Study of The Properties of Clay Brick Made with The Addition of Certain Additives

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Abstract :

This investigated is conducted to study the effect of adding of marble dust and polymer (Styrene Butadiene Rubber) on the properties of clay brick. Specimens manufactured from soil brought from (al-Huda plant of brick) located in Hilla . The proportions of the components of this soil were (% 49,% 18,% 33) (Clay, Sand, Silt), respectively, marble dust and (SBR) were added with percentages (12, 24,36) for marble dust and (5, 10, 15) for(SBR) by weight of dry soil. The properties of brick product were studied in two case ,in the first percentage of addition (water /soil) was (15) and the second was (27) , also studied the case of adding (SBR) without adding water with addition a constant percentage of (marble dust) for all proportions of (SBR). All Specimens were burnt in the same (al_Huda plant) at a temperature of (1000 ° C) after being dried natural for a period of (7 day), through practical results for all test observed that the marble dust and (SBR) when the (water / soil = 27%) have the negative effect for compressive strength but marble dust has the acceptable effect on properties (water absorption and efflorescence) . However when the (w/s=15%), the marble dust and (SBR) have an obvious positive effect for all properties of clay brick especially at addition of marble dust in (36 percentage) and (15 percentage) for polymer (SBR).

Keyword:-Clay Brick, Marble Dust, SBR, Efflorescence, water Absorption, Compressive Strength.

الخلاصة :-

تم إجراء هذا البحث لدراسة تأثير إضافة غبار الرخام والبوليمر (مطاط ستايرين البيوتاديين) على خصائص الطوب الطيني .صنعت النماذج بتربة تم جلبها من (معمل طابوق الهدى) الواقع في الحلة0كانت نسب مكونات هذه التربة هي (33 % ,18%, 49%) (Clay,Sand,silt)على التوالي. تم اضافة غبار المرمر بنسب (12%,24%, 36 %) و البوليمر SBR (0%،16%،20%،24%) من وزن التربة الجافة 0درست خواص الطابوق المنتج في حالة اضافة نسبتي الماء (15%) و(27%) و درست حالة اضافة نسب من (SBR) بدون اضافة ماء خلط و باضافة نسبة ثابتة من (غبار المرمر MD) لكافة نسب (SBR) في نفس المعمل تم حرق النماذج بدرجة حرارة (1000مئوية) بعد ان جففت لمدة (7 يوم) جفاف طبيعي ، من خلال النتائج العملية لكل الفحوصات لوحظ ان لغبار المرمر ومحلول (SBR) عند نسبة(ماء/ التربة =27%) تاثير غير ايجابي على مقاومة الانضغاط ولكن لغبار المرمر(MD) تاثير مقبول للخواص (الامتصاص والتزهر) اما عند النسبة (w/s= %15) فان لكل من غبارالمرمر والبوليمر (SBR) تاثير ايجابي واضح جدا على كل خواص الطابوق الطيني وخصوصا عند نسبة الاضافة (36%) لغبار المرمر و(15%) للبوليمر(SBR).

الكلمات مفتاحية:– الطابوق الطيني، غبار المرمر . البوليمر(SBR).التزهر في الطابوق . امتصاص الماء . مقاومة الانضغاط.

Introduction :

There are several trends regarding the development of the properties of bricks and the possibility for the development of certain additions of raw materials as marble dust was in the brick industry for the purpose of development and improvement of environmental conditions by investing of these materials as additives.

With the increasing demand for construction, Brick industry quality and cost of today is more important than before. Studies have an important role noticeable trend on the marble powder waste recycling in the production of bricks, which significant contributions to improving the environment and economy .

Rehman *et.al.*, 2014, studied using of marble dust and slag steel waste to manufacture of non-burnt brick which is proper for the environment , they found that bricks realize compressive strength maximum to traditional burnt clay bricks in lower than seven days also the results of water absorption for all the specimens were

achieved better values than values of the source specimens . However, water absorption of all the study bricks exceeded the permissible limits set by Indian and American standards. the use of marble dust and slag steel waste as clay replace auspicious for work, low cost bricks, environment friendly suitable having strengthfor efficiently using in the building industry.

