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The Influence of Straw and Plastic Fibers on Behavior and Strength of Concrete Mix

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Abstract: ***The straw and plastic fibers are used in concrete mix, to minimize crackswidthafter shrinkage and creep .Various types of mentioned admixturesare needed in concrete to eliminate cracks, and to increase strength of concrete and to make it more ductile. This research presents a discussion of two types of fibers used to reinforce concrete , such as straw and plastic fibers, separately and together, and this application is necessary to improve the concrete performance in its strength and ductility .Furthermore , this application is very important to achieve a limitation of the cracks, that may appear in concrete after its hardening.Plastic fiber can be produced from the plastic threads and waste propylene ,that are considered as waste materials after uses. Straw fiberis produced after harvesting thewheat , the straw waste is costly and noisy to eliminate by burning.A huge amount of plastic disposal as well as straw waste materials , cause a climate pollution. Using these both disposal materials in concrete mix (as an admixture) of different portions such as : 0.5% , 1.5% and 2.5% by weight of sand, will improve the ductility , and will inhibit the crack propagation.Thepaper is focused on testing different specimens of concrete mixes (cubes and cylinders)in order to investigate crack propagation, as well as to calculate both the concrete compression and tension.***

Keywords :plastic fiber, straw fiber,ductility, compression , tension,crack propagation.

I. INTRODUCTION

The concrete propertiesdepend on its components. the no reinforced concrete is known as a brittle material and it is very weak in tension comparing with compression. In general the fiberadmixtures in concrete areused, to increase the ductility. Also usingfibers in concrete decreases the width of the cracks. Using waste materials such as plastic and straw ,produces new types of thermal bricks , that have great incomes for poor countries,as Jordan.Many researchers were interested in some types of fibers. They studied the influence of theses fibers , that leads to improve the mechanical characteristics of concrete. The research activityregarding thedifferent applicationsof various types of plastic fibers after recycling , and straw fibers after harvesting , are carried out, in order to decrease the environmental pollution.

A detailed study in the field of using plastic fiber as well as straw fibers in concrete, were focused by many researchers [1,2]. Who studied how topreparemany types of industrial fibers, to use in concrete mix, in order to improve the behavior of concrete under loads.

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Special results were concluded regarding a compression and tension strength of concrete , also a development of sustainable construction material using industrial and agricultural solid waste were studied , and the researchers, [3,4],

Investigated the influence of natural reinforcement fibers, gypsum and cement on compressive strength of earth bricks materials. Plastic additives inconcrete mix divided into small pieces , as partial sandsubstitution admixture material in concrete components. These components have an attractive cheap materials with distinguish properties. Some researchers ,[5] , observed different types of plastic and natural fibers were used in plain concrete. Other specialists [6],studied the influence of starch on earth/hemp or flax straws mixtures properties in presence of super plasticizer when using an unsaturated polyester resin based on recycled polyethylene in polymer concrete , the compression of concrete was found very high, as well as bending strength , while tension strength was much more less, Also others found that the elastic modulus,is acceptable ,at 7 days .Theystudied the effect of waste plastic on workability (slump test), density, compression , splitting tension ,by using different concrete fibers. The slump wasdecreased whenthe percentage of fibers was increased and thecompression of the concrete was increased by small percentage at 1% of plastic fibers. Straw is not a favorable option because of its natural green material .The strawfiber is used to produce good admixture for concrete application , that can benefit both the wheat production ,and the plain concrete bricks. Some specialists in concrete [7,8], focused on composite formed concrete by Cement and Wheat Straw Treated with Na $(OH)_2$.

The main objective of this paper is studying how to increase the tension of concrete, by using straw fibers and plastic fibers, as well as to investigate the effect of crack propagation . Different percentages of straw and plastic fibers whenaddedtogether in concrete, leaded to produce new types of concrete bricks and mortars ,and finally some researchers studied ,[9.10] , the effect of jute as fiber reinforcement controlling the hydration characteristics of cement matrix, that is very important in producing new concrete bricks..

