Effect of Nano TiO_2 Additives on Some Properties of Out Door Building Unites

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ABSTRACT

In this paper a lower ratio of two powders; nano and micro titanium dioxide (TiO_2) powder were used as additive in fabrication of mortar. Particle size of TiO_2 powder were (80nm,1.6µm). These powders were used as additive to the mortar material (0.05, 0.1, 0.15 %) by cement weight in order to be used in construction application include layering building, and studies its effect on the mortar.

Inspections of the mortar specimens including optical microscope, surface roughness, micro hardness as well as x-ray diffraction (XRD).

Results demonstrate that surface roughness was diminished with augmentation of Nano TiO_2 powder added more than micro TiO_2 powder substances, while micro hardness was increased by raising the option of Nano TiO_2 powder to the mortar more than micro TiO_2 powder. Also, the mortar microstructure with the Nano TiO_2 powder has been enhanced more than micro TiO_2 powder, with increment in CSH phase, which make the development of mortar with TiO_2 Nano material useful and have a promising future in cutting edge development application.

Keyword: Nano powder, TiO_2,mortar, micro hardness, surface roughness.

INTRODUCTION

An extensive variety of difficulties are confronted by the building fabricating, running from the show of the materials to biological and security issues related to essential materials and their properties. New topical improvements in different ranges of nanotechnology show huge guarantee in tending to a significant number of these difficulties. Research and advancements have shown that the capacity with nanotechnology can enhance the execution of conventional development materials. For example,s steel, glass, coatings, protecting materials, et. al. Huge enhancements in solid quality, solidness and supportability are being accomplished with considered utilization of metal/metal oxide nanoparticles and built nanoparticles (carbon nanotubes and carbon Nano-fiber), and environment-responsive anticorrosion coatings shaped utilizing Nano epitome procedures are demonstrating pledge in research facility settings[1].

Research clarify that nanotechnology can add to novel cooling frameworks, and enhance the usefulness of sun based cells and protection. A scope of nanomaterial are additionally being utilized to add new functionalities, for example, self-cleaning properties, to conventional development industry items, for instance paint, glass, bond mortar and cement. The use of

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nanotecnological developments manages a profoundly multidisciplinary field of building. Nanotechnology is relied upon to get immeasurable changes apply autonomy, synthetic, mechanical, organic and also electrical engineering [2].

Nano scale powder are not new in besides nature or science. New improvements in origination and estimation frameworks for portraying materials at the Nano level have prompted an emission in nanotechnology-based materials in regions, for example, polymers, hardware, vehicles assembling, and drug. Matter can show unordinary physical, substance, and organic properties at the Nano scale, variety in huge routes from the properties of mass materials and single particles or molecules [3]. Some nanostructured materials are more grounded or have diverse alluring properties contrasted with different structures or sizes of the same material. Others are better at leading warmth or power. They may turn out to be all the more synthetically receptive or reflect light better or change tint as their size or structure is modified. Nanotechnology is not just working at ever-littler measurements; very, working at the Nano scale empowers researchers to use the single physical, synthetic, mechanical, and optical properties of materials that normally happen at that scale. Of specific significance for cement is the truly expanded surface territory of particles at the Nano scale. As the surface territory per mass of a material builds, a more noteworthy measure of the material can come into contact with circle materials, in this way influencing reactivity.

Concrete mortars containing Nano-particles have sensibly higher quality, low water ingestion and denser interfacial move zone contrasted with those of the OPC Ferro cement mortars [4].
The option of the Nano sized particles into mortars and concrete materials has surfaced as a brilliant answer for enhancing the trademark, efficiency, expense and dependability of cementeous materials with assortment of included Nano sized powders, for example, titanic, silica, alumina … and so forth [5] .Today it can see cement and steel as the current goliaths in development industry. As the innovation developed, more up to date and brilliant materials were created by the architects and analysts everywhere throughout the world and this procedure proceeds even today. Utilization of Nano innovation and Nano materials in structural designing is a late activity, which rose toward the end of the most recent century. The use of this innovation tackled a great deal of issues of the development business: appreciation to the higher quality and lower thickness of the Nano-materials [6].

