



Article Title: Experimental And Analysis Of Adding Silicon And Titanium Carbide Nanoparticles To The Cement Paste

Experimental and Analysis of Adding Silicon and Titanium Carbide Nanoparticles to the Cement Paste

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ABSTRACT

To improve the mechanical and physical properties of cement by adding the nanoparticles like Sic and Tic. Silicon carbide and titanium carbide powder of 20 nm size is used for the testing. They are adding at different proportion to the cement paste by replacing (1%, 2%, 4%, and 6%). By adding the Nanoparticulates will be increase the physical properties like setting time water absorption. Mechanical properties like compression and flexural strength. Done on 7, 14, 28 days curing.

Keywords: Nanoparticulates, silicon carbide, titanium carbide, mechanical properties.

1 Introduction

Now days the use of nanoparticles in the construction field will increase. The nanoparticles help to improve the physical and mechanical properties of the concrete. Nano powder can improve the mechanical properties of cement paste due to accelerating the formation of small sized crystals. The study focus on the structural changes of cement paste when adding Sic and Tic nanoparticles as admixtures in different proportion. Scanning Electron Microscopy and energy dispersive spectroscopy have been employed in identifying the structural changes in nanoparticles modified paste.

Silicon carbide (SiC), also known as carborundum. It is hard chemical a compound containing silicon and carbon. A semiconductor, it occurs in nature as the extremely rare mineral moissanite. SiC also has a very low coefficient of thermal expansion ($4.0 \times 10^{-6}/K$) and experiences X no phase transitions that would cause discontinuities in thermal expansion. Which accessories the strength of concrete. Titanium carbide, TiC, is an extremely hard (Mohs 9-9.5) refractory ceramic material, similar to tungsten carbide. It has the appearance of black powder with the sodium chloride (face-centered cubic) crystal structure. Its crystals as found in nature range in size from 0.1 to 0.3 m. Titanium carbide is used in preparation of cermets, which are frequently used to machine steel materials at high cutting speed. Increase the strength of cement paste, Enhance the mechanical properties, Enhance the physical properties.

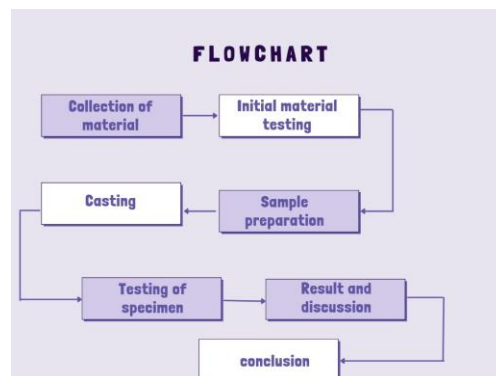


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2 Recent Works

Sobolev K, Flores I, Hermosillo R, Torres-Martínez LM (2006) Nanomaterials and nanotechnology for high-performance cement composites, Proceedings of ACI Session on Nanotechnology of concrete: Nanotechnology in concrete Zhang MH, Li H (2011) Pore structure and chloride permeability of concrete containing nanoparticles for pavement. Constr Build Mater 25: 608-616. Chen J. Kou SC, Poon CS (2012), Hydration and properties of nano-TiO₂ Blended cement composites. Cement and Concrete Composites 34: 642-649. Jo BW, Kim CH. Tae GH, Park JB (2007) Characteristics of cement mortar with Nano-SiO₂ particles. Constr Build Mater 21:1351-1355. Senff L, Hotza D. Repette WL, Ferreira VM, Labrincha JA (2010) Mortars with nano SiO₂; and micro-SiO₂- investigated by experimental design Nanotechnology in Construction 3: Zyganitidis I, Stefanidou M, Kalfagiannis N. Logothetidis (2011)

3 Methodology



3.1 Test Methods

1. Compressive strength: The compressive strength test was determined by Electrical digital compression tester (ELE International Accu- Tek 250): An electrical digital compression tester can provide a consistent testing on a wide range of specimens through a hydraulic pump and a digital readout system. 7.6x7.6x7.6 cm cube would be used for the compression test.

$$\text{Compressive strength} = P/A$$

Where P = load A = Area

2. Flexural strength: The flexural strength tests were conducted on 40*40*160 mm prism specimens in conformity with ASTM C (348-02). The prism specimens were subjected to two point loading. The flexural strength of the cement paste was tested at ages of (7, 14, 21, and 28 days). The average of three specimens was recorded for each testing age. Flexural strength was calculated by using the following equation:

$$S_f = 0.0028P$$

Where S_f: Flexural strength (MPa), P: Total maximum load (N).