Frieh *et.al.,* 1997, they reveal from the results of their research that the treatment of brick with paint of a polymer (SBR) solution by using the brush led to the low improvement in the compressive strength of both types of yellow and burnt brick compared with the untreated brick also it causes the absence of efflorescence phenomenon , but when using the style of submerge in (SBR) solution the compressive strength is decreases for both types of brick , especially when the submerging is for period (24) hours .

Baronio and Binda ,2011, studied the possibility of providing an important and required instructions for making and use of brick clay through their experimental tests (analysis of chemical , mineral and pozzolanicity) to consolidate effective a pozzolanicity under different temperature conditions .

Darshan *et.al.*, 2014, state in their study that the black soil bricks increases the compressive strength estimated at about 60% compared with normal bricks, an improvement in water absorption property by 20% and also that the black soil brick product a privileged plane surface, Free from cracks, homogeneous color and a clear mineral resonant . As for the change in size that has occurred in the bricks black cotton soil and as a result add some additives such as coal, sawdust is from 3-6 mm.

Swaminathan *et.al.,* 2009, showed that the physical property studies registered an addition of marble and granite dust at (50 wt. %) to the raw materials of brick confers high qualities for properties of brick when kilned at higher temperatures, such as bulk density and compressive, flexural strength, that results from the fact of the addition metallic materials (quartz and feldspar) , and also use of granite and marble waste as a raw material in the production of bricks alternative ideas exclude and worry about its effect on the environment .

Bökea *et.al.,* 2006, they used the tests XRD, SEM-EDS, AFM, TGA and chemical analyses to definition basic physical , the raw material compositions, the raw material compositions, mineralogical, and hydraulic properties of some historic Ottoman Bath brick-lime mortars and plaster , Test Results revealed that the crushed bricks powder that made from raw materials containing materials with a poor calcium having a very high pozzolanicity and also that the bricks used in the domes have poor pozzolanicity with various mineral and chemical compositions . According to the results of all the bricks analysis made with the large amounts of clay It has been selected consciously in innovate of the hydraulic mortars and plaster .

Saygili,2015, investigated the effectiveness addition of marble dust (MD) to clay soils, the test results showed that (MD) improves and solves all problems of the clayey soil, especially a phenomenon swelling, so the effective role may be in a good economical alternative in the active areas and It puts an end from environmental pollution , and state that the high plasticity specimens show better performance in the direct shears and welling tests low plasticity specimens show better performance in the unconfined compressive strength tests.

Bilgin *et.al.*, 2012, the results of their study demonstrate that the quantities of marble dust additive had a favorable effect on the chemical,physical and mechanical strength of the manufactured brick. With increasing demands of the construction industry, bricks quality and cost become more important from day to day. In addition, the usage of marble wastes for the production of industrial bricks has significant important role on the recycling waste marble powder in the brick production along with a great contributions to ecology of the country and economy.

Dhanapandiana and Shanthib, 2009, from the test results of (chemical and mineralogical analysis) in their Practical Search, it can be noticed that the addition wastes of granite and marble to the mixture of Rathapuram clay upto 50 wt.% with never harm effect in the properties of the products brick Which may calcification.

Deepa and Jain2 ,2013, their study results showed that depending on the prism tests and comparing its with the essential compressive stress from gained IS1905:1987 confirmed on crushing strength of bricks and mortar grade . The average value of the basic compressive stress of masonry which gained by prism test is 0.2 MPs and by IS1905:1987 is 0.292MPa.

Dhanapandian and Gnanavel ,2009, their study results revealed that the addition of marble dust and granite waste by 10% into the raw materials for the production of clay brick gradually increases water absorption , decreases the mechanical properties and unharmed Expectation and for human health, guaranteed ,then improve the environment.

Experimental Work:

Soil used :

Soil used in this study is brought from the(Al- Huda brick plant) located in Zaid bin Ali in Hilla. The proportions of the components of this soil are (33% ,%18, 49%)

(Silt, Sand, Clay), respectively. Tests of soil are made in the (Soil Mechanics and Environment) Laboratories in the College of Engineering (Table 1) and (Table 2) show the test results of physical and chemical properties of this soil.