Numerous scientists have considered the subject where: In 2014, B. Kartikeyan, et.al., [7] concentrated on the impact on utilizing Nano-sized mineral admixtures as a part of concrete as a halfway substitution of bond, compressive quality of the solid 3D shapes cast with fractional substitution of ground miniaturized scale silica GSF (Ground Silica Fume) for bond in 10% demonstrated an expansion by 7.5% contrasted and control solid blocks. The split tractable of solid barrels cast with 10 % GSF an enhanced quality of 19.2 % contrasted and chambers cast with control concrete cylinders. In 2012, S. Maheswaran, et.al., [8] examined the impact of Nano SiO_2 with molecule size reach from (12-50)nm in cement and to concentrate on the pore filling impact and its pozzolanic action with bond towards change of mechanical properties and strength viewpoints. Impressive change in the properties of porousness, pore filling impacts, lessening of CH(calcium hydroxide) filtering, rheological conduct of bond glues, warmth of hydration, miniaturized scale structure examination, the pozzolanic movement or responses and workability, quality and strength were reported. In 2012, Z. He, et.al., [9] contemplated the impact of nano-SiO_2 (NS), super-fine slag (SS) and elastic powder (RP) on the scraped spot resistance of solid ,Concrete joined with 5wt.% NS, 40wt.% SS were examined separately, and additionally 40% super-fine slag consolidating 20% supplanting of sand volume with RP. The examination test results demonstrated that the reference concrete had the most minimal compressive quality, modulus of versatility and scraped area resistance, the solid containing SS had the most elevated compressive quality and modulus of flexibility, the solid containing SS consolidating RP had the most noteworthy scraped area resistance. And in 2015 A.A. Abdul-

Hamead, et.al., [10] concentrated on the impact of Nano powders utilized copper oxide CuO and titanium dioxide (TiO_2) in creation of mortar as added substances (0.5, 2.5, 5, 7.5 wt %) in development application results shows that where there an increase some properties.

The essential intent for this work is studying the effect of addition Nano and micro TiO_2 powders to the mortar in different weight ratios and of on some properties.

Experimental Part

In this research ordinary Portland cement (OPC) and sand to produce the mortarhe Chemical composition of sand and cement are listed in Table (1) ,Table (2).

The water-to-cementitious materials ratio (w/c) of≈ 0.5 and a sand-to-cementitious materials ratio of 1:3(one part of the Ordinary Portland cement (OPC) and 3 parts of sand) according to ASTM Specifications (C109) [11].

The inspection of particle size was done in Nanotechnology and advanced research Center at University of Technology, (Models: Brookhaven Nano Brook 90 Plus USA) Particle Size Analyzer,ISO 13321 & ISO22412, Range: 2nm to 6μm, Scattering Angle 90°.The Principles of the operation is a Dilute suspensions, on the order of 0.0001 to 1.0% v/v are prepared, using suitable wetting and/or dispersing agents. The result were show in fig.(1) and it were (80nm) for TiO_2 Nano and (1.6μm) for micro. The amounts of cement and sand and Nano powders are shown as in Table (1). Sand, cement and the Nano powder were mixed and then placed in container subjected to an ultrasonic device before the addition of water in order to produce a perfect incorporation of the particles . Water were added to the dry mixed powder and prepared to mould. .plastic cubic with dimensions of (2X2X2)cm were used .at first of all we cleaned moulds and the internal faces were thoroughly oiled before use, to avoid the adhesion with the mortar after hardening.The moulded cubies mortar were left for 24 hour After that, the specimens marked and then completely immersed in curing water tank until the date of test.

Inspections include:

-Ssurface roughness (Ra) were taken by using roughness tester type TR 200.

-Micro hardness was carried out in the Mat. Eng. Dep./University of technology, according to ASTM E384. This device is featured by two grades micro-reading magnification with 100X and 400X times and Large LCD screen can directly show measurement methods. The test force that was used is 9.8N and the dwell time of the test force was 15 Sec and the number of measurement was 4times. It has been measured according to[11].

$$HV = \frac{F}{A} \qquad \text{...... (1)}$$

Where:

F: the force applied, A: is the surface area of the resulting indentation.

-Optical microscopy was carried out in the Mat. Eng. Dep./University of technology, by using

X-ray diffraction (type ADX-2500) was used and this inspection. The XRD apparatus with X-ray tube Cu(1.5406A^o),voltage 40kV Current 30.0 (mA),scan range 20-80 deg, scan speed : 10.0000 (deg/min) sampling pitch : 0.2000 (deg), FWHM threshold : 0.050 (deg)

Results and Discussion

The surface morphology (surface roughness) of the mortar were shown in Fig.(2) for TiO_2 Nano and micro for different mixing ratios compared with without TiO_2 additions.