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3. Water absorption: Water absorption tests were conducted on the control cement paste specimens and the cement paste modified with the nanoparticles. The test was carried out in accordance to ASTM C (642-1997). In the test procedure, the specimens were dried in an oven at (100-110°C) for 24 hours, and then their masses were measured. Next, the specimens were fully immersed in a water tank for 24 hours, then they were taken out. Their surfaces were dried with a cloth and finally their weights were measured again. The test was conducted on the specimens with different curing ages (7, 14, 21, and 28 days), and the percentage of water absorption was calculated from the following equation:

$$\text{Water absorption (\%)} = (W_2 - W_1) / W_1 \times 100$$

Where W₁: The average weight of dry sample (g), W₂: The average weight of the wet sample (g).

4. Setting time of Cement Take 400 gm of cement for making a paste. The required quantity of water is 0.87 P, P = consistency of water. Water should be potable or distilled water.

3.2 Initial Setting Time of Cement

Place the mould under the rod bearing the needle. (Needle for determining the initial setting time) Lower the needle slightly until it comes in contact with the surface of the test block and quickly release, allowing it to penetrate the test block. In the starting, the needle will completely penetrate the test block. Repeat this procedure until the needle fails to penetrate the block to the 5.0 ± 0.5 mm from the bottom of the mould. The period elapsing between the time when water is added to the cement and the time at which the needle fails to penetrate the test block to the 5.0 ± 0.5 mm from the bottom of the mould is called the initial setting time.

3.3 Final Setting Time of Cement

To determine the final setting time the first needle is replaced by the (needle for determining the final setting time) needle with an annular attachment. When applying the needle gently to the surface of the mould, the needle makes an impression thereon. Cement called as final set while the attachment fails to make an impression on the surface of the test block. The period elapsing between the time when water is added to the cement and the time at which the needle fails to make an impression on the surface of the test block is called the final setting time. Initial Setting Time of Cement – Note down the time, when needle fails to penetrate 5 – 7 mm from the bottom of the test block. This time is denoted as an initial setting time of cement.

Final Setting Time of Cement – Note down the time, when needle fails to make an impression on the surface of the test block. This time is denoted as a final setting time of cement.



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4 Result and Discussion

4.1 Compression Strength

The Compressing strength result of cement paste with nanoparticles (SiC and TiC) percentages (1%, 2%, 4% and 6%) at curing periods (7, 14 and 28 days) are presented in Figures 1 – 4, respectfully. The Nanoparticles were higher compressive strength then the normal cement paste specimen at all curing periods

Compressive strength

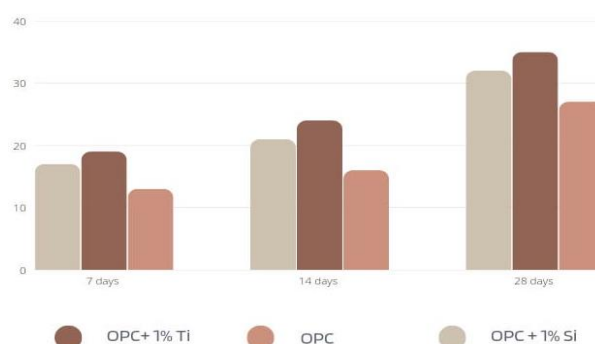


Figure 1: Effect of (1% SiC) and (1% TiC) nanoparticles on the compressive strength for the cement paste specimens at different curing time

Compressive strength

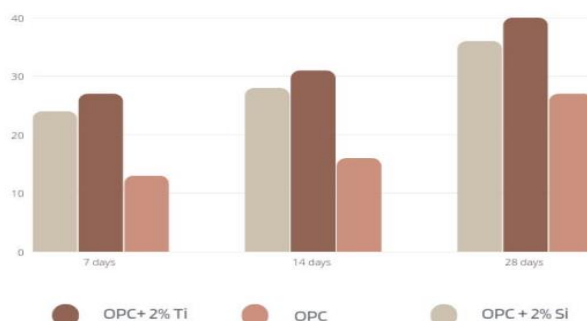


Figure 2: Effect of (2% SiC) and (2% TiC) nanoparticles on the compressive strength for the cement paste specimens at different curing time



