3.785	29.99	0.925	16.98	30.21	Sprightly
4		Lower		0.292	2.255	30.02	1.054	20.41	31.92	Sprightly
5	Stations 5	Upper		0.542	1.532	32.51	1.29	25.15	15.52	Sprightly
6		Lower		1.309	1.621	33.62	1.025	15.61	27.51	Sprightly
7	Stations 7	Upper		1.53	3.375	26.92	0.40	17.91	35.74	Sprightly
8		Lower		1.18	2.951	30.85	1.517	23.09	13.05	Sprightly
9	Stations 9	Upper		0.542	1.383	33.71	1.304	20.07	29.18	Sprightly
10		Lower		0.778	3.82	28.91	1.18	14.95	35.99	Sprightly
11	Stations 11	Upper		0.758	1.44	32.21	1.201	17.62	32.51	Sprightly
12		Lower		1.05	2.079	28.95	1.105	21.61	36.61	Sprightly
13	Stations 13	Upper		1.326	3.452	29.10	1.502	15.63	31.13	sprightly
14		Lower		0.942	1.992	27.83	1.42	13.91	28.61	sprightly
15	Stations 15	Upper		1.625	2.75	30.82	1.28	19.61	27.81	sprightly
16		Lower		1.421	3.644	32.22	1.419	18.52	26.06	sprightly
Range		Upper		0.542-1.625	1.383-3.785	26.92-33.71	0.4-1.502	15.63-25.15	15.52-35.74	
		Lower		0.292-1.411	1.621-3.82	25.86-33.62	1.01-1.517	12.31-23.09	13.05-36.61	
Average		Upper		1.105	2.475	30.411	1.1615	18.873	28.389	
		Lower		0.969	2.623	29.783	1.2162	17.551	28.475	

Table 10 shows the results of the evaluation of the bricks produced in degrees of burns (1050 °) to mix raw material and rice husks 2.5%

NO	Stations	Levels	raw material and rice husks 2.5%	linear shrinkage %	volumetric shrinkage %	porosity %	bulk density gm/cm^3	absorption %	compressive KN/m^2	efflorescence
1	Stations 1	Upper	**1050**	1.576	3.588	26.09	1.231	18.09	39.32	sprightly
2		Lower		1.916	2.538	30.12	1.229	13.66	35.23	sprightly
3	Stations 3	Upper		1.823	3.227	31.64	1.293	16.31	27.99	sprightly
4		Lower		1.832	2.653	25.11	1.394	17.81	25.51	sprightly
5	Stations 5	Upper		1.654	2.084	27.09	1.363	15,99	22.01	sprightly
6		Lower		1.262	3.167	29.65	1.446	20.51	32.51	sprightly
7	Stations 7	Upper		1.362	2.993	33.09	1.145	26.01	15.51	sprightly
8		Lower		1.522	2.225	28.54	1.18	22.83	34.09	sprightly
9	Stations 9	Upper		1.591	3.523	29.04	1.176	18.52	39.65	sprightly
10		Lower		2.03	2.28	34.21	1.232	16.82	35.53	sprightly
11	Stations 11	Upper		1.828	3.532	35.99	1.165	25.91	15.93	sprightly
12		Lower		2.35	2.579	30.03	1.328	17.41	28.70	sprightly
13	Stations 13	Upper		1.88	2.931	28.88	1.475	20.14	34.71	sprightly
14		Lower		2.089	3.563	26.34	1.177	24.21	13.51	sprightly
15	Stations 15	Upper		1.575	2.117	34.61	1.401	19.63	38.40	sprightly
16		Lower		1.828	3.470	30.82	1.179	21.90	30.35	sprightly
Range		Upper		1.362-1.88	2.084-3.588	26.09-35.99	1.145-1.475	16.31-26.01	39.65-15.51	
		Lower		1.262-2.35	2.225-3.563	25.11-34.21	1.177-1.446	13.66-24.21	13.51-35.53	
Average		Upper		1.661	2.999	30.804	1.281	20.659	29.19	
		Lower		1.8536	2.809	29.353	1.2706	19.394	29.429	

Table 11 shows the results of the evaluation of the bricks produced in degrees of burns (850 °) of the raw material mixture and rice husks 5%

NO	Stations	Levels	raw material mixture and rice husks 5%	linear shrinkage %	volumetric shrinkage %	porosity %	bulk density gm/cm^3	absorption %	compressive KN/m^2	efflorescence
1	Stations 1	Upper	**850**	1.498	3.83	30.89	0.965	22.24	18.03	sprightly
2		Lower		1.841	2.98	35.44	0.72	20.35	15.63	sprightly
3	Stations 3	Upper		1.805	4.196	39.495	0.95	23.51	14.82	sprightly
4		Lower		1.929	3.578	33.741	0.32	26.03	13.25	sprightly
5	Stations 5	Upper		1.258	3.566	36.791	1.56	27.41	10.23	sprightly
6		Lower		1.460	3.89	33.67	1.34	22.61	20.28	sprightly
7	Stations 7	Upper		1.681	4.269	35.807	0.33	20.86	23.30	sprightly
8		Lower		1.933	4.891	36.525	0.846	18.63	19.29	sprightly
9	Stations 9	Upper		1.490	2.964	31.188	0.725	19.99	23.21	sprightly
10		Lower		1.388	3.643	34.018	0.7438	21.65	22.41	sprightly
11	Stations 11	Upper		1.861	3.899	35.86	1.28	20.65	19.21	sprightly
12		Lower		1.951	3.61	329.27	1.298	17.71	15.26	sprightly
13	Stations 13	Upper		1.961	2.987	33.429	0.902	16.17	21.27	sprightly
14		Lower		1.870	2.896	38.842	0.738	27.62	10.29	sprightly
15	Stations 15	Upper		1.980	3.625	32.62	0. 87	22.51	15.99	sprightly
16		Lower		1.995	3.839	33.58	0. 98	23.84	18.33	sprightly
Range		Upper		1.258-1.98	2.964-4.269	30.89-39.495	0.33-1.56	16.17-27.41	10.23-23.3	
		Lower		1.388-1.995	2.896-4.891	32.93-38.842	0.32-1.34	17.71-27.62	10.29-22.41	
Average		Upper		1.692	3.667	34.51	0.959	21.668	18.258	
		Lower		1.796	3.666	34.843	0.858	22.305	16.843	