II. EXPERIMENTAL WORK

A. Plastic fiberadmixture :

The concrete components are ordinary Portland cement , fine aggregate , gravel of 19 mm and smaller size , drinking water, as well as plastic fibers,asshown in fig(1) . The concretecomponents proportionswere (1:1.8:2.5) and the water to cement ratio is 0.65, are summarized in Table (1)

Table(1) : $1m^3$Concrete mix ingredients with1.5%plastic (or 1.5% straw fiber) (in kg)

D. Water	O.P. Cement	Sand	Gravel
195	300	531.9	1350

The plastic admixture was added to concrete mix in different dosages ,as (0.5 % to 2.5 % by weight of sand) or (2.7kg to 13.5kg) . The control concrete cubes and cylinders , were prepared as a reference concrete mix for comparison purposes. The normal control concrete mix proportions used in these experiments (1: 1.8:2.5) and the drinking water to cement ratio is a round 0.65 , Table (2) below :

Table(2): $1m^3$ Control concrete mix (in kg) for comparison

D. Water	O.P. Cement	Sand	Gravel
195	300	540	1350

A.1 Concrete Molds :

For compressive strength , concrete cubes of 150 mm dimensions, were used . While for tensile strength , cylinder molds of diameter 150 mm and height about 300 mm were prepared for splitting test . Concrete curing was taking place ,for a period of 7 days and 28 days before test. Three specimens for each test were casted (three cubes and three cylinders for control concrete).

Fig.(2) Wheat Straw Fiber

B.2 Testing Machine :

The tests was done according to ASTM recommendations.

C. Both Plastic fiber and straw fiber admixtures:

The concrete components used for this experimental work for concrete with both 1.5% plastic fiber, and 1.5%straw fiber. The concrete mix proportions are seen in Table(3) below:

Table (3) :$1m^3$ Concrete mix ingredients with both 1.5% Plasticand 1.5% straw fiber (in kg)

D. Water	O.P. Cement	Sand	Gravel
195	300	523.8	1350

A.2 Testing Machine :

The tests was done according to ASTM recommendations.

Fig.(1) Plastic Fiber

B. Straw fiber admixture :

The concrete components used for this experimental work are the same as for concrete with plastic fiber, as shown in fig(2) below . The concrete mix proportions used in these experiments are the same as for concrete with plastic fibers (1: 1.8:2.5) and the water to cement ratio is a round 0.65 , Table (1) . The straw fibers were used in concrete mix as a partial replacement of sand in a percentage between 0.5 % to 2.5 % by weight of sand, exactly the same as for concrete with plastic fibers**.**

B.1 ConcreteMolds:

For compressive strength , concrete cubes of 150 mm dimensions, were used . While for tensile strength , cylinder molds of diameter 150 mm and height about 300 mm were prepared for splitting test. Curing was taking place , for a period of 7 days and 28 days before test. Three specimens for each test were casted.

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C.2 Testing Machine :

The tests were carried out according to ASTM. Universal machine of capacity 1000 KN was used.

III.TEST RESULTS AND DISCUSSION

The optimum percentage of both fibers that was used , exactly 1.5% of sand , showed very good results. As a result of the tests, it is clearly seen that , the slump value was as the following :

When the fibers content increases , the workability (slump value) decreases . .The slump value of the control normal concrete was measured about 62 mm , and it was decreased to 57 mm (for concrete with 1.5% plastic fibers) , while it was decreased to 50 mm (for concrete with 1.5% straw fibers). Also it was reduced to 46 mm (for concrete with both 1.5% plastic fibers and with 1.5% straw fibers).

The results were tabulated for compressive strength, and for tensile strength according to the percentage of concrete with plastic fibers, and concrete with straw fibers and both fibers together , Table (4) below :

The optimal percentage of both plastic fiber and straw fiber is 15%. And it is when use the plastic fiber alone, so as straw fiber includes a cellulose material that decreases the bond with the cement mortar.