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Compressive strength(MPa)

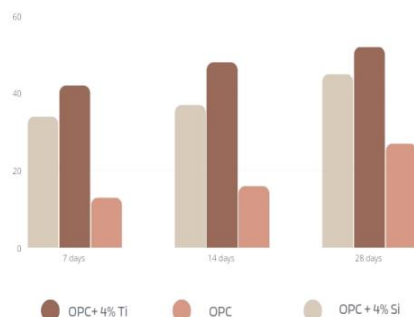


Figure 3 : Effect of (4% SiC) and (4% TiC) nanoparticles on the compressive strength for the cement paste specimens at different curing time.

Compressive strength(MPa)

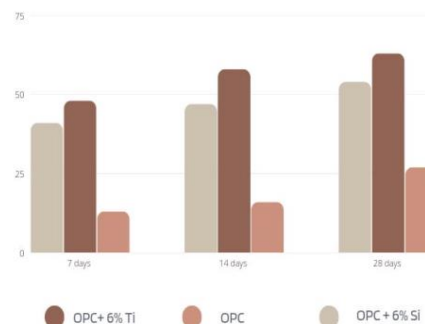


Figure 4 : Effect of (6% SiC) and (6% TiC) nanoparticles on the compressive strength for the cement paste specimens at different curing time.

The compressive strength increased with increasing the curing period for all cement paste mixtures. It can also be seen that the cement paste mixtures with (TiC) nanoparticles had the highest strength at all curing periods, and the compressive strength of the cement paste increased with increasing the percentage of nanoparticles up to (6%).

4.2 Flexural Strength

The results of the flexural strength of the control cement pastes and the cement paste samples modified by various percentages (1%, 2%, 4% and 6%) of (SiC and TiC) nanoparticles at different curing time (7, 14, and 28 days) are presented in Figures 5- 8.

Flexural strength(MPa)

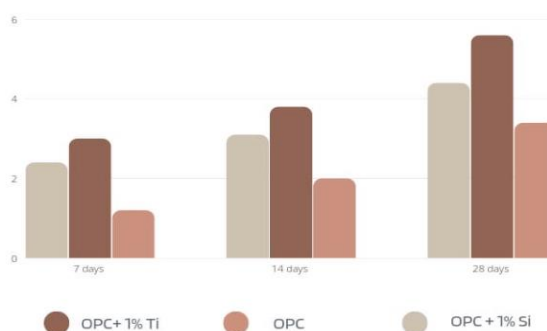


Figure 5: (Effect of 1% SiC and 1% TiC) nanoparticles on the flexural strength for the cement paste specimens at different curing time.



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Flexural strength(MPa)

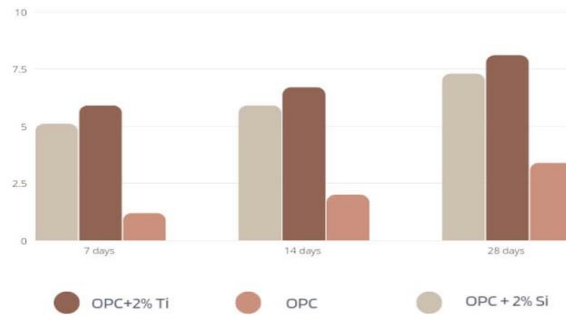


Figure 6: (Effect of 2% SiC and 2% TiC) nanoparticles on the flexural strength for the cement paste specimens at different curing time.

Flexural strength(MPa)

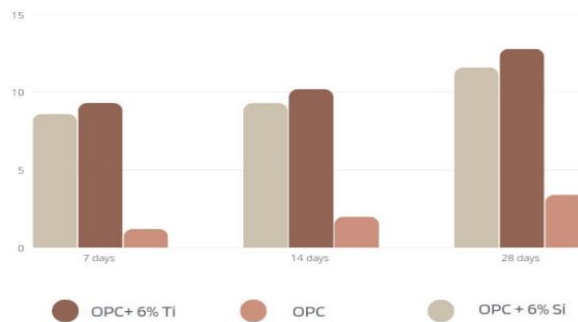


Figure 8: (Effect of 6% SiC and 6% TiC) nanoparticles on the flexural strength for the cement paste specimens at different curing time.

