Effect of Addition of A Marble Dust on Drying Shrinkage Cracks of Cement Mortar Reinforced with Various Fibers

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ABSTRACT :

This investigation is conducted to study the effect of addition of marble powder (marble dust) and different fibers on drying shrinkage cracks and some properties of fibers reinforcment cement mortar. Steel molds having a trapezoidal section, and the end restrained at square shape with(2.7 meter) at length are used to study restrained drying shrinkage of cement mortar. Specimens of (compressive .flextural. splitting strength) were cast. The admixture (marble dust) was used to replacie weight of cement with three levels of (4%, 8% and 16%) and the fiber hemp and sisal fiber were added for all mixes with proportion by volum of cement . All specimens were cured for (14 days). Average of three results was taken for any test of compressive, tensil and flextural strength. The experimental results showed that the adding of this admixture(marble dust) cause adelay in a formation of cracks predicted from a drying shrinkage ,decreases of its width , and hence increases of (compressive, splitting tensil and flextural strength) at levels of (4%, and 8%). Thus there is a the positive effect when fiberes added for all mixes of cement mortar with addition of (marble dust). All The admixtures (marble dust and fibers) have the obvious visible effect in the delay of the information of shrinkage cracks and the decrease of its width as Compared to the cement mortar mixes when marble dust added a alone.

Key words :- marble dust, cement mortar , Compressive strength , drying shrinkage cracks, tensil strength , sisal fiber , hemp fiber , flextural strength.

الخلاصة

هذه الدراسة تهدف الى دراسة تأثير اضافة (غبار المرمر) مع الياف مختلفة على انكماش الجفاف وبعض الخواص لمونة السمنت المسلحة بالالياف، في هذه الدراسة تم استخدام قوالب حديدية بمقطع على شكل شبه منحرف بطول (2.7 متر) ومن نهايتيه قالب بشكل مربع لغرض تقييد النموذج لضمان حدوث (تشققات انكماش الجفاف) لمونه السمنت وأيضاً تم صب نماذج لغرض تعيين مقاومة الانضغاط ومقاومة الانشطارو الانثناء. استخدمت ثلاث نسب مئوية من (مسحوق المرمر) وهي (4% مر و 8% و 16%) كاستبدال من وزن السمنت ، واستخدمت الياف (السيسال واالقنب). بنسب حجمية من السمنت .تم انضاج النماذج جميعاً بفترة إنضاج (14 يوم). تم اخذ معدل ثلاثة نتائج لكل فحص من مقاومة الانضغاط والشد و الانثناء. أوضحت النتائج العملية أن إضافة ا المضاف(MD) يؤخر حدوث التشققات الناتجة من (انكماش الجفاف) لمونة السمنت ويقلل من عرضها ويزيد من مقاومة الانضغاط والشد و الانثناء عند النسب (4% و 8%) ونفس التاثير عند اضافة الالياف لمونة السمنت جميعا و كل على حدة مع (غبار المرمر) ولكل نسب الاضافة لها . وعند اضافةالالياف مع غبار المرمر سوية نلاحظ تأثير ملموس في تأخير حدوث (تشققات الانكماش)في مونة السمنت و تقليل في عرض تلك التشققات مقارنة مع خلطات مونة السمنت المضاف لها غبار المرمر لوحده .

الكلمات المفتاحية : غبار المرمر.مونه المنت. مقاومه الانضغاط . تشققات انكماش الجفاف.مقاومه الشد. مقاومه الانثناء. الياف السيسال . الياف القنب.

INTRODUCTION :

Marble dust comes as a by-product of marble re-shaping, which is formed by the dolostone or crystallization of limestone. As a calcite material through different atmospheric and temperature changes, the crystals will appear. Similar to that of crushed limestone, marble dust is characterized by it's fine powder texture. The dust has a slight shimmer to it, because of the crystallized particles,.

Since the ancient times material as a building, has been commonly used. Marble waste (as a by-product) is a very important material which requires adequate environmental disposal effort. Either as a filler material in cement or fine aggregates, the material by-product from the marble can be used in concrete.

Using of marble powder in building industry, is a one of the logical means for reduction of the waste. Some attempts have been established on strength and workability were to find the possibilities of using the powder in mortars and concretes comparing with conventional samples of mortar and concrete.

LITERATUREREVIEW

(Valeria, *et. al.,* 2008), studied the cohesiveness of mortar and concrete. During concrete placing, due to high fineness of marble powder, the cohesiveness affect the tendency of energy loss, as usual for other ultra-fine mineral additions (such as silica fume) .

(Baboorai *et.al.,* 2011), studied of partial replacement of marble powder (as an additive) of cement or any other fine and its effect on the concrete properties. The experimental test showed that using marble powder enhances the compressive strength and workability of concrete and mortar tests.

. (Omar *et.al.,*2012) , studied the experimentally the effect of partial replacement of limestone waste and/or marble powder of sand on the concrete properties. The percent of replacement limestone waste of sand was 25%, 50%, and 75%. While, the mixes present of marble powder were 5%, 10% and 15%. The experimental work test flexural strength, modulus of elasticity, permeability, compressive strength, and indirect tensile strength. They found that the slump test enhanced with using limestone. Also, they notice good performance in presence of limestone with marble powder.

(Sounthararajan *et . al.,* 2013) , studied the enhance of concrete strength by marble powder lime content. They studied partial replacement of cement by 10% of the waste powder on mechanical properties of hardened concrete (such as splitting tensile strength, flexural strength and compressive strength with different percentage).

(Vaidevi, 2013) , studied the partial replacement of marble dust of cement effect on concrete. In their investigation they used marble dust, as cementitious material, on the concrete mixtures. The study showed that lower cost, in construction of buildings, occurs by using more marble wastes than those in ordinary concrete materials.

(Manju *et.al.,* 2014) , studied the Partial Replacement of of Marble Waste Powder by Cement. They noticed that optimum replacement of marble powder percentage with cement is 12.5 % of cement for mechanical properties tests.

(Kishan *et .al.,* 2015) , they studied of using marble powder and fly ash to substitute cement.The study showed that no negative effect of workability of SCC. the use of 10% marble powder and 25% Fly Ash to Substitute cement in binder material is increased The Fresh property such as Filling ability and Passing ability is . the increase of Marble powder in SCC increases slump flow, and decreases both T50 test time and V –funnel time.

