JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue

JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)

An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Effect of Carbon Nanofiber Addition on Compressive and Tensile Strength of Mortar Mixture

Ali Musa[#1], Zeyad Katab[#2], Saad Abdelmola[#3]

[#1.2.3]*Department of Civil Engineering, Tobruk University*
Tobruk - Libya

Abstract: **The use of nanotechnology is relatively new in civil engineering aspects. carbon nanofibers have unique mechanical properties, and quickly become one of the most promising nanomaterials. Cement and concrete have low tensile strength. The modification of the cement mixture with carbon nanofiber improves the concrete properties, the resistance of water penetration, and also leads to build a better structure. The main objective of this paper is to study the effect of carbon nanofiber on the compressive strength and tensile strength on a mortar mixture. The test on CNF mortar has shown that the addition of such nanofibers decreases the compressive of the mortar by 23.8% and tensile strength of the mortar by 8.65%. The decrease takes place due to the weak adhesion between the particles of cement and nanofiber, and the voids created in the sample by the nanofiber.**

IndexTerms **- Carbon nanofiber, mortar mixture, tensile test, compressive test.**

I. INTRODUCTION

Concrete is the most commonly and widely used material for construction in the world. Concrete is a proportioned mixture of cement, water, fine and coarse aggregates that can be used to build various structures. However, cementitious materials usually, are brittle and have low tensile strength .Carbon nanofibers are relatively newly created materials and their use in concrete is still under investigation. The idea behind this transition to fiber reinforced concrete (FRC) is that the tensile strength is developed from many individual fibers rather than a few pieces of steel [1][6]. Song et al. (2005) [2] stated that improving the behavior of materials by using fibers is not a new concept; fibers are widely used as reinforcing materials in concrete. Metaxa et al. (2013) [7] stated that carbon nanofibers are quickly becoming one of the most promising nanomaterials because of their unique mechanical properties. Coleman et al. (2006) [3] shown that the use of discrete fibers results in a more uniform distribution of stress within the matrix. Recently, exceptional types of carbon nanofilaments have raised the interest of some concrete researchers because of their remarkable mechanical, chemical, electrical, and thermal properties, and excellent performance in reinforcing polymer-based materials [3]. Mullapudi et al. (2013) [4] found that the compressive strength increased up to 21% with the addition of CNFS at 1.0% of volume of binder but reduced the compressive strength with more than 1.0% of CNF concentration in concrete mix due to the discrepancy of the hydration with higher of nanofibers. Metaxa et al. (2013) [7] found that the flexural strength and Young's modulus of cement matrix are increased up to 40% and 75% respectively with the 0.048% weight of CNFs concentration. The research on nanofibers have mainly been focused on the cement paste and it is concluded that the properties of the cement paste can be enhanced by increased compressive strength, lower thermal conductivity, increased durability, and increased electrical conductivity for health monitoring purposes [6][7].

II. EXPERIMENTAL WORK

1- A ratio of 1:2.75 cement to sand, and a net W/C ratio of 0.49 is used. The weight of mortar mixture is 5500g, and the carbon nanofiber is 55g. The ratio of the carbon nanofiber is 3.75% of the amount of cement.
2- Place the mix water in pan; add the cement and mix for 30 seconds. Add approximately half the sand and mix for another 30 seconds. Add the remaining sand and mix for about two minutes.
3- Lightly coat the molds with oil or a releasing spray to ease the process of removing the sample.
4- Fill the molds half full and tamp each one 32 times in about 10 seconds, using a plastic tamper in the following method: the tamping is to be completed in four rounds with each round beginning in a different corner of the specimen. Complete all 32 tamping for one sample before moving on to the next. When all the samples have had their first layer tamped, add the next layer and repeat the taming procedure. To finish, fill the molds, smooth the surface then using a sawing motions strike the excess off the top with the edge of a trowel held perpendicular to the mold.