Table 12 shows the results of the evaluation of the bricks produced in degrees of burns (1050 °) to mix raw material and rice husks 5%

NO	Stations	Levels	mix raw material and rice husks 5%	linear shrinkage %	volumetric shrinkage %	porosity %	bulk density gm/cm^3	absorption %	compressive KN/m^2	efflorescence
1	Stations 1	Upper	**1050**	1.523	3.54	31.49	0.81	22.02	23.05	sprightly
2		Lower		1.48	4.02	29.69	0.723	24.15	11.32	sprightly
3	Stations 3	Upper		1.29	3.89	39.46	0.715	27.129	10.82	sprightly
4		Lower		1.73	3.251	38.21	0.93	25.59	14..24	sprightly
5	Stations 5	Upper		2.23	4.192	31.60	1.58	24.99	15.03	sprightly
6		Lower		1.81	4.171	32.96	0.52	20.98	13.61	sprightly
7	Stations 7	Upper		2.18	3.97	35.23	1.211	18.099	20.62	sprightly
8		Lower		1.55	4.352	34.54	1.031	26.981	11.72	sprightly
9	Stations 9	Upper		2.31	3.56	30.87	0.931	18.59	21.06	sprightly
10		Lower		1.98	3.86	32.63	0.873	24.981	15.65	sprightly
11	Stations 11	Upper		1.68	4.98	34.99	0.693	23.98	14.51	sprightly
12		Lower		2.45	3.92	30.59	1.56	26.55	15.61	sprightly
13	Stations 13	Upper		2.59	4.89	36.32	0.928	24.99	16.55	sprightly
14		Lower		2.29	4.352	31.30	1.023	20.09	22.54	sprightly
15	Stations 15	Upper		1.897	3.89	35.93	1.098	23.05	15.61	sprightly
16		Lower		1.497	4.57	37.89	0.99	20.16	25.97	sprightly
Range		Upper		1.29-2.59	3.54-4.98	30.87-39.46	0.693-1.58	18.099-27.129	10.82-23.05	
		Lower		1.48-2.45	3.251-4.57	38.21-29.69	0.52-1.56	20.09-26.981	11.32-25.97	
Average		Upper		1.963	4.114	34.486	0.996	22.856	17.156	
		Lower		1.848	4.062	33.476	0.956	23.685	16.631	

6-2-1-1 Study the effect of additives on the linear shrinkage of the bricks product:-

When studying the figures (5), (6) we conclude that the highest value for the linear shrinkage reached when adding raw materials and sand 10%, reaching 1.7501% of the upper layer and 1.796% of the lower layer when adding raw materials and rice husks5%, at burning 850°. The less value when adding raw materials and sand 15% where 0.794% to the upper layer and 0.743% of the lower layer at burning 850°. And the highest value for the linear shrinkage reached when adding raw materials and rice husks 5%, reaching 1.963% of the upper layer and 1.848% of the lower layer at burning 1050°. The less value when adding raw materials and sand 15% where 0.658% to the upper layer and 0.541% of the lower layer at burning 1050°.

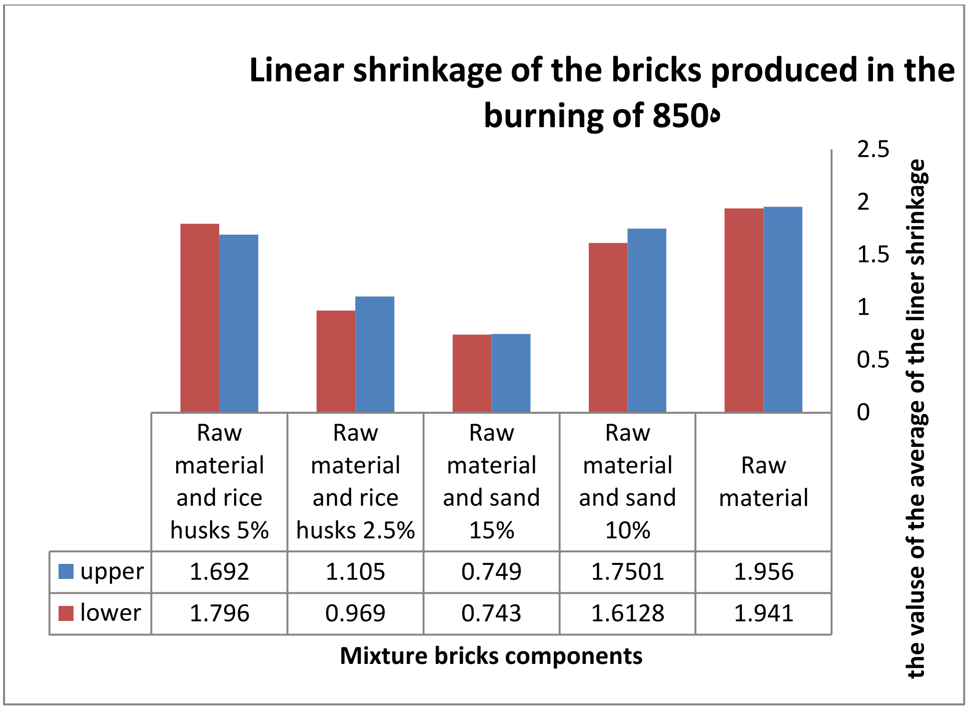


Fig (5) the effect of additives on the linear shrinkage of bricks at burning 850°.