(Bhupendra *et.al.,* 2015) , showed that the waste marble powder is capable of improving hardened concrete performance and compressive strength of the concrete has increased with the increas percentage of marble powder additions up to 20%

(Raminder and *et. al.,* 2015), studied the effect of partial replacement of waste marble waste of cement on mechanical properties and workability decrease. Same effect on the workability of concrete can be seen for the partial replacement of coarse aggregates with tile aggregates. Partial replacement of cement with waste marble Powder increases Compressive Strength of concrete upto 10% , while partial replacement of coarse aggregates with tile aggregate increases Compressive Strength upto 30 %. They noticed that if the replacement level increased from 10% to 15% for waste marble powder and 30% to 45% of tile aggregates, a decrease in the compressive strength of concrete will occure.

(Disha , Mohd. , Abhishek 2016), studied the effect of curing days of marble dust concrete in the strength of concrete. They found that the increase of curing days would increase the strength but up to specific limit and after that the strength will decrease.

(Rishi *et.al* .,2014), studied the experimental effect of replacement sand and/or cement with marble waste powder or granular. They noticed that this replacement enhanced the split tensile and compressive strength up to certain limit. While, this strength is decreased in case of replacement of combination sand and cement.

EXPERIMENTAL WORKS:

Materials:

1. Cement:

Ordinary Portland cement (Type 1) from Al-kouffa cement factory is used for cement mortar mixes. This cement conformed to the Iraqi specification (IQS NO 5-1984). The physical and chemical properties are given in Table (1) and Table (2).

Table (1): Physical Properties Of The OPC Used.

Physical properties	Test Result	I.O.S.NO5: 1984
Fineness, blain test (m^2/kg)	332	$\geq$ 230
Sitting time, Vicat's method Initial hrs:min Final hrs:min	 1: 11 2: 28	 $\geq$ 00:45 $\leq$10: 00
Compressive strength of 70 mm Cube (MPa) 3day 7day	 20.3 28.6	 $\geq$ 15 $\geq$ 23
Soundness %, (Auto clave) method	0.48	$\leq$ 0.8

Table (2): Chemical Properties Of OPC Used.

Oxide	(%)	I.O.S. NO5: 1984
CaO	63.93	-
SiO_2	22.0	-
Al_3O_3	5.3	-
Fe_2O_3	3.65	-
MgO	3.84	$\leq$5%
SO_3	2.43	$\leq$2.8%
L.S.F	0.91	0.66 – 1.02
L.O.I	1.74	$\leq$4%
I.R	0.95	$\leq$1.5 %
Compounds Composition	**(%)**	**I.Q.S. NO5: 1984**
C_3S	37.3	-
C_2S	32.8	-
C_3A	9.22	-
C_4AF	10.44	-

2. Fine Aggregate:

Natural sand from Al- Akhaidur was used. Its grading and other characteristics conformed to the Iraqi specification (IQS NO.45- 1984) as shown in Table (3).

Table (3): Properties Of The Sand Used.

Sieve size (mm)	Percent passing (%)	(I.O.S. NO45 : 1984)
9.5	100	100
4.75	100	90-100
2.36	91	85-100
1.18	81	75-100
0.6	68	60-74
0.3	17	12-40
0.15	7	1-10
Impurities content	1.9	≤ 3
Sulphate content SO_3	0.084	≤ 0.05
Fineness modules	2.37	-

3.Marble:

The Marble Dust chosen for these experiments was white coloured. It is directly obtained from deposits of marble factories during cutting and shaping . Marble Dust was sieved with sieve (No 0,25mm) .The physical and chemical properties are given in Tables (4) and (5).

Table (4) : Physical Properties Of Marble :

color	white
form	dust
odor	odorless
moisture content (%): fineness(kg/m2)	1.45 1500
Specific gravity : 2.31	

Table (5) : Chemical Properties Of Marble

Oxide compounds	Marble Dust (Mass %)
SiO_2	30.35
Al_2O_3	0.92
Fe_20_3	7.48
CaO	41.45
MgO	17.29
Density (g/cm^3)	2.80

4. Sisal fibre:

Sisal fibers brought from the local market separated from each other and cut at lengths (12-16 mm),Table(6)shows the general specifications, plate(1) shows Sisal fibers.

Table(6). Physical And Mechanical Properties Of(Sisal Fibre) Description Sisal Fibre. (Chatveera And Nimityongskul, 1987)

Diameter (mm)	0.15-0.26
Length (mm)	12-15
Apparent specific gravity	0.69
Moisture content (%)	11.00
Water absorption (%)	119.00
Tensile strength (MPa)	297.83
Modulus of elasticity (GPa)	11.37

Plate(1): sisal fibers used in this study

5. Hemp fiber:

Hemp fibers brought from the local market separated from each other and cut at lengths (10mm), Table(7) shows the general properties of hemp fiber , and plate(2) shows this fibers.

Table (7): Typical Properties Of Hemp Fiber (Recent Projects).

Elongation at failure %	Apsorption %	E/ Denstiy %	E (Gpa)	Tensile strength N/mm2	Denstiy gr/cm3
1.6	8	47	70	400-500	1.48

Plate (2) : Hemp Fiber Used In This Study

Molds:

The molds used in this study are as follows:

1. Channel shape steel molds having a Trapezoidal section, (2700) mm in length, dimension of section (80, 50, 60) mm (top base, bottom base, height) respectively, This frame is used to study shrinkage cracking of end (restrained cement mortar specimens).
2. (50 * 50 * 50) mm cube steel molds of cement mortar specimens for compressive strength test, for tensile strength cylinders (100,200)mm, and prisms (100,100,300) mm for flextural strength . For the Trapezoidal section steel mold, a layer of polyethylene sheets was put over the mold base after being cleaned and carefully oiled to minimize base friction with shrinkage specimens of cement morta
3. **Mix design:**

The cement mortar mix is designed according to (ASTM C270-14a). The quantities of the materials for cement mortar are as follows:

Mix proportions	1 : 3 (cement : sand)
W/C ratio	0.10 (by weight of (cement + sand))

Cement (kg/m^3)	Sand (kg/m^3)	Water (kg/m^3)
560	1685	233

Curing:

Wet hassian sheet and polyethylene sheets were used to cover the surface of shrinkage specimens after casting to prevent plastic shrinkage cracking due to rapid evaporation from the upper surface of specimens. The chosen period of curing time is (14 days). Compressive, tensile and flextural strength specimens are put in water at ($22^{\circ}C$) for (14 days) after their being covered with polyethylene sheets.