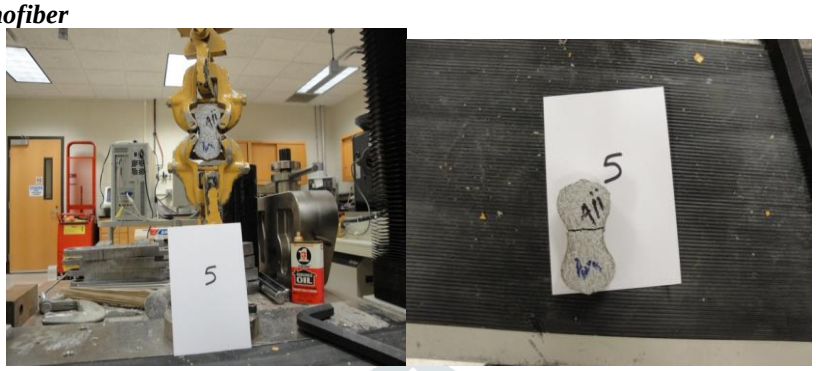
5- Tag the specimens and set them aside for curing: moist cured for one day then remove the specimen from the mold and water cure until testing.
6- Testing times are at 7,14, and 28 days. Three peanut samples and three cube sample are to be testing.
7- Repeat the same steps to make another three samples of peanut and cube but add 0.01% nanofiber to the water.

Testing the samples

The tensile and compressive tests have been applied. The average of three samples have been taken. First, the tensile test has been done to see the range of extension in peanut samples with and without nanofiber. Then, the compression test has been set for both two groups of samples with and without nanofiber.

1- Tensile Test

1.1: Samples Without Nanofiber



Before After

Fig. 1: Sample 5 without nanofiber

Befor After

Fig. 2: Sample 6 without nanofiber

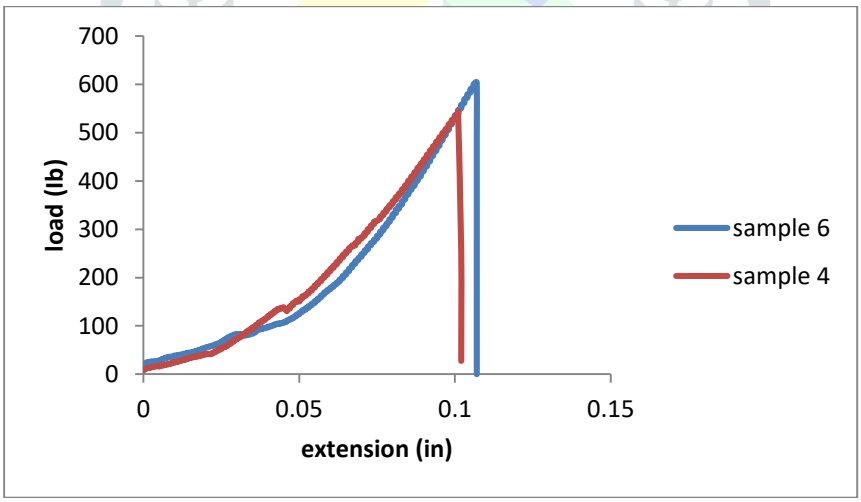


Fig. 3: Samples without nanofiber

As we see in figure 3 the extension starts increasing gradually when the load increases until the sample failed suddenly, and the average of peak extension is 0.104 in.