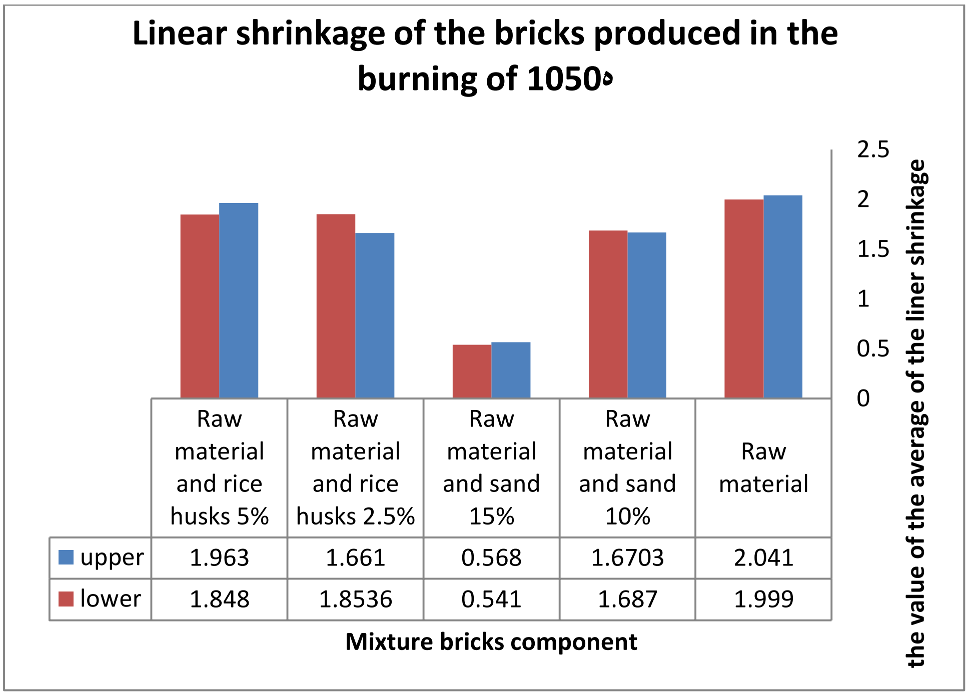


Fig (6) the effect of additives on the linear shrinkage of bricks at burning 1050°.

6-2-1-2 Study the effect of additives on the volumetric shrinkage of the bricks product:-

When studying the figures (7), (8) we conclude that the highest value for the volumetric shrinkage reached when adding raw materials and rice husks 5%, reaching 3.667% of the upper layer and 3.666% of the lower layer at burning 850°. The less value when adding raw materials and rice husks 2.5% where 2.999% to the upper layer and 2.809% of the lower layer at burning 850°. And the highest value for the volumetric shrinkage reached when adding raw materials and rice husks 5%, reaching 4.114% of the upper layer and 4.038% of the lower layer at burning 1050° when adding raw materials and sand 10%. The less value when adding raw materials and sand 15% where 2.895% to the upper layer and 2.809% of the lower layer at burning 1050° when adding raw materials and rice husks 2.5%.

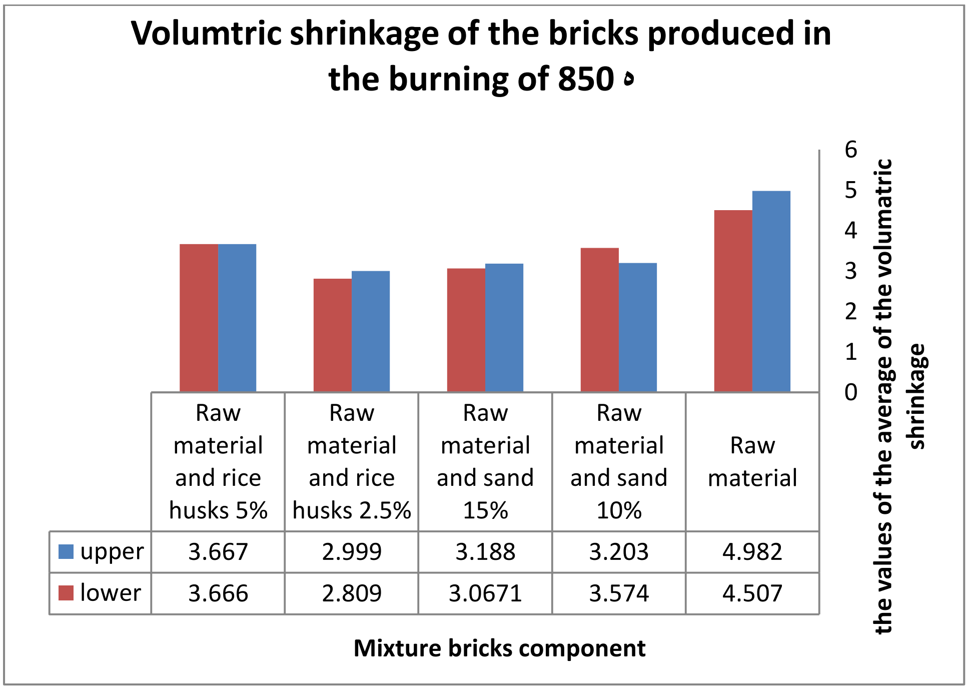


Fig (7) the effect of additives on the volumetric shrinkage of bricks at burning 850°.