Testing:

1. Drying shrinkage Test:

This test was done according to (ASTM C1581M-09a). Cement mortar specimens were tested for restrained shrinkage cracking. The end of the mold offers an end- restraint to the web, which would be formed as result of the stresses induced from concrete shrinkage. Reading was taken at the occurrence of crack, till when no movement could be recorded. A crack dial microscope took in the reading for the crack width at (different periods). Results average for two specimens for each mix was taken. Portable dailed CrackeMeter are shown in Plate(3)

Plate(3): Portable dailed CrackeMeter

Plat(4): Specimens For Drying Shrinkage Cracks.

2. Compressive, Splting Tensil And Flextural Strength Tests:

Compressive test was done according to (ASTM C109/C109M-13), **tensil** test was done according to ASTM C496/C496m and flextural test was done according to ASTM (C348 – 14) . The specimen's surfaces should be dried from the excess water after taken out from water tank and kept in the laboratory for two minutes to obtain saturated dry surface specimens before testing. Average for three results was taken for each mix except for drying shrinkage specimens, that it was two for each mix.

The results of the compressive strength tests of specimens with and without admixtures are given in Table (8,9,10) and Figure (1,2,3,4 ---------12). Results illustrate that the increase of admixture (Md) addition increases the compressive strength up to level (8%). There was a reduction of about (16 %). AL-Khalaf, 1983, The reduction of water powder ratio (W/P) can be attributed to the increase of compressive strength, that due to absorption of these fine particle to water content, and the effect of their fineness and large surface area, cement mortar density. Especially at early age, and that can be attributed to the accelerated hydration cement paste. The cause of the reduction in compressive strength at level (16%) was due to the high fineness, high absorption of water and the large amount of this admixture, which leads to lack in hydration action and presence of air voids in cement mortar structure.

Table (8): (Compressive , Tensil And Flextural Strength) Test Results For The Cement Mortar Specimens Made With And Without Of (MD).

Mixes symbol	Admixture content (by weight of cement) %	Compressive strength at age (14 days) MPa	tensil strength at age (14days) MPa	flextural strength at age (14days) MPa
MD0	0	24.97	1.95	3.76
MD4	4	26.11	2.13	3.86
MD8	8	28.34	2.21	4.14
MD16	16	23.66	1,87	3.34

Table (9): Compressive , Tensil And Flextural Strength) Test Results For The Cement Mortar Specimens Made With And Without Of (MD And (Sisal Fiber.).

Mixes symbol	Admixture content (by weight of cement) %	Compressive strength at age (14 days) MPa	tensil strength at age (14 days) MPa	flextural strength at age (14 days) MPa
*MD0	0	24.97	1.95	3.76
**MDsf1	4	32.55	3.52	5.22
***MDsf2	8	34.24	3.99	5.61
***MDsf3	16	36.89	4.67	5.76

* cement mortar mix without((MD)and fiber) .
** cement mortar mix with ((MD 4%) and(sf 0.4 %).
*** cement mortar mix with (MD 8%) and(sf 0.8 %).
**** cement mortar mix with((MD 16%) and(sf 1.2%).

Table (10): Compressive , Tensil And Flextural Strength) Test Results For The Cement Mortar Specimens Made With And Without Of { (MD) And **(Hemp Fiber.)}.**

Mixes symbol	Admixture content (by weight of cement) %	Compressive strength at age (14 days) MPa	tensil strength at age (14 days) MPa	flextural strength at age (14 days) MPa
*MD0	0	24.97	1.95	3.76
** MD hf1	4	30.55	3.9	5.8
*** MD hf2	8	34.44	3.95	5.89
**** MDhf3	16	34.11	4.44	5.80

* cement mortar mix without((MD)and fiber) .
** cement mortar mix with ((MD 4%) and(hf 0.4 %).
*** cement mortar mix with (MD 8%) and(hf 0.8 %).
**** cement mortar mix with((MD 16%) and(hf 1.2%).

Table (11): Crack Development And Crack Width For Cement Mortar Specimens Made With And Without Of Admixture (MD) At Drying Period (130 Days).

Control Specimens (0%)(MD)	Drying period (days)	7	15	30	40	50	60	70	80	90	130
	Crack width (mm)	0.20	0.33	0.53	0.62	0.77	0.83	0.89	0.89	0.89	0.89
Specimens with admixture contains (4%)(MD)	Drying period (days)	10	18	28	38	48	58	68	80	90	130
	Crack width (mm)	0.12	0.12	0.23	0.28	0.37	0.44	0.49	0.55	0.55	0.55
Specimens with admixture contains (8%)(MD)	Drying period (days)	14	22	30	40	50	60	90	100	130	
	Crack width (mm)	0.08	0.11	0.23	0.33	0.49	0.52	0.52	0.52	0.52	
Specimens with admixture contains (12%)(MD)	Drying period (days)	43	72	80	90	100	130				
	Crack width (mm)	0.20	0.29	0.29	0.30	0.30	0.30				

Table (12): Crack Development And Crack Width For Cement Mortar Specimens Made With And Without Of Admixture (Md , Sf) At Drying Period (130 Days).