1.2: Samples with Nanofiber

Before After

Fig. 4: Sample 2 with nanofiber

Before After

Fig. 5: sample 3 with nanofiber

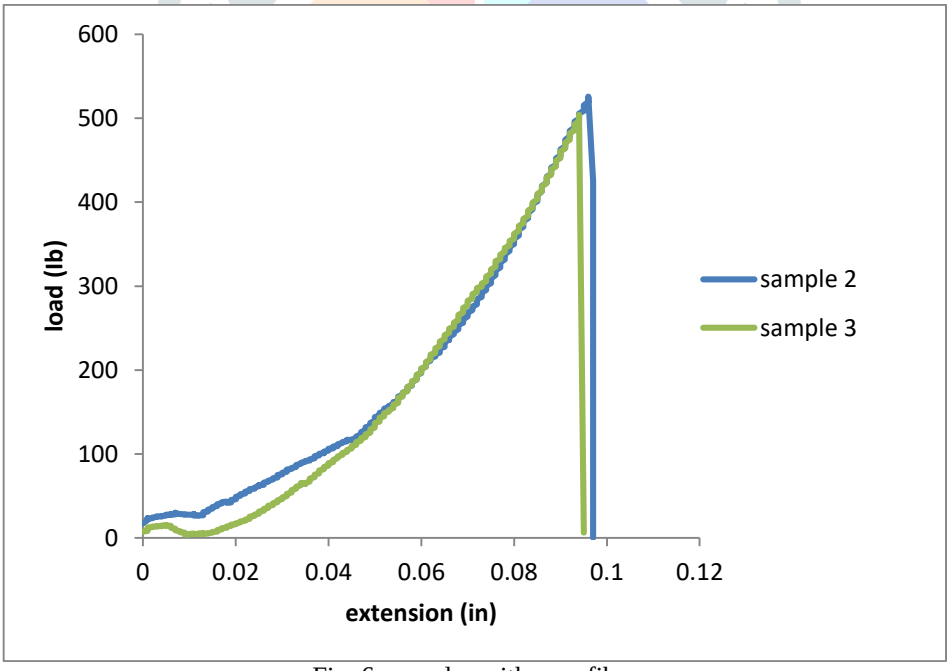
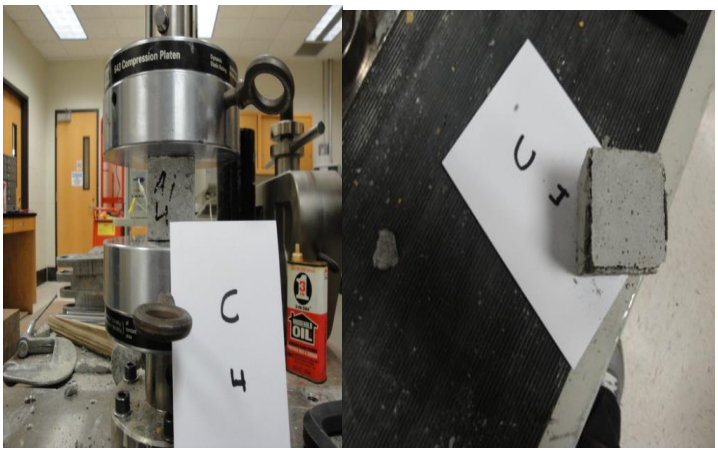


Fig. 6: samples with nanofiber

In figure 6 the extension starts going up when the load start increasing until the average of peak extension becomes 0.095 (in). With comparing the two sets of specimens, it's been found that the specimens without nanofiber can extend more than the samples with nanofiber. The reason for that due to the weak adhesion between the particles of cement and nanofiber. Also, the nanofiber creates more voids in our samples.