Physical And Chemical Properties Of The Soil) : Table (1

values	Soil properties		ت
20	Moisture Content %		1.
2.67	Specific Gravity		2.
30	L.L%	Atterberg Limits	3.
17	P.L%		4.
13	P.I%		5.
49	Clay%	Grain Size Of Soils	6.
33	Silt%		7.
18	Sand%		8.
2.45	Sulphate %		9.
3.27	%Gypsum		10.
0.16	%Chloride		11.
23	%Carbonate		12.
0.017	Total Soluble Salts		13.
7.6	PH		14.
0.46	%Organic Matter		15.

Table(2): Diameter Of Soil Particles With Passing Percentage Of Finer Particles

D (mm)	% Passing
3.99	100.0
2.76	100.0
0.79	92.0
0.42	90.0
0.149	83.0
0.078	76.0
0.071	71.0
0.064	89.0
0.050	67.0
0.031	61.0
0.029	58.0
0.016	52.0
0.014	0.0

Marble Dust :-

The Marble Dust used in this study is brought from deposits of factories of cutting and shaping in Hilla.The physical and chemical properties are given in Tables (3) and (4).

Table (3) : Physical Properties of Marble Dust

Color	White
Form	Dust
Odor	Odorless
Moisture content (%): Fineness(kg/m2)	1.39 1500
Specific gravity : 2.29	

Table (4) : Chemical Properties of Marble Dust

Marble Dust (Mass %)	Oxide compounds
29.33	SiO_2
0.91	Al_2O_3
7.22	Fe_20_3
40.87	CaO
16.88	MgO
2.79	Density (g/cm^3)

(SBR) Styrene Butadiene Rubber:-

(SBR) used Brought from local market which is made by (Alshariqa comp.) in U.A.E ,its properties are given in Table (5).

Styrene Butadiene Rubber) SBR (of Properties: (5) Table

SBR	Property
18	Tensile strength (MPa)
565	Elongation at tear (%)
48.0	Mooney viscosity (100 °C)
2.1	Polydispersity

Mixing and preparing of Specimens:

Soil is cleaned well from the materials and organic materials, crushed,Softened and added the proportions to the water (27%) in the first stage and (15%) in the second stage homogeneity uniformly been confused to give a total strength and leave the mixture for a week "for the purpose of fermentation, then re-homogeneity and mixed and molded by adding the admixtures to give a mixture of acceptable plasticity.The specimens of brick was prepared by putting the mix with complete homogeneity , Manual compaction continued strong in wooden mold with dimension of (6.8, 10 .20) cm (height, width, length) Respectively, greased special oil for this purpose, at the fullness and access to surface models the removal of excess mix by a piece of metal, then the surface well settled by (manual trowels), models were left for a period of one week for the purpose of ensuring the dry-out and ensure that for cracks in the bricks, then placed in an oven at a temperature (110°C) , fully cooled ,put in the oven at a temperature of (1000°C) for purpose of burning it , get the form in its final form, conducted by engineering tests (water absorption, efflorescence and compressive strength) after cooled it. It has been taking the average of three results for each test for all specimens of clay brick. .

Water Absorption Test:

This test is made According to the Iraqi Specification (IQS:1988. NO.24) in the Concrete laboratory in College of Engineering. The specimens were placed in the oven at temperature of (110°C) for a period of 24 hours , then are weighed to take the dry weight, put in the water for 24 hours ،dried with a clean cloth, and weighed to take the wet weight , The average of the three test results for each Specimen is taken. The percentage of water absorption is calculated by weight difference between the Specimen immersed in water and the dry Specimen using the following Equation : -

$$\text{Water absorption ratio \%} = \{(\text{wet weight} - \text{dry weight}) / \text{dry weight}\} * 100$$

Efflorescence Test :

This test is made According to the Iraqi Specification (IQS 1988, No.24) in the Concrete laboratory in our College of Engineering.