Flexural strength(MPa)

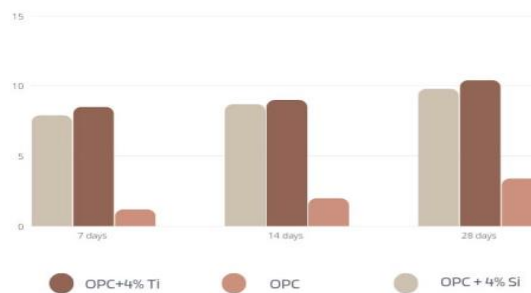


Figure 7: (Effect of 4% SiC and 4% TiC) nanoparticles on the flexural strength for the cement paste specimens at different curing time.

The flexural strength of the cement paste increase by adding the SiC and TiC. Compare to the normal cement paste.



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4.3 Water Absorption

The water absorption test was conducted in order to study the effect of mixing nanoparticles with the cement paste mixtures. Figures 9 – 12.

Water absorbtion

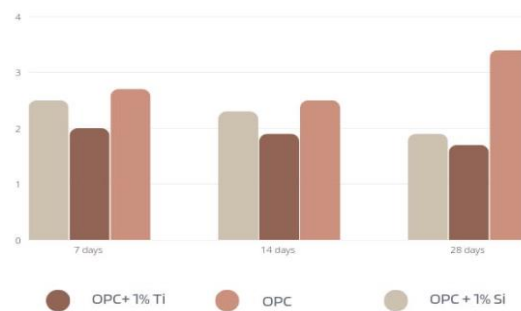


Figure 9 : Effect of (1% SiC) and (1% TiC) nanoparticles on the water absorption for the cement paste specimens at different curing time.

Water absorbtion

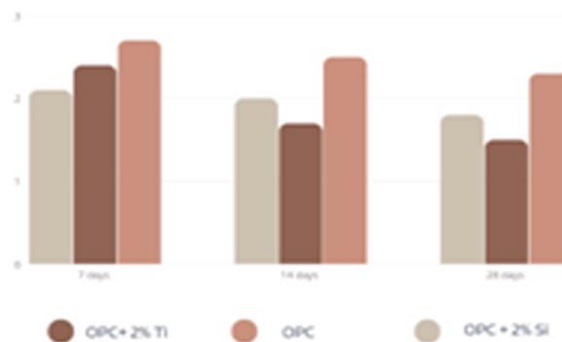


Figure 10 : Effect of (2% SiC) and (2% TiC) nanoparticles on the water absorption for the cement paste specimens at different curing time.



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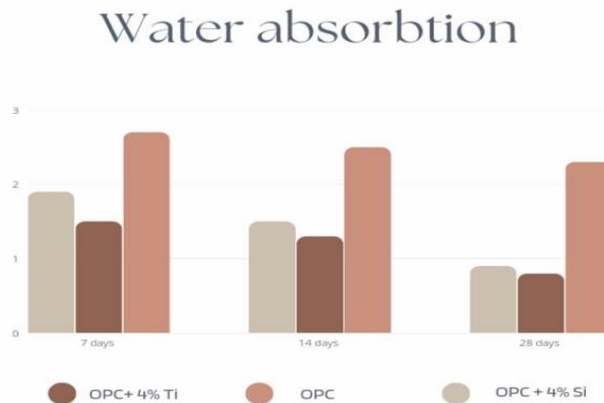


Figure 11: Effect of (4% SiC) and (4% TiC) nanoparticles on the water absorption for the cement paste specimens at different curing time.

The Test results also indicate that the absorption cement pastes modified by nanoparticles continues degrees with increase in the nanoparticles.

Setting Time.

1. Initial setting time

By adding the nanoparticles initial setting time will be comparative same us normal setting time of cement.

2. Final Setting time

Final setting time would be 6 hours.

Percentage	Titanium Carbide (min)	Silicon Carbide (min)	OPC
1	35	40	35
2	35	40	35
4	32	38	35
6	32	35	35

5 Conclusion

In this project Silicon carbide and titanium carbide powder of 20 nm size is used for the testing. They are adding at different proportion to the cement paste by replacing (1%, 2%, 4%, and 6%). The material properties initial testing was made for the preparation of specimens. The cement paste will be tested for mechanical and physical properties at different curing ages 7, 14 and 28 days. Results will be taken based on experiments. By adding the nanosilicates compression strength flexural strength and will be increases water absorption will be decreases.



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