Control Specimens (MDsf 0)	Drying period (days)	7	15	30	40	50	60	70	80	90	130
	Crack width (mm)	0.18	0.28	0.45	0.62	0.72	0.85	0.85	0.89	0.89	0.89
Specimens with admixture contains (MDsf 1)	Drying period (days)	15	18	28	38	43	54	69	80	90	130
	Crack width (mm)	0.10	0.16	0.23	0.29	0.40	0.41	0.50	0.58	0.58	0.58
Specimens with admixture contains (MDsf 2)	Drying period (days)	17	20	36	42	58	60	90	100	130	
	Crack width (mm)	0.13	0.19	0.27	0.33	0.43	0.50	0.50	0.50	0.50	
Specimens with admixture contains (MDsf 3)	Drying period (days)	39	66	80	93	100	130				
	Crack width (mm)	0.26	0.30	0.37	0.37	0.37	0.37				

Table (13): Crack Development And Crack Width For Cement Mortar Specimens Made With And Without Of Admixture (Md , Hf) At Drying Period (130 Days).

Control Specimens (MD hf 0)	Drying period (days)	7	15	30	40	50	60	70	80	90	130
	Crack width (mm)	0.22	0.40	0.57	0.68	0.76	0.83	0.89	0.91	0.91	0.91
Specimens with admixture contains (MD hf 1)	Drying period (days)	21	34	40	45	51	58	73	80	90	130
	Crack width (mm)	0.11	0.15	0.27	0.31	0.38	0.48	0.48	0.59	0.59	0.59
Specimens with admixture contains (MD hf 2)	Drying period (days)	25	30	38	40	53	58	88	98	130	
	Crack width (mm)	0.05	0.11	0.20	0.31	0.44	0.52	0.56	0.56	0.56	
Specimens with admixture contains (MD hf 3)	Drying period (days)	56	70	80	90	100	130				
	Crack width (mm)	0.17	0.25	0.25	0.33	0.33	0.33				

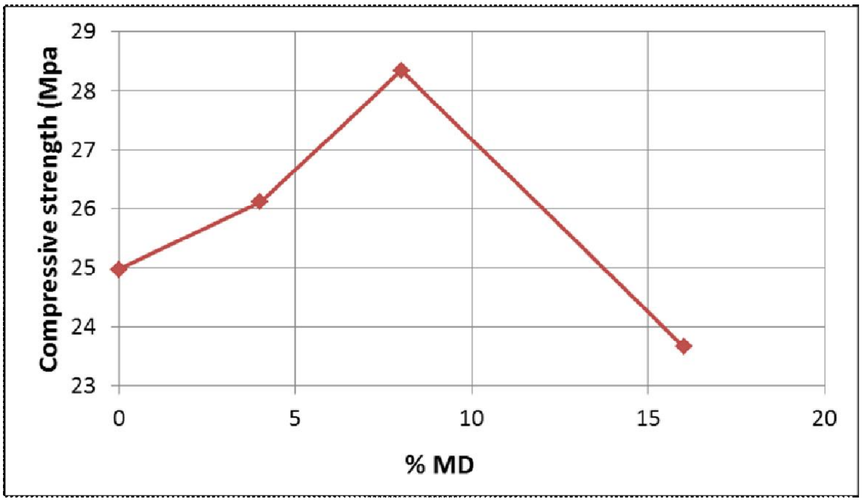

Fig: (1): Compressive Strength Test Results For The Cement Mortar Specimens Made With And Without (MD) .

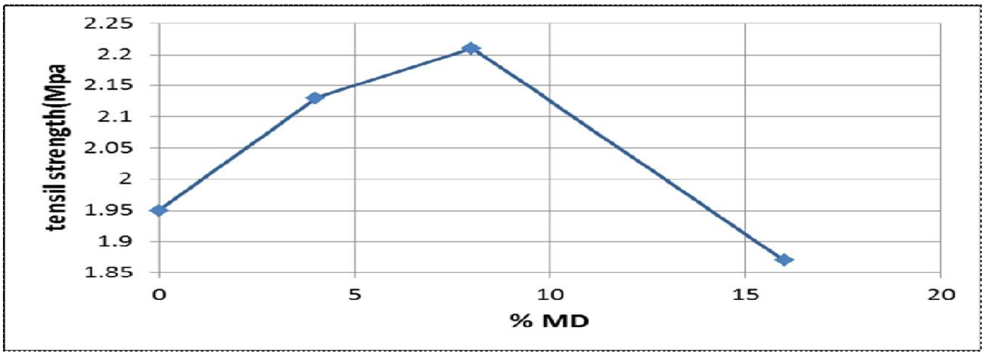

Fig: (2):Tensil Strength Test Results For The Cement Mortar Specimens Made With And Without (MD) .

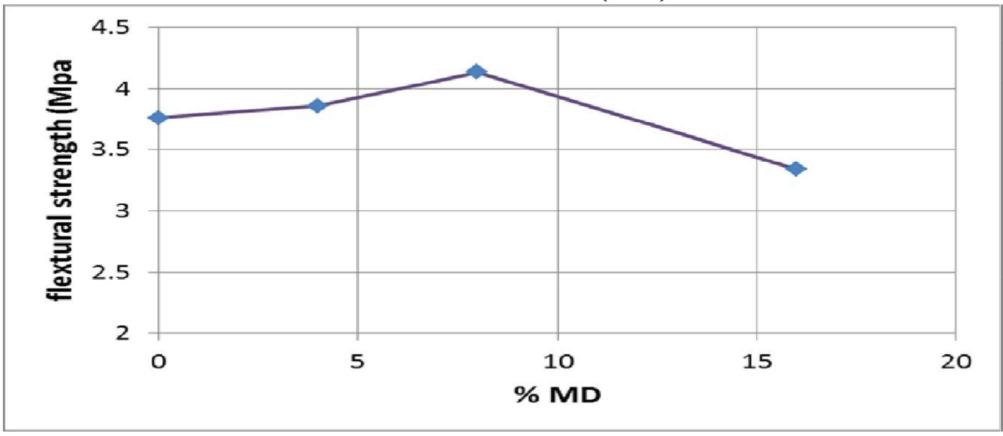

Fig (3): Flextural Strength Test Results For The Cement Mortar Specimens Made With And Without (MD) .