Each specimen is put on its end in flat small container containing distilled water for seven days , and isadded the water when its dry ,then left in the same room without water for three days for the purpose of drying up, and a development of the efflorescence phenomenon , after that Calculated total efflorescence area in each specimen . The average of the three test results for each Specimen is taken.The efflorescence ratio is calculated by the following equation :

$$\text{efflorescence ratio \%} = \{(\text{Total areas of efflorescence} / \text{Total areas of brick sides})\} * 100$$

Strength Compressive Test :

This test is made According to the Iraqi Specification (IQS 1988: NO.24) in the Concrete laboratory in our College of Engineering ,a machine with capacity of (1900 KN) as shown in plate (2) is used in this test. Specimens is immersed in the water at room temperature and left to for at least (24) hours, remove from the water and then allows the water to drine for five minutes , then wipe with a clean cloth and placed in a testing device between two sheets of plywood) until failure (put the loading rate at (140 (kg / cm 2), After the failure occurs take the reading of (load failure) to measure of Compressive strength .The average of the three test results for each Specimen is taken.

Compressive strength is Calculated by the following equation :--

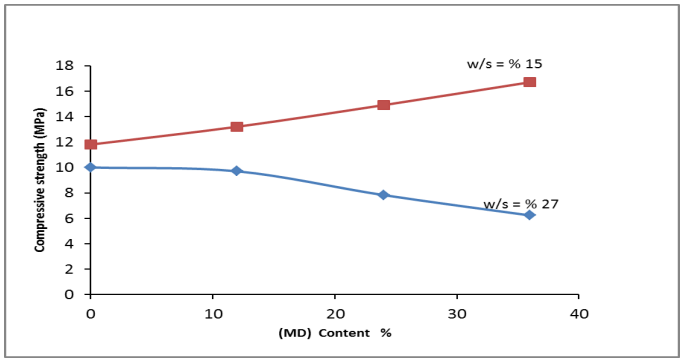
Compressive strength (Mpa) = load failure (N) / Surface area(mm2)

Results And Discussion:

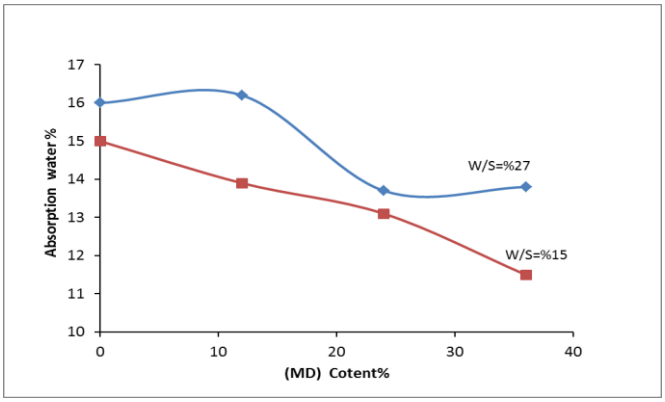
From the experimental results of this study which are summarized in Tables (6,7,8) and plotted in Figures (1—14), it can be observed that the compressive strength of clay brick is decreased when (MD) admixtures added and w/s is (27) percentage ,but the another properties like as water absorption and the efflorescence were ameliorated ,these attributes are to be confirmed from the results which is apparent in Table(6) and Figures (1,2, and 3) .

Table (6): Effect of Addition of (Marble Dust) on Properties of Clay Brick.

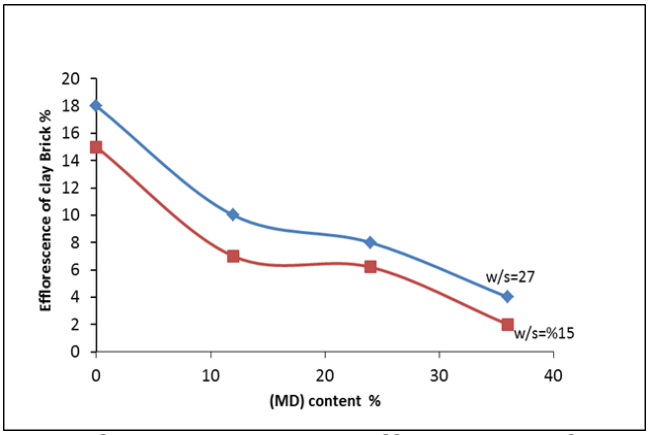
NO.	MD %	W/S %	Compressive Strength (Mpa)	Absorption %	Efflorescence %
1	0	27%	10.5	16	18
2	12	27%	9.7	16.2	10
3	24	27%	7,83	13.7	8
4	36	7%2	6.23	14.8	4
1	0	15%	11.5	15	15
2	12	15%	13.2	13.9	7
3	24	15%	14.9	13.1	6.2
4	36	15%	16.7	11.5	2