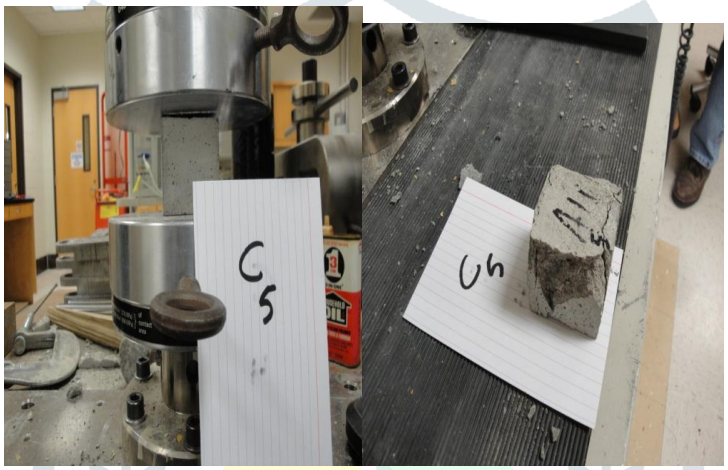
2- Compression Test

2.1: Samples Without Nanofiber



Before After

Fig. 7: sample 4 without nanofiber



Before After

Fig.8: Sample 5 without nanofiber

Before After

Fig. 9: Samples 6 without nanofiber

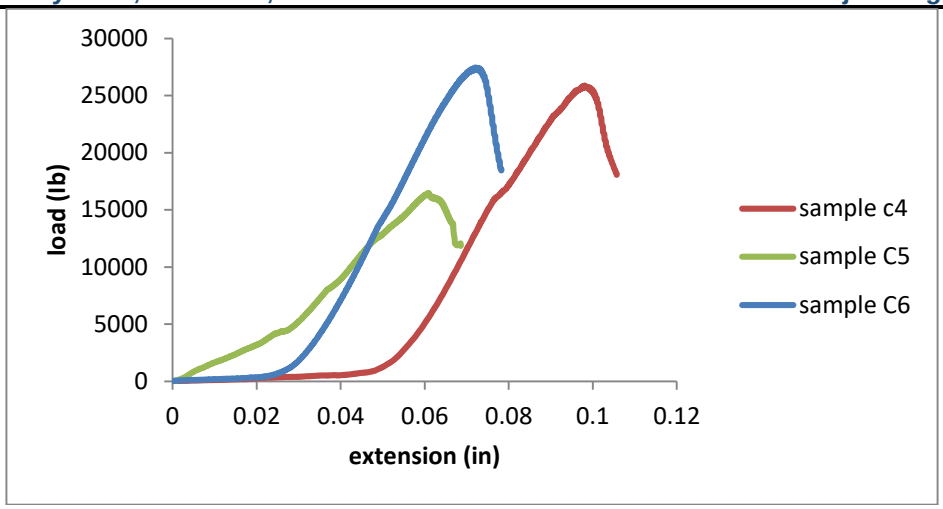
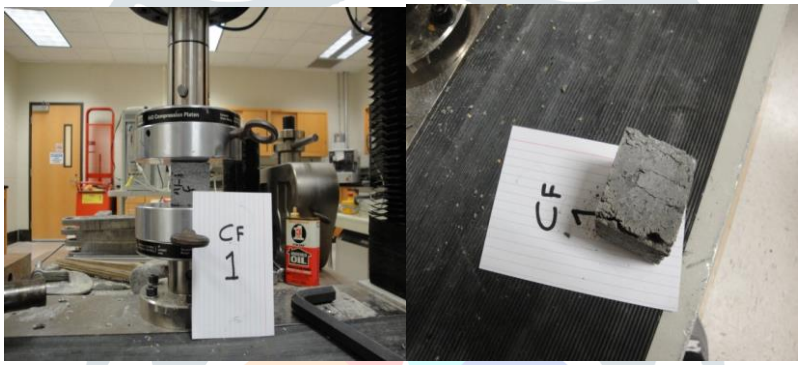


Fig. 10: samples without nanofiber

It is obviously to see that the extension starts to increase gradually then start to decrease the fail suddenly. The average of peak extension for three samples is 0.084 (in).