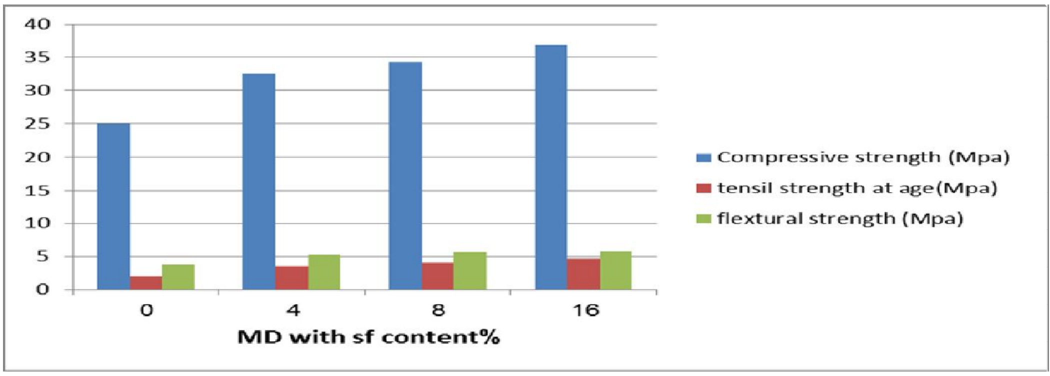

Fig (4) :(Compressiv,Tensil, And Flextural Strength) Test Results For The Cement Mortar Specimens Made With And Without (MD) .

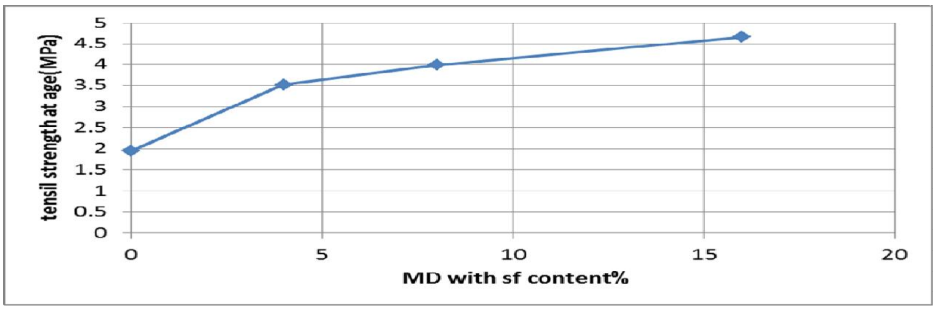

Fig (5): Compressive Strength Test Results For The Cement Mortar Specimens Made With And Without (MD, Sf)

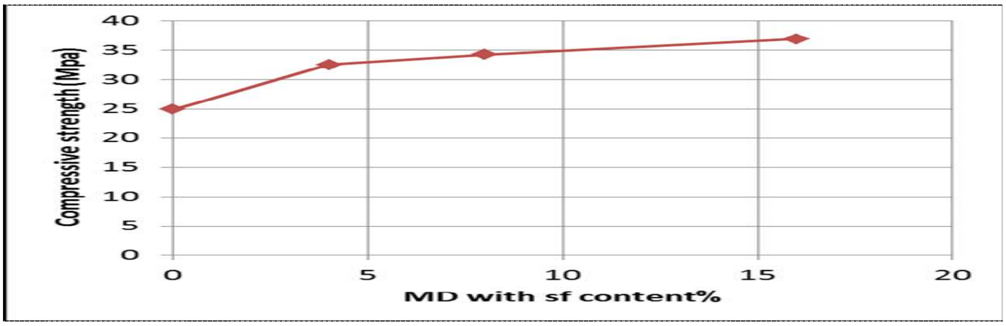

Fig: (6): Tensil Strength Test Results For The Cement Mortar Specimens Made With And Without (MD,Sf) .

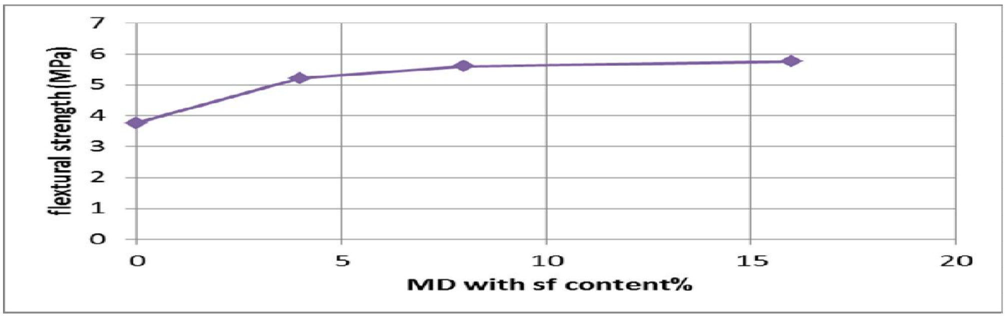

Fig: (7):F Lextural Strength Test Results For The Cement Mortar Specimens Made With And Without (Md,Sf) .

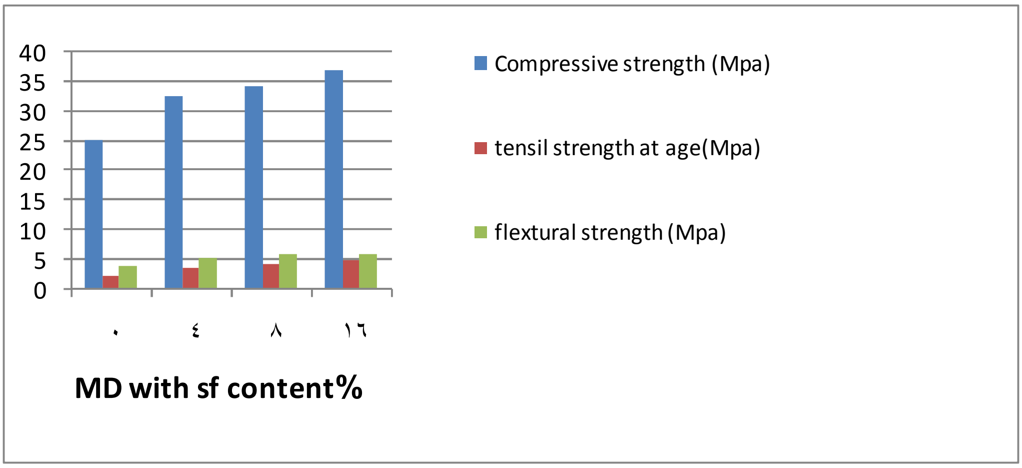

fig (8) :(Compressiv,Tensil, and Flextural strength) test results for the cement mortar specimens made with and without (MD,sf) .