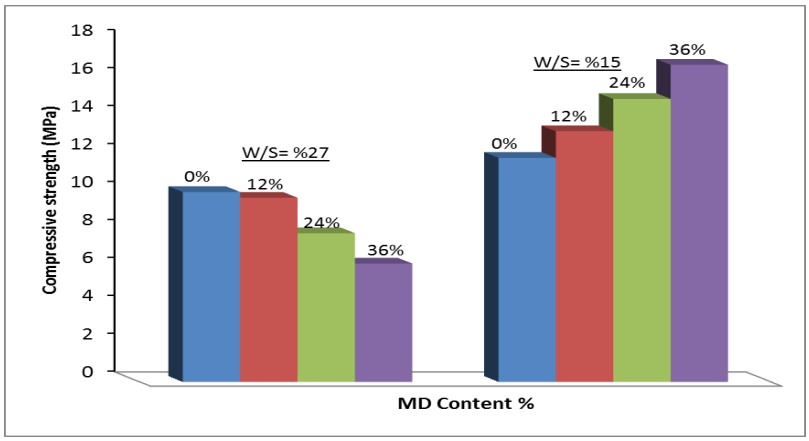
Fig(1) : Effect of Adding of Marble Dust (MD) Contents on Compressive Strength of Clay Brick



Fig(2) : Effect of Adding of (MD) Contents on Water Absorption of Clay

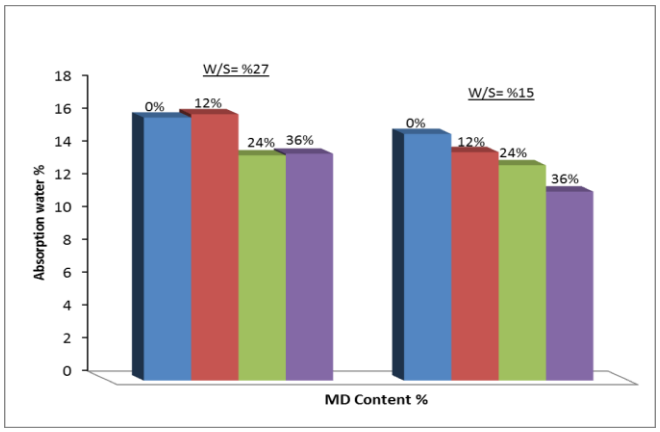


Fig(3) : Effect of Adding of (MD) Content on Efflorescence of clay Brick

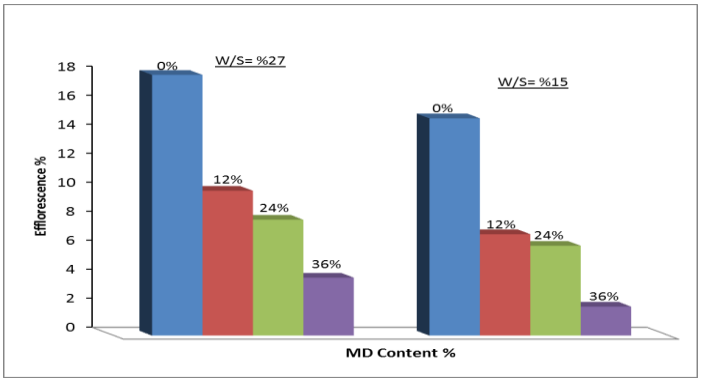


Fig(4) Effect of Adding of (MD) Contents on Compressive Strength of Clay Brick

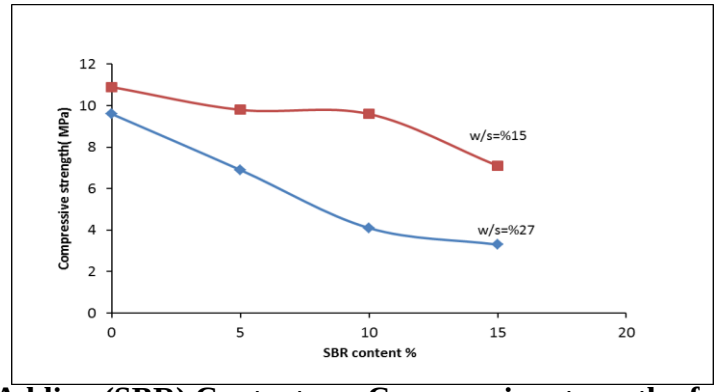
The same of The above-mentioned Tables and Figures are reveal that when the proportion of w/s is (15) percentage this situation is Contributed in the increment of all characters of clay brick especially of the efflorescence property where the increase is about (86.6) percentage at addition of (MD) is (36) percentage and the increase of about (45) percentage for compressive strength at the same proportion , and it can be noticed from Table (7) and Figures (7,8,9) that