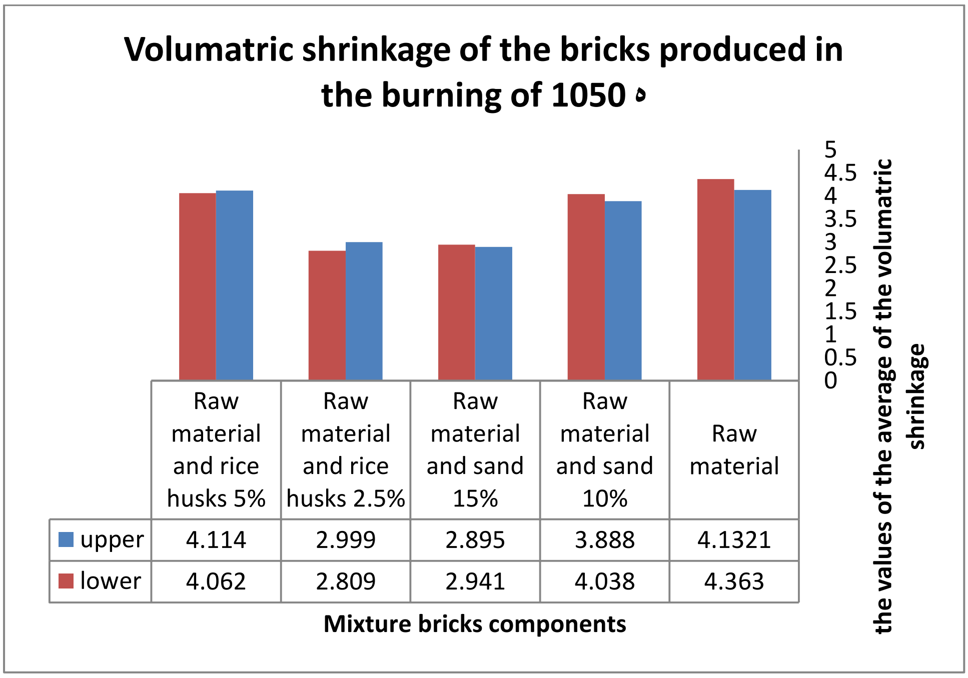


Fig (8) the effect of additives on the volumetric shrinkage of bricks at burning 1050°.

6-2-1-3 Study the effect of additives on the porosity of the bricks product:-

When studying the figures (9), (10) we conclude that the highest value for the porosity reached when adding raw materials and rice husks 5%, reaching 34.51% of the upper layer and 34.843% of the lower layer at burning 850°. The less value when adding raw materials and sand 15% where 25.406% to the upper layer and 25.369% of the lower layer at burning 850°. And the highest value for the porosity reached when adding raw materials and rice husks 5%, reaching 34.486% of the upper layer and 33.476% of the lower layer at burning 1050°. The less value when adding raw materials and sand 15% where 25.389% to the upper layer and 26.596% of the lower layer at burning 1050° when adding raw materials and sand 10%.

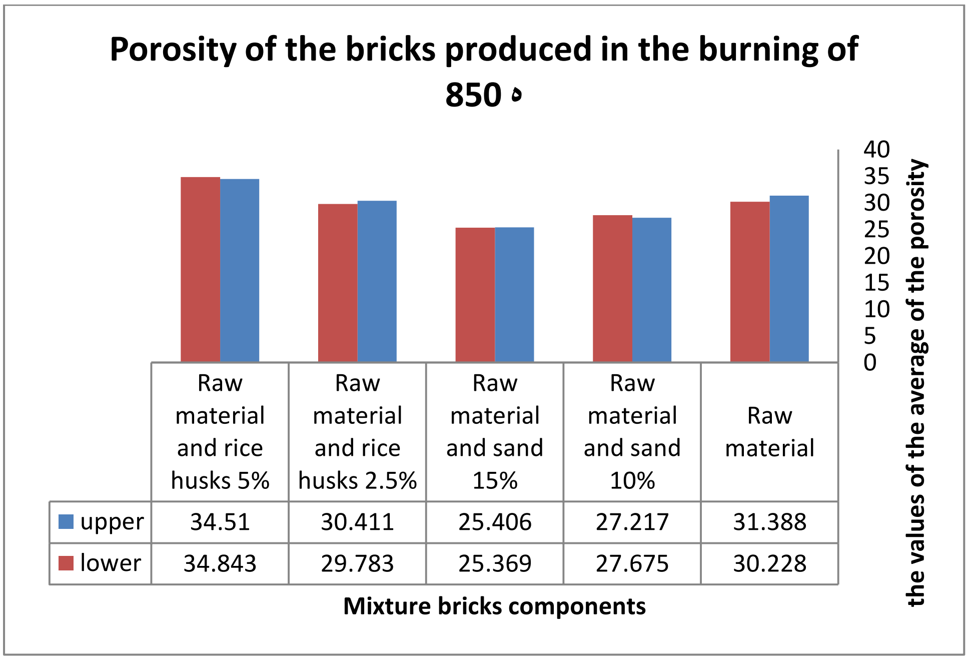


Fig (9) The effect of additives on porosity of bricks at burning 850°.