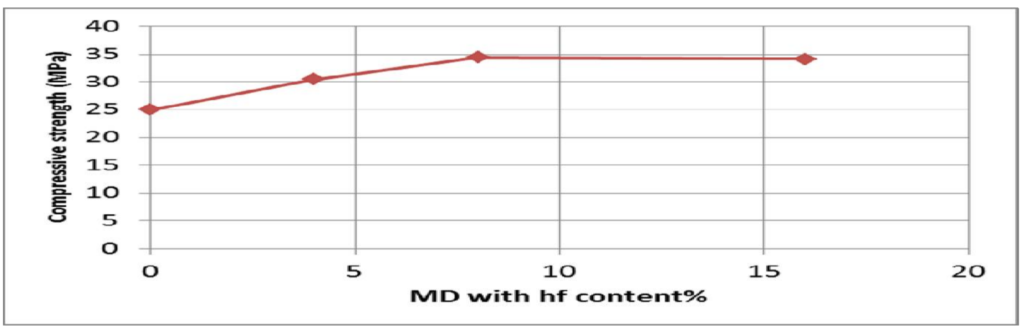

Fig: (9): Compressive Strength Test Results For The Cement Mortar Specimens Made With And Without (MD ,Hf) .

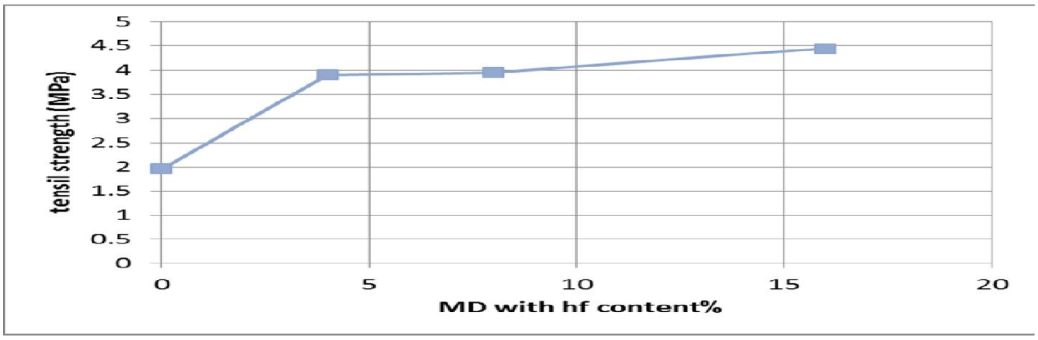

Fig: (10): Tensil Strength Test Results For The Cement Mortar Specimens Made With And Without (MD,Hf) .

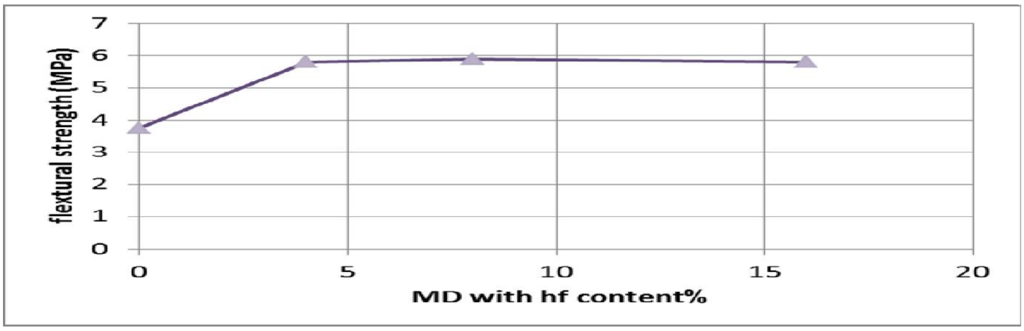

fig: (11):F lextural strength test results for the cement mortar specimens made with and without (md,hf)

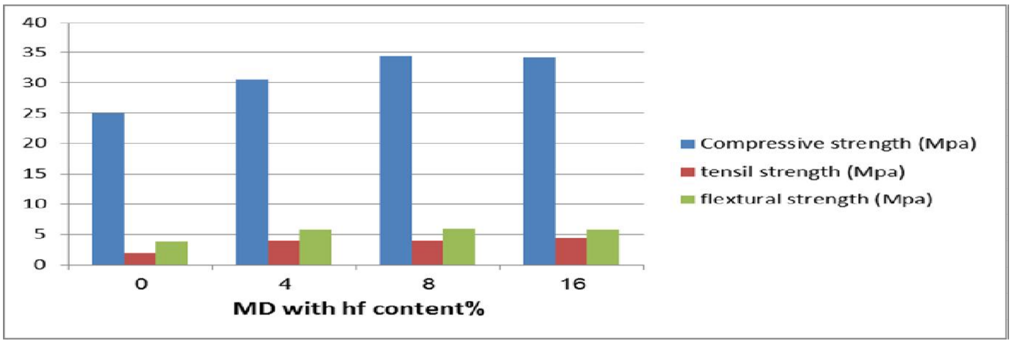

fig (12) :(Compressiv,Tensil, and Flextural strength) test results for the cement mortar specimens made with and without (MD,hf) .

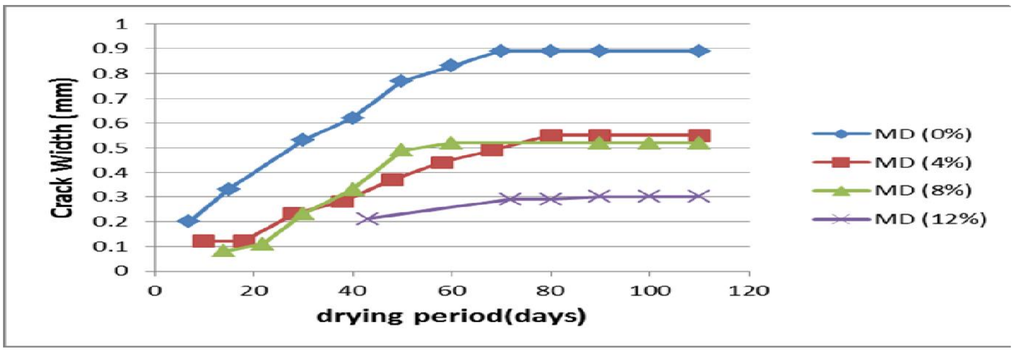

Figure (13): Crack Width Development For Specimen With And Without Of Admixture (MD) .