when the proportion of (w/s) for all mixes making brick is (27%) the properties for specimens of clay brick have negative effect especially at addition of (SBR) of (15%) where the increasing in the efflorescence is about of (132%) while at addition of (w/s =15%) the properties of (compressive strength and efflorescence) are improved ,but the property of (water absorption) is not improved where the increasing of (water absorption) is (10.4%) at (15%) of SBR content , the increment of compressive strength is at the (15) percentage of (SBR) is (13.5%) and the reduction of the efflorescence is (50%).



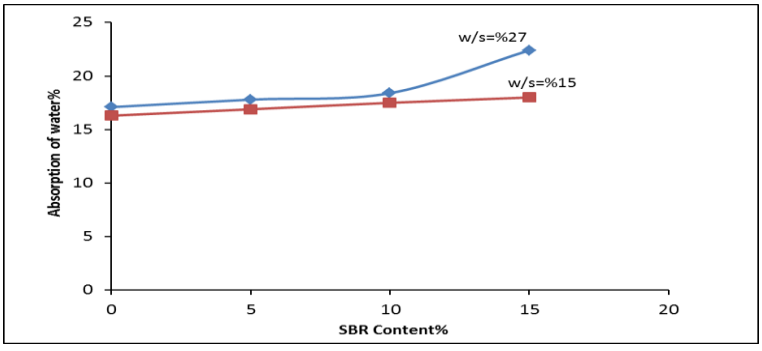
Fig(5) Effect of Adding of (MD) Contents on Water Absorption of Clay Brick



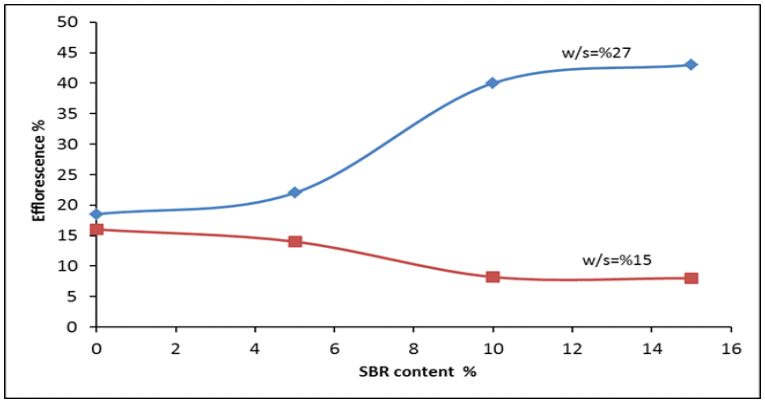
Fig(6) Effect of Adding of (MD) Contents on Efflorescence of Clay Brick



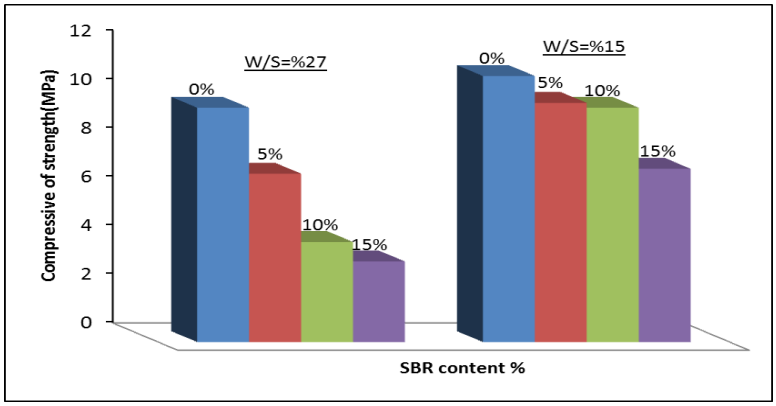
Fig(7) : Effect of Adding (SBR) Contents on Compressive strength of clay Brick