The surface roughness as observed presents the regular uniformly distributed cement paste and the cement paste modified with Nano and micro particles at (0.05 ,0.1 and 0.15) weight mass %, in a 1 × 1 cm^2 scanning area[12]. As can be seen in this figure roughness of mortar without additives was 10μm , and with TiO_2 micro powder decreased to 8.9 μm and 2.77 μm with Nano powder, due to the effect of large surface area of Nano powder which regular and modified cement mortar characteristic[13,14,15]

Figure(3) shows the results of micro hardness of cement mortar samples , its seam that the micro hardness results with the additions of Nano powder and micro TiO_2 at higher ratio (0.1 - 0.15) while its appear equal results at the lower ratio 0.05 % . The micro-hardness were increased about (0.83 - 5.18) times because addition an apparent of hard smooth grain as decreased the coarse $Ca(OH)_2$ hard grain responsible of softening[16,17].

Figure (4) shows the microstructure of prepared mortar with different mixing ratio symbolize a composite materials, it can be appeared that each single one the mortar mixed samples pertinence to the Nano powder more micro powder in the crystal structure within the mortar, which identify that these Nano powder completely blended within C-S-H gel, as well as padding the pores and increase in density, smoothening of the grain which belong to CH in general [18,19].

X-ray diffraction pattern results are shown in Fig(5) for Portlandite cement mortar in (a) as the reference; modify with TiO_2 micro in (b) and Nano in (c) powder particles at (1.5 wt%), after water curing for 28 days . In Fig.(5) the phases component were,[20]

-CSH :$CaO.SiO_2.H_2O$, orthorhombic, JCPDS (09-0210)
-CS :$CaSiO_3$, Monoclinic crystallized JCPDS (18-0306)
-Portlandite : $Ca(OH)_2$,Hexagonal crystallized, JCPDS (04-0733)
-Tobermorite :$Ca_5Si_6(O,OH,F)_{18}.5H_2O$,Orthorhombic crystallized ,JCPDS (45-1480)
-Ettringite :$Ca_6Al_2(SO_4)_3(OH)_{12}.26H_2O$, Hexagonal crystallized, JCPDS (41-1451)
-Finally Titanium Dioxide: TiO_2, rutile, JCPDS (21-1276).

The results Also shown in Table (2), which shows an increase in the gelling and the presence of CSH phase by Nano addendum more than Micro as well as the presence of TiO_2 peaks, and fumble lowering CS,[17,18]. This due to increasing of surface area and the reinforcement with ceramic powder.

CONCLUSIONS

Using titanium dioxide (TiO_2) Nano powder was good layering outdoor building with more characteristics. All the mortar samples had a reduction in there surface roughness after the addition of the TiO_2 powders.

The addition TiO_2 micro powder to the samples of mortar, decreased the surface roughness about 11% and 72% compare with Nano powder. While all the mortar samples had a increased in micro hardness. After the addition of the TiO_2 micro powder, the micro hardness increased about 83% but with Nano powder increased about more than five times as received mortar.

Micro structure homogeneity increased with Nano more than micro additives, due to TiO_2 particles being smaller than mixed particles, thus leading to an improvement in the surface characteristic of the mortar by smoothening of the grain and closing the pores.

A survey of these results strongly suggests that improvements in composite performance require for outdoor building.

Table (1) Chemical composition of sand and cement

Wt%	SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	SO_3	Na_2O	K_2O
Cement	17.85	4.26	7.33	63.3	2.31	2.57	0.30	0.81
Sand	99.3	0.06	053	<1	0.02	0.03	0.03	0.03

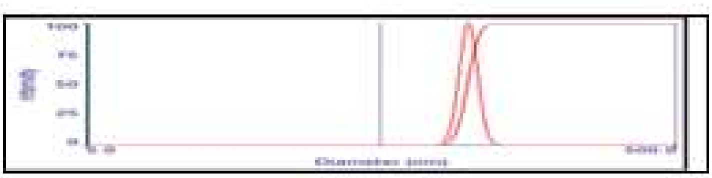
Table (2) : Weight ratio for each Components.

Sample	Water ml	Sand wt%	Cement wt%	TiO_2 wt%
T0	2.5	75	25	0
T1	2.5		24.95	0.05
T2	2.5		24.9	0.1

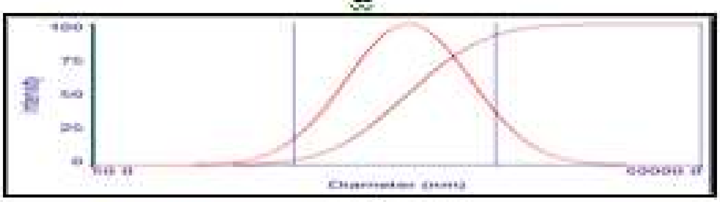
T3	2.5		24.85	0.15

Table(3) The XRD results of prepared mortar at age 28 day.