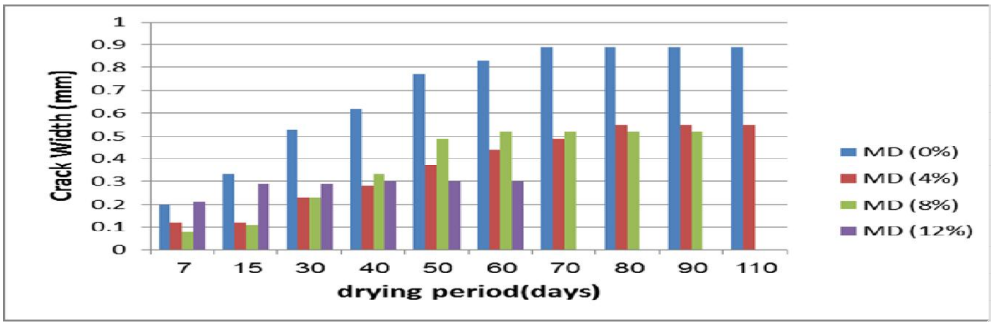

Figure (14): Crack width development for specimen with and without of admixture (MD) .

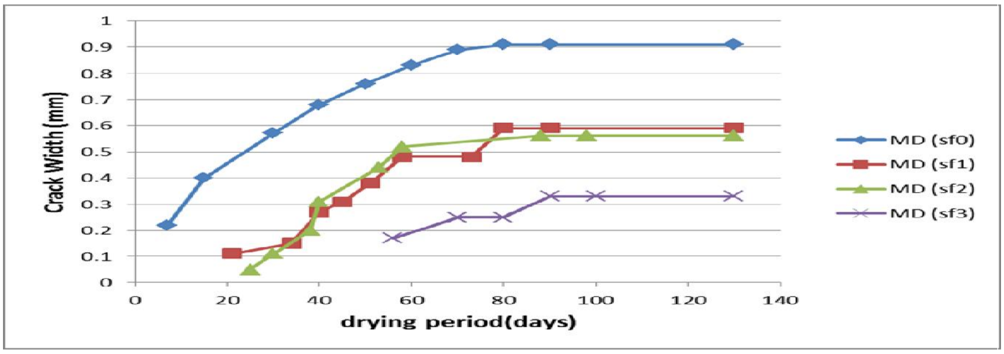

Figure (15): Crack width development for specimen with and without of admixture (MD ,sf) .

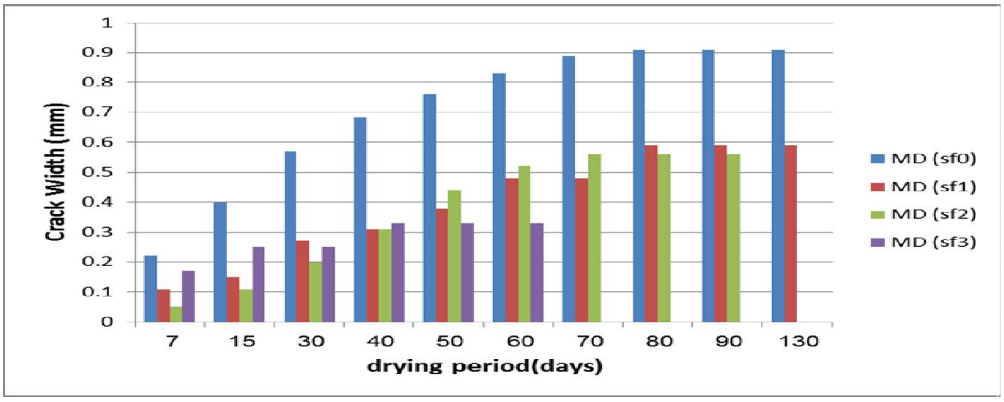

Figure (16): Crack width development for specimen with and without of admixture (MD ,sf) .

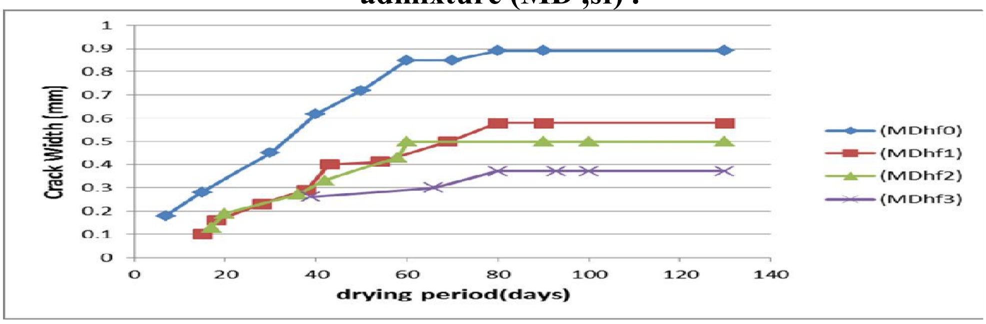

Figure (17): Crack width development for specimen with and without of admixture (MD ,hf) .