Table (4): Compression and Tension of concrete mix with different types of fibers and different percentage

No.	Fibers Admixtures (%)	Average Compresion (MPa)	Average Tension (MPa)
Plastic Fiber			
1	**0** (control concrete)	**38.4**	**3.1**
2	0.5	39.2	3.4
3	**1.5**	**40.2**	**3.5**
4	2.5	32.2	2.7
Straw Fiber			
1	0 (control concrete)	38.4	3.1
2	0.5	37.6	3.2
3	**1.5**	**37.1**	**3.3**
4	2.5	29.1	2.5
Plastic and Straw Fibers			
1	0 (control concrete)	38.4	3.1
2	0.5	38.9	3.3
3	**1.5**	**39.8**	**3.4**
4	2.5	32	2.6

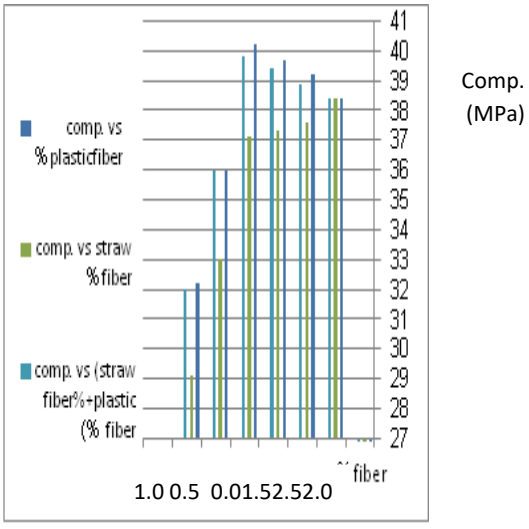

Fig.(3) Fiber type vs. Comp. Strength of Concrete

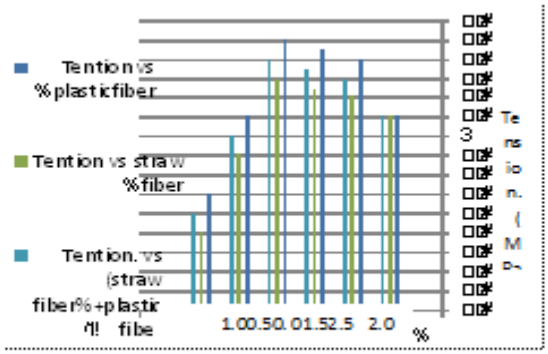

Fig.(4) Fiber type vs. Tension. Strength of Concrete

From Table (4) ,Fig.(3),and Fig.(4) it is observed the following:

1. The compression of controlcontrolwas 38.4MPa. It was increased to 40.2MPa(for concrete with 1.5% plastic fibers) , while it was decreased to 32.2Mpa (for concrete with 2.5% plastic fibers) . Also the strength was decreased to 37.1MPa (for concrete with 1.5% straw fibers) , and it was decreased to 29.1Mpa (for concrete with 2.5% straw fibers).
2. Also the compressive strength was increased to 39.8% (for concrete with both 1.5% plastic fibers and with 1.5% straw fibers) , and it was reduced to 32Mpa (for concrete with both 2.5% plastic fibers with 2.5% straw fibers) .
3. Finally , the tension strength was 3.1MPa for normal concrete ,and it was increased to 3.5MPa(for concrete with 1.5% plastic fiber) , and it was increased to 3.3MPa (for concrete with 1.5% straw fiber), while it was decreased to 2.7MPa (for concrete with 2.5% plastic fiber) , and it was also decreased to 2.5MPa (for concrete with 2.5% straw fiber), while it was increased to 3.4MPa (for concrete with both 1.5% plastic fibers and 1.5% with straw fiber), but it was decreased to 2.6MPa (for concrete with both 2.5% plastic and 2.5% with straw fibers).

IV. CONCLUSIONS

The final observation were concluded as follows:

1) The addition admixtures for both **1.5% plastic** fibers as well as **1.5% straw** fibers to the concrete mix leaded to **reduce** the **slump** value for about **25.8%** .
2) By adding **1.5%** of **straw** fiber to the concrete mix , **adecrease** of concrete **compression** was about **3.39%** comparing with normal control concrete , while the tensile strength was **increased** more than **6.1 %** .
3) While using **plastic fiber of 1.5%** in concrete mix , the concrete **compressionincreases** more than **4.5%** of control concrete , but concrete **tension** was **increased** by **11.4%**.
4) From the observations of failure pattern , it can be concluded that when using both admixture materials together (**1.5% plastic fiber and1.5% straw fiber**) , it is obviouslyseen **anincrease** in **compressive**strength of concrete about **3.52%** but there is a valuable **increase** of **tensile**

strength of about **8.82%** . The **tensile strength** of concrete leads to **an increase**in **the ductility** which causes **a less brittle** concrete, and **a crack widthlimitation**.

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