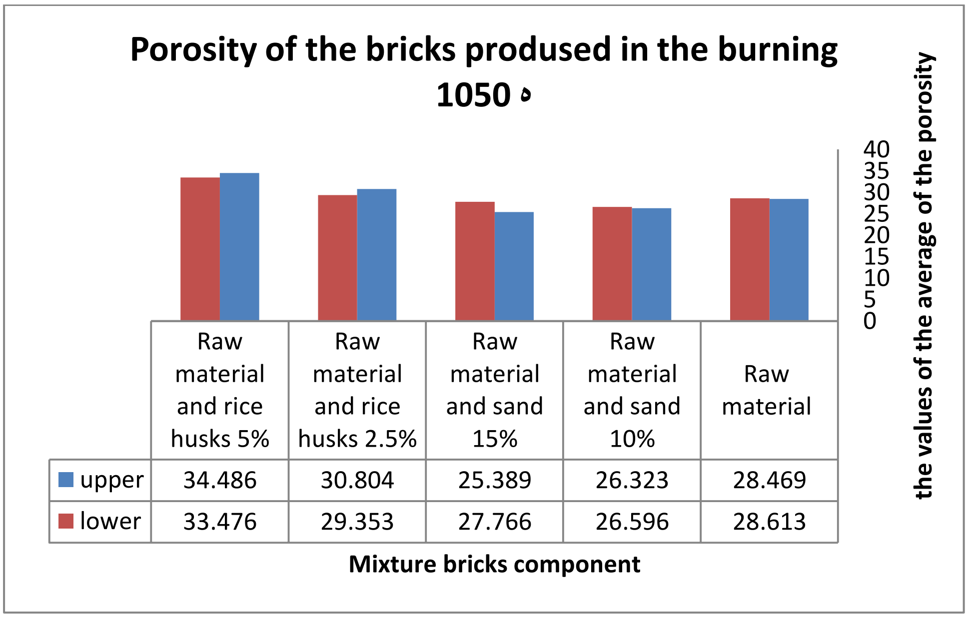


Fig (10) The effect of additives on the porosity of bricks at burning 1050°.

6-2-1-4 Study the effect of additives on the bulk density(gm/cm^3) of the bricks product:-

When studying the figures (11), (12) we conclude that the highest value for the bulk density reached when adding raw materials and sand 15%, reaching 1.7203gm/cm^3 of the upper layer and 1.606 gm/cm^3 of the lower layer at burning 850°. The less value when adding raw materials and rice husks 5% where 0.959 gm/cm^3 to the upper layer and 0.858gm/cm^3 of the lower layer at burning 850°. And the highest value for the bulk density reached when adding raw materials and sand 15%, reaching 1.7214 gm/cm^3 of the upper layer and 1.711 gm/cm^3 of the lower layer at burning 1050°. The less value when adding raw materials and rice husks 2.5% where 0.996 gm/cm^3 to the upper layer and 0.956 gm/cm^3 of the lower layer at burning 1050° .

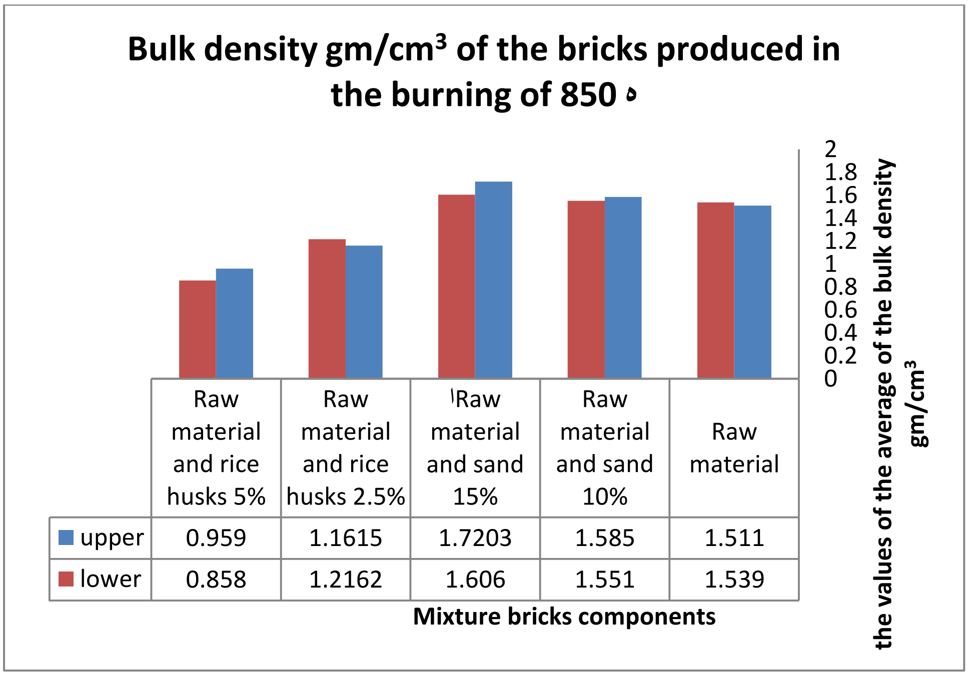


Fig (11) the effect of additives on bulk density(gm/cm^3) of bricks at burning 850°.