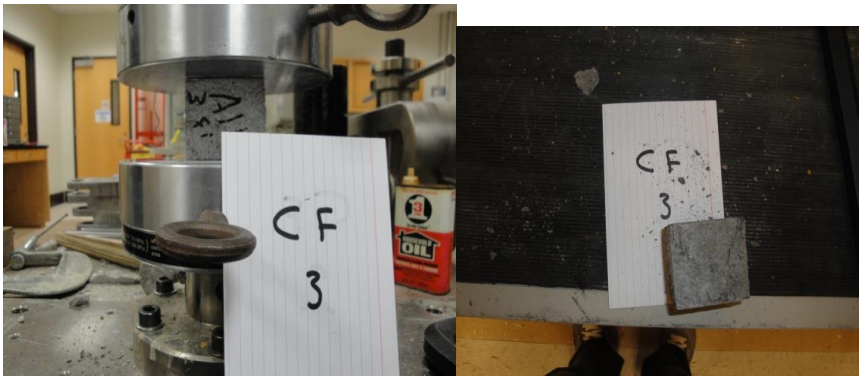
2.2: Samples with Nanofiber



Before After

Fig. 11: Sample 1 with nanofiber

Fig.12: sample 2 with nanofiber



Before After

Fig.13: sample 3 with nanofiber

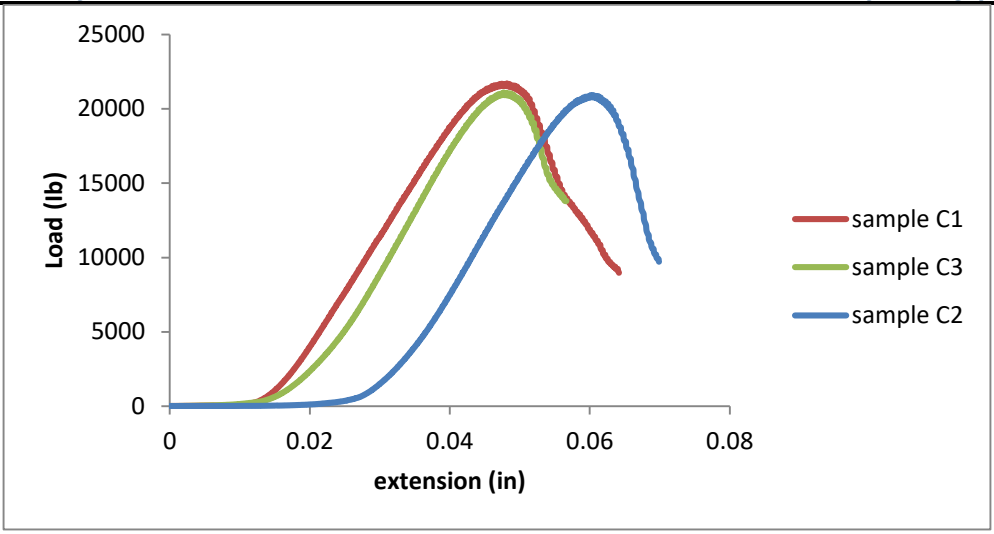


Fig. 14: samples with nanofiber

It is clear to see an increasing in the extension as the increase in the load. The samples have the same behaviour the start increasing the falls almost at the peak extension. The average of peak extension is 0.064 in. When the extension of specimens without nanofiber compared with the specimens with nanofiber, it's been found that the extension in samples without nanofiber more than the samples with nanofiber.

III- CONCLUSION

1- During the tensile test, the average of peak extension in the samples without nanofiber is 0.104 in, and with nanofiber is 0.095 in. The decrease ratio in the extension is 8.65%. The decrease takes place due to the weak adhesion between the particles of cement and nanofiber.

2- During the compressive test, the average of peak extension for the three samples without using nanofiber is 0.084 in, and with using nanofiber is 0.064 in. The decrease ratio is 23.8%. The decrease in the extension because of the stickiness between the cement and nanofiber practices. Also, due to the voids in the nanofiber specimens.

IV- REFERENCES

[1] Altoubat, S., Yazdanbakhsh, A., and Rieder, K.-A. (2009). "Shear behavior of macro-synthetic fiber-reinforced concrete beams without stirrups." ACI Mater. J., 106(4), 381–389.

[2] Song PS, Hwang S, Sheu BC. "Strength Properties of Nylon and Polypropylene-Fiber-Reinforced Concretes". Cement and Concrete Research; 2005, 35(8):1546–1550.

[3] Coleman, J. N., Khan, U., Blau, W. J., and Gun'ko, Y. K. (2006). "Small but strong: A review of the mechanical properties of carbon nanotube- polymer composites." Carbon, 44(9), 1624–1652.

[4] T.R.S. Mullapudi, D. Gao, and A. Ayoub, "Non-destructive Evaluation of Carbon Nanofiber Concrete," Magazine of Concrete Research, ICE, vol. 65 (18), 2013, pp. 1081-1091

[5] Z. S. Metaxa, M. S. Konsta-Gdoutos, and S. P. Shah, "Mechanical Properties and Nanostructure of Cement-Based Materials Reinforced with Carbon Nanofibers and Polyvinyl Alcohol (PVA) Microfibers," ACI SP 270-10, 2010, pp. 115-124

[6] Hunashyal, A. M., Tippa, S. V., Quadri, S. S., and Banapurmath, N. R., (2011) Experimental Investigation on Effect of Carbon Nanotubes and Carbon Fibres on the Behavior of Plain Cement Mortar Composite Round Bars under Direct Tension, *International Scholarly Research Network ISRN Nanotechnology*, Article ID: 856849.

[7] Metaxa, Z. S., Konsta-Gdutous, M. S., and Shah, S. P., (2013). "Carbon nanofiber cementitious composites-effects of debulking procedure on dispersion and reinforcing efficiency", *Cement and Concrete Composites*, 36: 25-32.