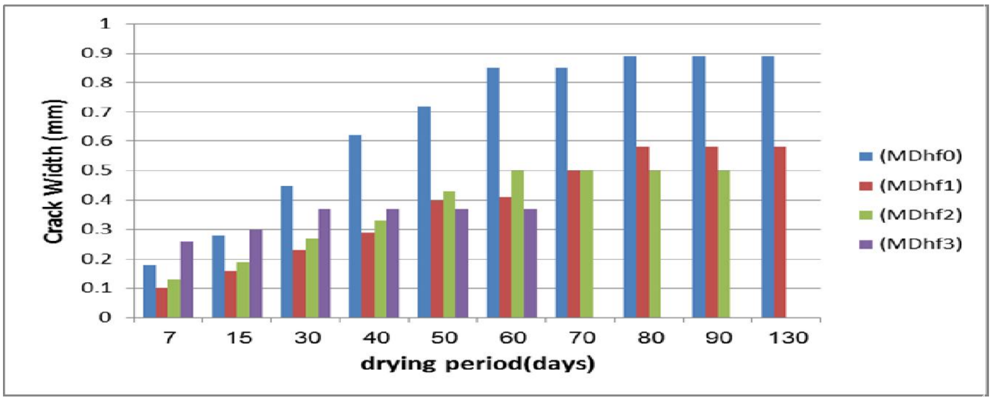

Figure (18): Crack Width Development For Specimen With And Without Of Admixture (MD ,Hf) .

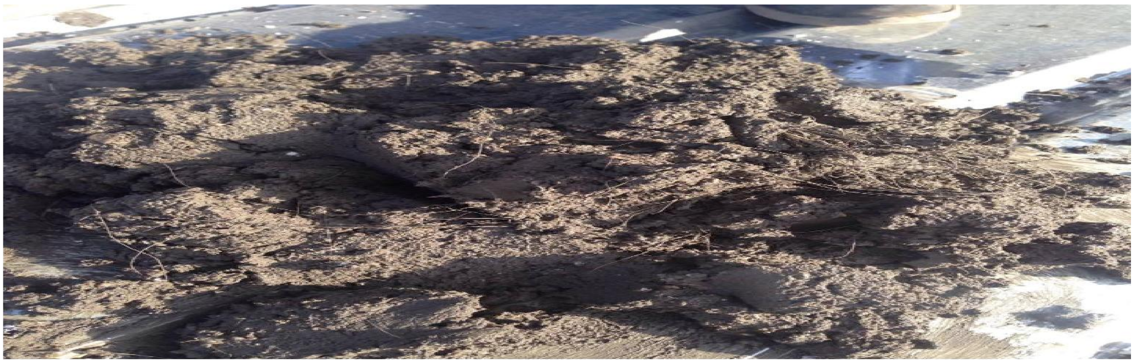

Plate (5) : mix with sisal fiber .

Plate (6): flextural Strength Testing Machine

plat (7): Compressive Strength Testing Machine.

Plat(8):- specimen for Drying shrinkage cracks for mix (MD0.4%) .

RESULTS AND DISCUSSION

Shrinkage Cracks test:

From Table (11,12,13) and Figures (13, 14,15,16,17,18) it can be seen that the effects of admixture MD on drying shrinkage cracking was different depending on the admixture content. The measurement of crack width for all specimens was achieved by portable dialed crackmeter, which is shown in Plate (4) at (different periods) at early ages and the later ages. The first crack time for each specimen was recorded to evaluate the improvement in cement mortar shrinkage cracking. A clear influence in cracking time was caused for admixture at level (8%) as compared to control specimens.

Marble dust (MD) is classified as a very soft material, thus achieved a wide surface area, and it is can cover the gel granules with high efficiency and cause reduction in the surrounding water. This will contribute to the reduce the water out of the inner layers of the capillary pores and thus the delay of the growth of cracks resulting from mortar shrinkage.

AL- Khalaf, 1983, state that, cracking time increases when admixtures are used but on the other side these admixtures have a high surfactant effect, forming air voids in concrete during the mixing process, and thus the concrete strength is reduced.

Al-Nassar, 2002, generally, the crack width development is slower with age progress when admixtures were added as compared to control mix. This can be considered, as an advantage reflection of using some admixture, as reducing crack width is very important from durability point of view because of its effect on the structural action of the member.

Al-Rawi, 1985, the position of crack occurred within the middle third of cement mortar specimen rather than at the side third. This means that the higher restrained shrinkage strain is at the middle of the specimen rather than at the sides. This behavior is attributed to the growth of a strain gradient at the end, which increases the restraint loss and reduces the possibility of cracking, while at interior, higher strain would be developed due to the buildup of friction forces and the absence of strain gradient, so cracks would be expected to initiate at the interior regions of member.

From the Table (,12,13,14,15) and Figures (17,18,19,20), it can be seen that the specimens with admixture show delay of occurrence of crack and decrease in their width at early age especially at mix (MDhf2%) .

Strength Tests:

The results of the(compressive,tensil and flextural strength tests) of specimens with and without admixtures (MD) are given in Table (1) and Figure (1,2,3,4). the Results illustrate that the increase of admixture (MD) addition increases the compressive,tensil and flextural strength at a level (8%). But there was a reduction of about (5.2,4.1,11%) in (compressive,tensil and flextural strength) a level (16%) respictivily . The results of the(compressive,tensil and flextural strength tests) of specimens with and without admixtures (MD with fibers sf,hf,pf) are given in Table (2,3,4) and Figure (from5 to 16). The results illustrate that the increase of thes admixture addition increases the compressive,tensil and flextural strength .

AL-Khalaf, 1983, The reduction of water powder ratio (W/P) can be attributed to the increase of compressive strength, due to the absorption of these fine particle to water content, and the effect of their fineness and large surface area, cement mortar density especially at early age. That can be attributed to the accelerated hydration cement paste. The cause of the reduction in compressive strength at level (16%) was due to the high fineness, high absorption of water and the large amount of this admixture, which leads to lack in hydration action and presence of air voids in cement mortar structure.

CONCLUSIONS :

1. The drying shrinkage cracking development of cement mortar is attached by amount of (marble dust,sisal fiber and hamp fiber) .
2. For all cement mortar specimens containing different contents of (marble dust), first crack width is lower than that of the control specimens.
3. The cracking time increases with the increase of the (marble dust) content, especially at highest admixture content.
4. The development of crack width for specimens with (marble dust) is lower than that of control specimen. The drawdown is 39.7% at level 8%.
5. Adding (marble dust) content alone or with (sisal fiber or hamp fiber) increases the compressive strength, tensil and flextural strength but high contents of (marble dust) decrease the compressive strength .The addition of marble dust with (sisal fiber or hamp fiber) for cement mortar specimens is delaying the occurrence of cracking as comparing to the case of control mix.

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