Co.	$2\theta_{st}$	I_{st}%	Ref		micro		nano		hkl
			$2\theta_m$	I_m%	$2\theta_m$	I_m%	$2\theta_m$	I_m%	
CSH	29.063	100	29.282	76	29.066	100	29.8248	100	**103**
	35.598	40	35.971	61	34.966	15	35.053	3	**202**
	39.492	70	39.246	17	----	--	39.618	16	**111**
	48.376	20	48.400	18	48.057	14	48.942	27	**010**
	49.787	100	49.978	11	49.237	14	50.020	92	**020**
	54.222	100	54.251	60	----	--	54.705	7	**303**
	56.783	10	56.550	21	----	--	57.80	11	**021**
	59.559	20	59.923	26	60.0425	8	60.000	10	**312**
CS	26.840	60	26.473	56	----	--	26.000	4	**202**
	39.856	100	39.498	17	40.014	17	39.861	12	**111**
	67.308	45	67.6000	15	67.426	8	----	--	**220**
$Ca(OH)_2$	34.089	100	33.949	13	34.04	11	34.039	14	**101**
	47.124	42	47.497	22	47.000	14	47.172	22	**102**
Ett.	22.944	31	22.8788	9	23.070	7	23.026	10	**114**
	27.507	21	27.3188	100	--	--	27.0540	45	**300**
	32.268	25	32.2763	16	--		32.600	6	**304**
Tom.	25.325	30	----	--	25.200	5	-----	--	**205**
	26.923	16	26.473	56	----	--	----	--	**023**
	28.967	92	----	--	28.4000	7	28.0000	10	**220**
	30.044	70	----	--	30.112	82	29.8248	100	**400**
	43.495	13			43.200	7	43.550	19	**228**
TiO_2	27.447	100	----	--	27.245	46	27.400	21	**110**
	36.086	50	----	--	36. 366	10	36.159	20	**101**
	41.226	25	----		40.147	17	41.596	10	**111**



a



b

Figure.(1): P.S Spectra of Tio_2 a: nanometer b. micrometer.

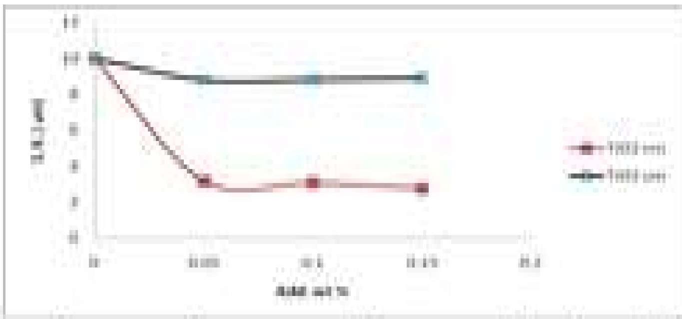


Figure.(2): Surface roughness of prepared mortar with nano and micro additives of TiO_2 at different ratio.

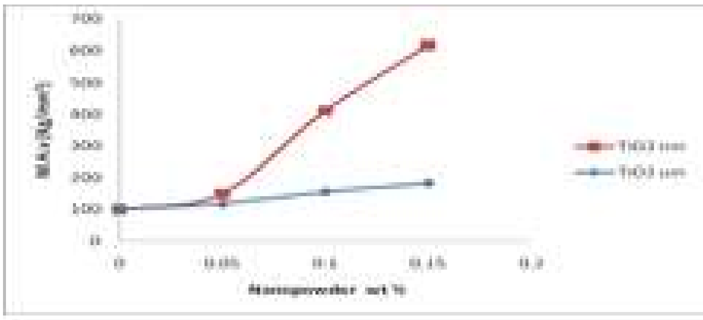


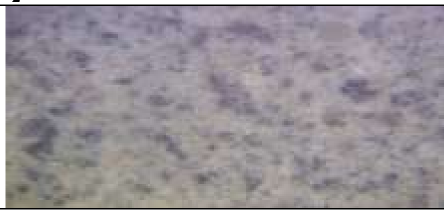
Figure.(3): Microhardness of the mortar with nano and micro additives of TiO_2 at different ratio.

a	**B**

0.15% TiO_2

c	**D**

0.1% TiO_2



e	**F**

0.05% TiO_2

g:0%

Figure (4) 2-D Optical microscope images of the mortar with Nano (in: a ,c ,e) and micro (in: b ,d, f)additives of TiO_2 at different ratio , and ref. in (g),X50.

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