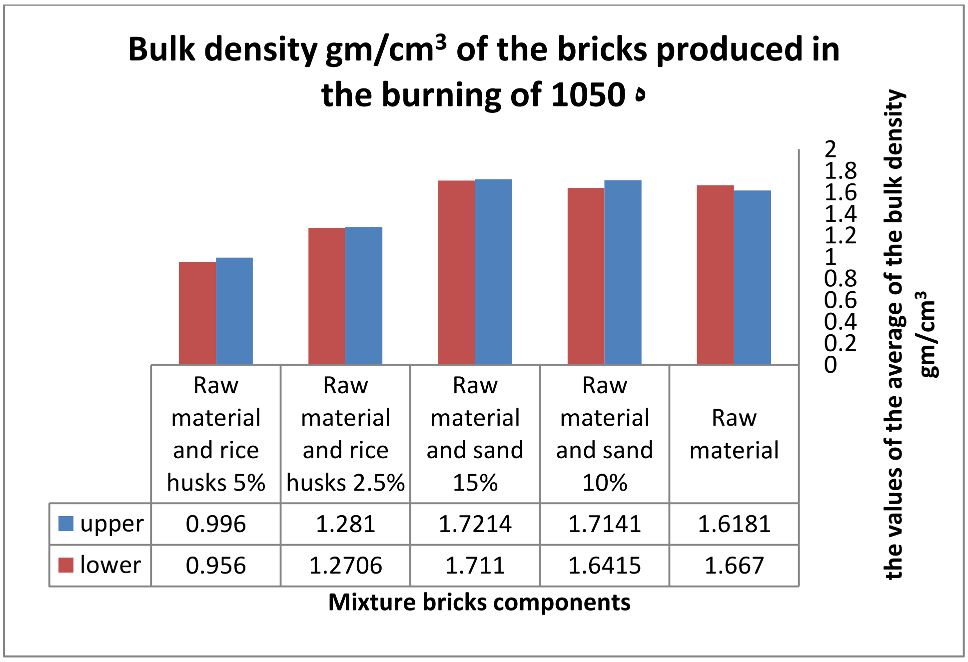


Fig (12) the effect of additives on the bulk density(gm/cm^3) of bricks at burning 1050°.

6-2-1-5 Study the effect of additives on the uniaxial compressive strength (KN/m^2) of the bricks product:-

When studying the figures (13), (14) we conclude that the highest value for the uniaxial compressive strength reached when adding raw materials and rice husks 2.5%, reaching 28.389 $KN/m^2$of the upper layer and 28.475 KN/m^2 of the lower layer at burning 850°. The less value when adding raw materials and rice husks 5% where 18.258 $KN/m^2$to the upper layer and 16.843 KN/m^2 of the lower layer at burning 850°. And the highest value for the uniaxial compressive strength reached when adding raw materials and rice husks 2.5%, reaching 29.19 KN/m^2 of the upper layer and 29.429 KN/m^2 of the lower layer at burning 1050°. The less value when adding raw materials and rice husks 5% where 17.156 KN/m^2 to the upper layer and 16.631 $KN/m^2$of the lower layer at burning 1050° .

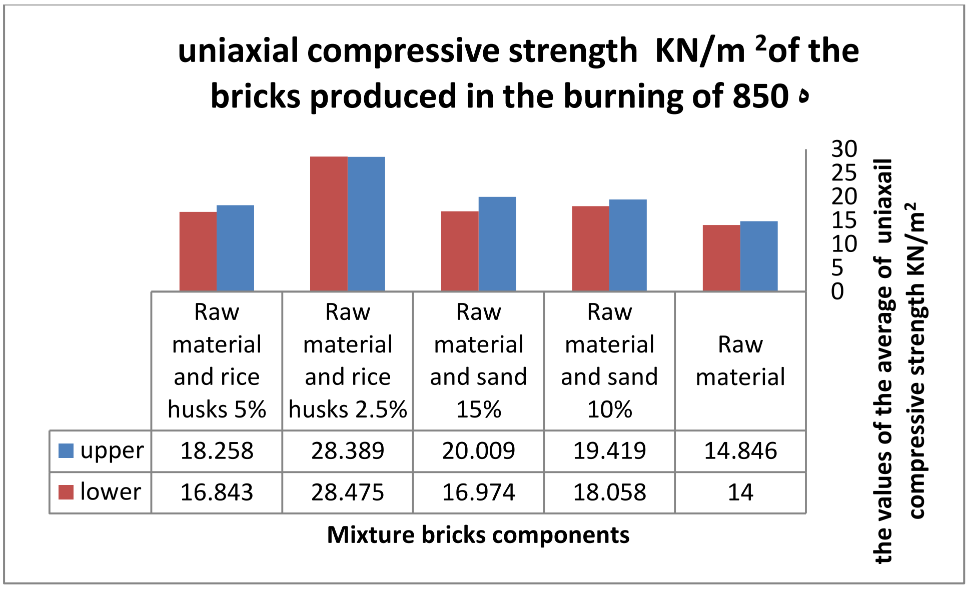


Fig (13) the effect of additives on uniaxial compressive strength(KN/m^2) of bricks at burning 850°.