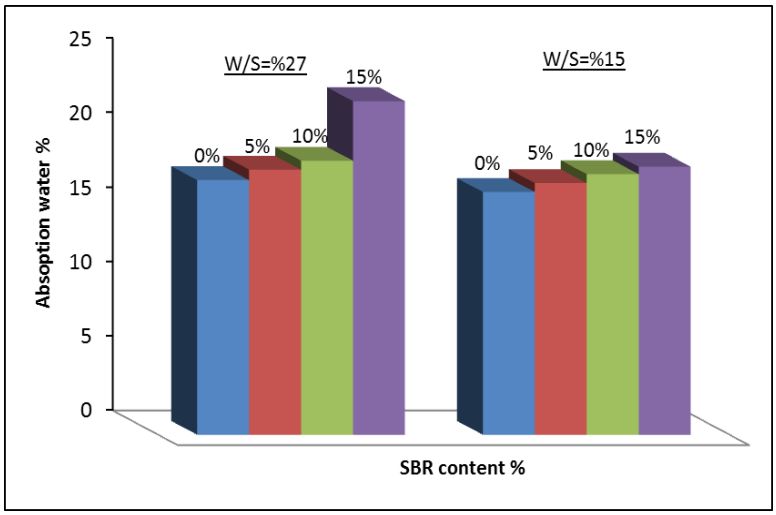
Fig(8) : Effect of Adding of (SBR) Contents on water Absorption of Clay Brick



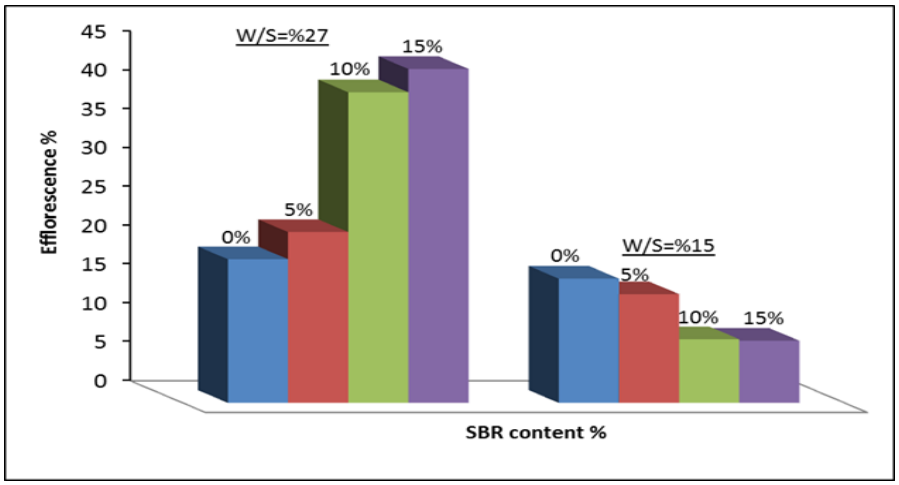
Fig(9) : Effect of Adding of (SBR) Contents on Effloresecence of Clay Brick