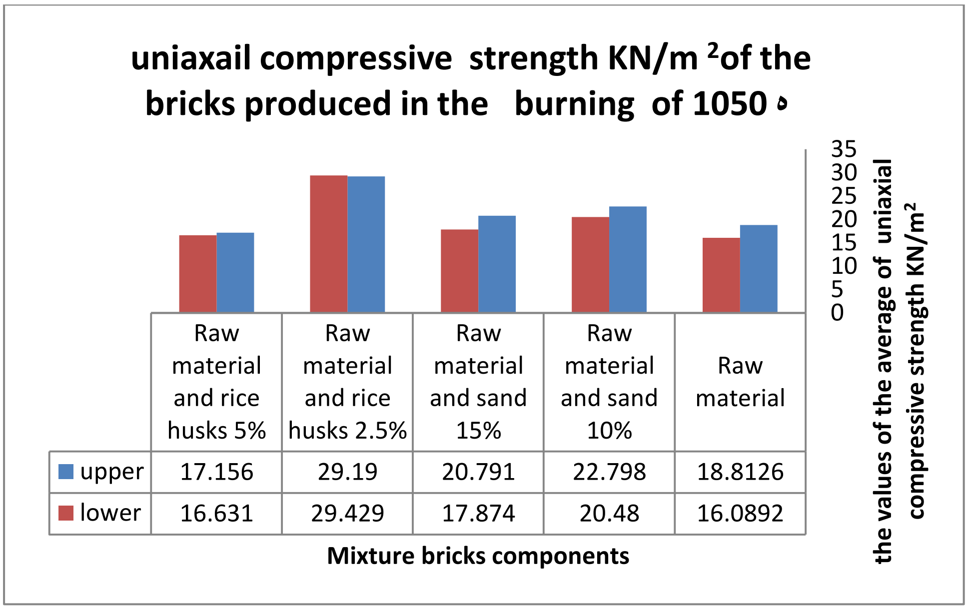


Fig (14) the effect of additives on uniaxial compressive strength(KN/m^2) of bricks at burning 1050°.

6-2-1-6 Study the effect of additives on the absorption of the bricks product:-

When studying the figures (15), (16) we conclude that the highest value for the absorption reached when adding raw materials and rice husks 5%, reaching 21.668**%** of the upper layer and 22.305% of the lower layer at burning 850°. The less value when adding raw materials and rice husks 2.5% where 20.659% to the upper layer and 17.551% of the lower layer at burning 850°. And the highest value for the absorption reached when adding raw materials and rice husks 5%, reaching 22.856% of the upper layer and 23.685% of the lower layer at burning 1050°. The less value when adding raw materials and sand 10% where 18.941% to the upper layer and 19.394% of the lower layer when adding raw materials and rice husks 2.5% at burning 1050°.

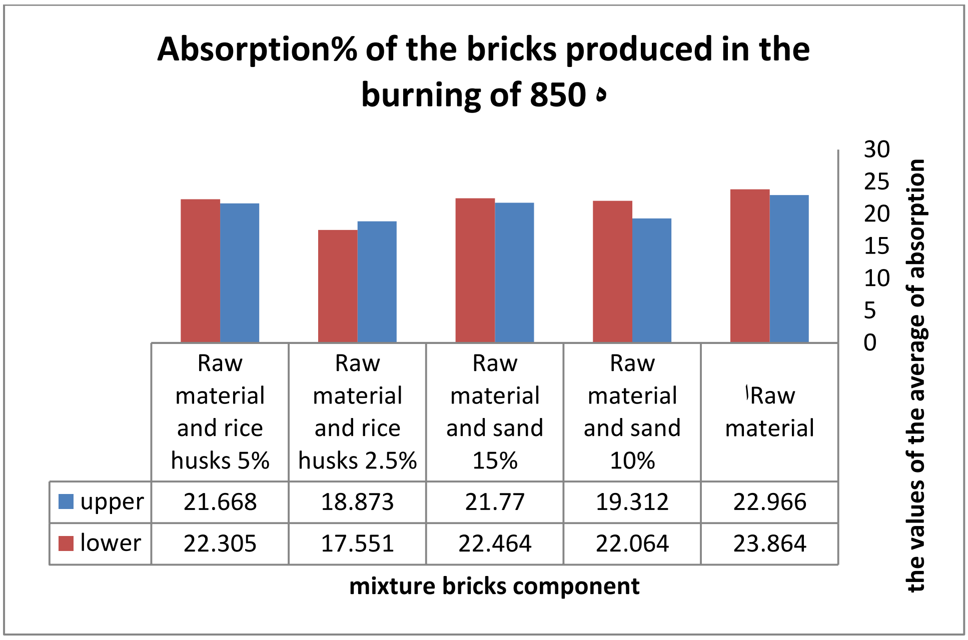


Fig (15) the effect of additives on absorption of bricks at burning 850°.

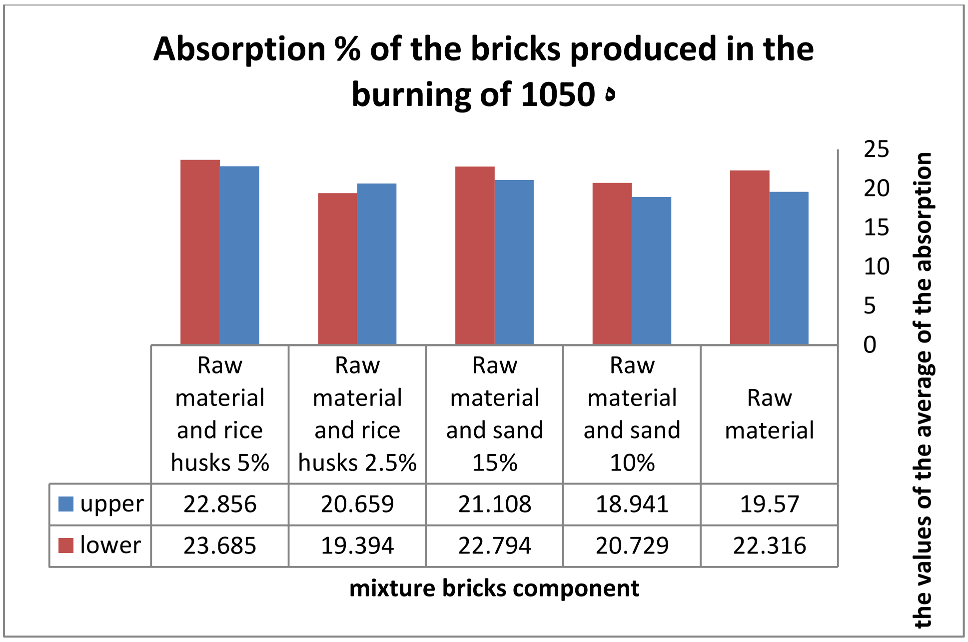


Fig (16) the effect of additives on absorption of bricks at burning 1050°.