Fig(10) Effect of Adding of (SBR) Contents on Compressive strength of Clay Brick



Fig(11) : Effect of Adding of (SBR) Contents on water Absorption of clay Brick



Fig(12) : Effect of Adding of (SBR) Contents on Efflorescence of clay Brick

Table(7): Effecte Of Adding of (SBR) On Properties of Clay Brick

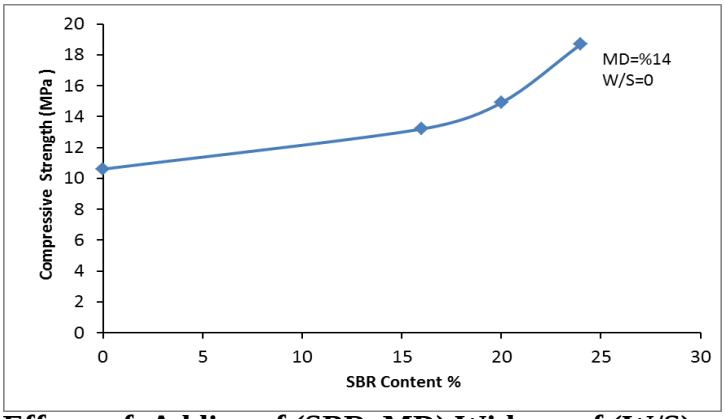
NO	SBR %	W/S %	Compressive Strength (Mpa)	Absorption %	Efflorescence %
1	0	27%	9.6	17.1	18.5
2	5	27%	6.9	17.8	22
3	10	27%	4.1	18.4	40
4	15	27%	3.3	22.4	43
1	0	15%	10.9	16.3	16
2	5	15%	9.8	16.9	14
3	10	15%	9.7	17.5	8.2
4	15	15%	7.1	18	8

Table(8): Effect Of Adding Of (SBR ,MD) Without (W/S) On Properties Of Clay Brick

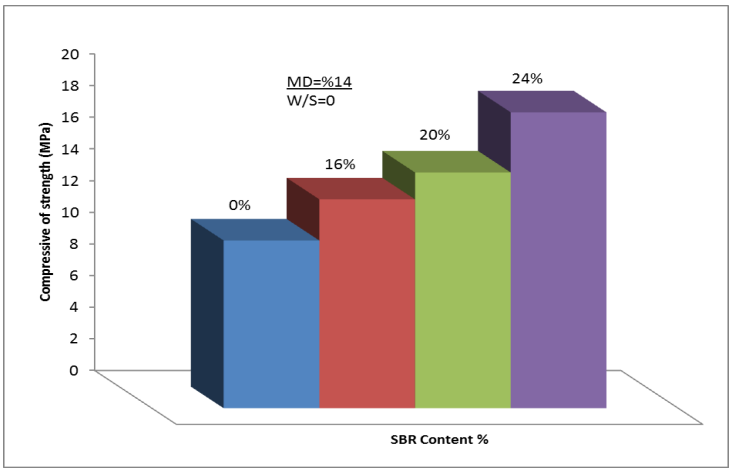
SBR %	MD %	W/S %	Compressive Strength (Mpa)
0	14	0	10.6
16	14	0	13.2
20	14	0	14.9
24	14	0	18.7

Table (8) is revealing of the test results of the compressive strength in addition of Different contents of (SBR) admixture when (w/s=0%) ,(MD=14%),from these results it can be noticed that an increment in compressive strength with the increasing of (SBR)contents , the increasing are (24.5%, 40%,76.4%) with (SBR) contents of (16% , 20% , 24 %) respectively.

Plate(1): Mold and Specimens of Clay Brick Made with Adding of (marble dust)



Figure(13): Effecte of Adding of (SBR ,MD) Without of (W/S) on Properties of Clay Brick



Figure(14): Effecte of adding (SBR,MD) without (w/s) on properties of clay brick

Plate (2): Compressive Strength Testing Machine

Porosity decreases because of the increasing sintering process with the increasing temperature. But marble powder shows the opposite behavior under the effect of the sintering temperature due to releasing of CO2, which leads to porous in the structure depending on Sometimes of the conditions associated with that process related brick industry.

Conclusion :

1) The addition of (marble dust) admixture on clay brick mixes at high contents of (w/s) decreases a compressive strength and to improve the properties of water absorption and efflorescence.
2) The addition of (marble dust) admixture on clay brick mixes at low contents of (w/s) causes the obvious positive effect on compressive strength , efflorescence and water Absorption , especially the efflorescence property .
3) All properties of clay brick specimens have increased with increasing of the (marble dust) contents when using of w/s of (15) percentage .

4) Adding of (Styrene Butadiene Rubber SBR) contents on all clay brick make mixes decreases compressive strength , efflorescence and water Absorption .
5) The addition of (Styrene Butadiene Rubber) admixture without of (w/s) and Adding of constant content of (marble dust) has a significant effect on compressive strength, where the compressive strength is increasing with the increase of (SBR) polymer contents .

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