6-3 Industrial evaluation of bricks product samples:

It is evaluated the bricks product samples and laboratory manufacturer by comparing the physical, engineering and chemical properties according to [14] and the [31]as follows in the tables (13) and (14) .When comparing the properties of brick product with [14]and [31]table (15) matching samples with classes (A, B, C), while the total rate of the samples for studied area they match classes (A,B) according to[14], while matching the total rate samples with [31]of all the rates match the class(A) except the mixture consisting of raw material match (B, C) at a temperature of (850°) and add of rice husks by(2.5%) give a best additives as matched class (A) according to [14]and [31] .

Table (13) show to [14].

(UPPER) efflorescence LIMITS	Maximum absorption of % brick	Minimum bearing of brick KN/m^2	CLASSES
sprightly	**22 %**	**16**	A
	20 %	**18**	A for 10 bricks
medium	**26 %**	**11**	b
	24 %	**13**	B for 10 bricks
high	**28 %**	**7**	C
	26 %	**9**	C for 10 bricks

Table (14) show to [31]

(UPPER efflorescence LIMITS)	Minimum absorption of %brick	Minimum bearing of brick KN/m^2	CLASSES
-	**20**	**17**	A
-	**25**	**15**	B
-	**-**	**9**	C

Table (15) show compared to the properties of brick product with[14].

NO	Stations	Levels	Bricks produced in the burning of 850 ° degrees different proportions of mixtures					Product bricks in the degree of burning 1050 ° different proportions of mixtures				
			Raw material	Raw material and sand 10%	Raw material and sand 15%	Raw material and rice husk 2.5%	Raw material and rice husk 5%	Raw material	Raw material and sand 10%	Raw material and sand 15%	Raw material and rice husk 2.5%	Raw material scales rice 5%
1	Stations 1	Upper	A	A	A	A	A	A	A	A	A	A
2		Lower	**B**	**A**	**B**	**A**	**B**	**B**	**A**	**B**	**A**	B
3	Stations 3	Upper	**A**	**A**	**A**	**A**	**B**	**B**	**A**	**A**	**A**	C
4		Lower	**A**	**B**	**B**	**A**	**B**	**B**	**B**	**A**	**A**	B
5	Stations 5	Upper	**C**	**A**	**A**	**B**	**C**	**A**	**A**	**B**	**A**	B
6		Lower	**B**	**B**	**A**	**A**	**A**	**B**	**B**	**A**	**A**	B
7	Stations 7	Upper	**A**	**A**	**B**	**A**	**A**	**B**	**A**	**A**	**B**	A
8		Lower	**B**	**B**	**B**	**B**	**A**	**A**	**B**	**B**	**A**	B
9	Stations 9	Upper	**B**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	A
10		Lower	**B**	**A**	**A**	**A**	**A**	**B**	**A**	**B**	**A**	B
11	Stations 11	Upper	**B**	**B**	**B**	**A**	**A**	**B**	**B**	**A**	**B**	B
12		Lower	**C**	**B**	**B**	**A**	**B**	**C**	**A**	**B**	**A**	B
13	Stations 13	Upper	**B**	**B**	**A**	**A**	**A**	**A**	**B**	**B**	**A**	B
14		Lower	**B**	**A**	**A**	**A**	**C**	**A**	**A**	**A**	**B**	A
15	Stations 15	Upper	**C**	**A**	**B**	**A**	**B**	**A**	**A**	**A**	**A**	B
16		Lower	**B**	**B**	**B**	**A**	**A**	**B**	**B**	**B**	**A**	A
	Average	Upper	**B**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	B

7- Conclusions:

1-The upper layer of Injana formation consists of brown, and reddish brown claystone layers as well as sandstone layers, while the lower layer consists of gray to gray-green claystone layers with siltstone and marl.

2- The grain size analysis of rocks for the Injana formation showed the claystone percentage is higher than those of siltstone and sandstone percentage. The claystone percentage ranges from (60-83.9%) and the average is (72.907%) . The percentage of siltstone ranges from (2.15 to 5.31)% and the average is (% (24.34). The percentage of sand is between (0-7%) and the average is (1.906%).

3- The values of physical properties of bulk density ,specific gravity, porosity, liquid limit, plastic limit, plasticity index, Stikicy limit and Riecke index of the upper layer of Injana formation more than the lower layer, while the cohesion (c)and the angle of internal friction(Ø) values of the upper layer of Injana formation more than the lower layer.

4- The claystone of Injana Formation provide the raw material for the bricks construction they match classes (A,B) according to [14]and match class(A) according to[31].

5. The best mixing of bricks product showed a significant improvement of the samples when (10%) of sand and (2.5%) from the husks rice when added of water absorption, uniaxial compressive strength and efflorescence.

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