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A BRIEF STUDY ON THE STRENGTH PROPERTIES OF MODIFIED CONCRETE UTILIZING LIGHT WEIGHT SILICA FUME AGGREGATES AND TETRA BLENDED CEMENT ALONG WITH POZZOLANIC & NANO MATERIAL (TIO2)

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ABSTRACT
An endeavor is made to think about the strength properties of changed M20 review concrete with 100% substitution of characteristic totals by light weight silica fume aggregates. It is likewise supplanted concrete with three quantities of pozzolanic materials i.e., Silica fume, slag and fly ash in equivalent extents alongside changing rates of Nano TiO2 in spells of 0,0.5%,1% and 1.5% on 11% of pozzolanic materials. Following 28 days different tests are completed on the altered concrete, for example, compressive strength test, flexural strength test, modulus of elasticity, impact value and in-plane shear strength. The outcomes are seen to be very fascinating.

Keywords: light Expandable Silica Fume Aggregate, Nano TiO2, Silica fume, slag, Fly ash, compressive strength, split tensile strength, modulus of elasticity, flexure, Impact value, In-plane shear strength.

1. INTRODUCTION

Concrete is a more current development material contrasted with steel and stone. Utilization of cement in developments and structures may have started not exactly a century prior. Be that as it may, in later past, wide and powerful research has been seen on enhancing the properties of cement fusing extensive variety of strengthening establishing materials, for example, pozzolanic materials and Nanoparticles. As of late Nano innovation has pulled in more noteworthy logical consideration basically because of the use of Nano particles which came about critical enhancement in different properties of cement. As a result, industrnties can plan new and novel items and to re-design many existing items that capacity at phenomenal levels. There are few reports on joining of Nano particles in cement based concrete.
The ongoing headways in the development business require improvement of new materials. Light weight aggregatwe has been the subject of broad research especially from the modern and horticultural waste which would some way or another make issue for transfer. The most essential normal for light weight aggregate is its lower warm conductivity and lower thickness. An endeavor is made to get ready counterfeit light weight aggregate solid utilizing silica fume and cold bonding technique.
The essential point of lightweight cement is to decrease the dead weight of structure to be used which at that point enables a draftsman to reduce the proportion of structural components (areas/beams) and size of establishment also. Lightweight material can possibly diminish the seismic mass of the structure and thusly lessen the level of seismic forces following up on a structure.
The fundamental reason for utilizing Nano measured materials in cement is to enhance the compressive and flexural strength at early age; it is conceivable because of the high surface to volume proportion. It additionally enhances the pore structure of cement. Nano estimated materials can decrease the porosity as they retain less water contrasted with customary cementitious materials. The nearness of Nano materials lessens the measure of cement content in concrete than the traditional concrete. This can be accomplished without relinquishing much the strength attributes; consequently it is conceivable to deliver ecofriendly concrete called green cement.

2. Literature review

M. Kosior-Kazberuk, et.al., (2007)(1) demonstrated that the fly slag beneficially affects compressive quality of all concretes tried. In spite of the fact that the rate of Strength increment of fly fiery remains concrete is slower and manages for longer periods, the cements containing fly cinder are equipped for building up a higher quality than Portland bond concrete and additionally the impact heater concrete cement. Following 180 days of capacity the cements containing 20

% of fly powder, identified with bond mass, picked up a compressive quality around 25 % higher than the solid without expansion, for a wide range of concrete.

R.V Balendran, et.al., (2002) (2) considered on "quality and solidness execution of High Performance concrete fusing pozzolanic materials at hoisted temperatures". The incorporation of pozzolanic materials like fly cinder and silica rage upgrades the properties of cement both in crisp and solidified states. On account of superior cement (HPC), their job in improving the usefulness, quality and solidness is to a great degree critical.

Ali-Nazari, et.al., (2010) (3), dealt with four arrangement of N mixed cements and i.e N1, N2, N3 and N4 with 0.5%, 1.0%, 1.5% and 2.0% of Nano-TiO_2 particles, individually per weight of bond in the solid and settled w/c proportion of 0.4 was utilized. It was inferred that the functionality decrease, expanded with the expanding NT (Nano Titanium Dioxide) content and compressive quality of cement following 28 days was 13.86%, 17.93%, 15.49% and 6.79% higher with the incorporation of 0.5%, 1%, 1.5%, and 2%NT separately. The last outcome with 1% NT content is the ideal.

Luciano Senff et al., (4) In his examination utilized shapeless Nano silica particles and directed experimention on concrete glues and mortars and their impact on new properties was dissected.

From the concise writing overview directed here it creates the impression considerably less consideration has been paid before on the investigation of cement changed with fake total i.e., Light Expandable Silica Fume total with tetra mixed concrete alongside Nano materials, for example, Nano Tio2, in mix of dynamic pozzolanic material, for example, Silica seethe, Fly Ash and Slag. Thus the present examination has been under taken.

3. Materials used

3. 1.Materials used: The following materials are used for preparing the concrete mix.
1. ULTRATECH cement of 53 grade
2. Fly ash
3. Silica fume
4. Slag
5. Nano Tio_2
6. Fine aggregate i.e sand
7. Coarse aggregate i.e Silica fume aggregates
8. Water

3.2 Cement: Ordinary Portland cement ULTRATECH 53 grade is used as binder. Some physical properties are presented in table 3.1

Table 3.1: properties of cement:

S.NO	PROPERTY	NUMERICAL VALUE
1	**Normal consistency**	**30%**
2	**Fineness**	**5%**
3	**Specific gravity**	**3.26**
4	**Setting time Initial and Final**	**50 minuties and 460 minuties**

3.3 Fly ash: The fly ash admixture is procured from Rayalaseema Thermal plant, Muddanur.

Some physical properties are presented in table 3.2

Table 3.2: Physical properties of fly-ash

S.NO.	PROPERTY	NUMERICAL VALUE
1	Bulk density loosest state	800 kg/m^3
2	Bulk density compacted state	960 kg/m^3
3	Fineness	0%
4	Specific gravity	2.7

3.4 Silica Fume: The silica fume admixture is procured from ferro silica unit at Ahmadabad. Some physical properties are presented in table 3.3.

Table 3.3: Properties of Silica fume

S.NO.	PROPERTY	NUMERICAL VALUE
1	Bulk density loosest state	420 kg/m^3
2	Bulk density compacted state	700 kg/m^3
3	Fineness (retained on 90 micron seive)	0%
4	Specific gravity	2.1

3.5 Nano Titanium dioxide: Nano titanium dioxide is procured from AVANSA technologies, KHANPUR.. Some physical properties are presented in table 3.4.

Table 3.4: Properties of Nano Titanium dioxide

S.NO.	PROPERTY	TEST RESULTS
1	Purity	99.9%
2	Colour	White
3	SSA	289m^2/g
4	Bulk density	0.12-0.18 g/cm^3

3.6 Fine Aggregate: Natural sand from close-by Chitravathi River close Bathalapalli with particular gravity of 2.54 is utilized as a fine total which is fitting in with zone-II of IS: 383-1970 [7].

3.7 Silica fume aggregate: Silica fume is a side-effect as smoke that out comes from electric heaters of businesses creating Silicon metal or ferrosilicon compounds. Silicon and ferrosilicon amalgams are delivered in electric heaters and the crude materials are quartz, coal and wood chips. Before the mid 1970's almost all silica rage was released into air. After ecological concerns required accumulation and land filling turned out to be monetarily supported to utilize Silica Fume in different applications. As a result of concoction and physical properties it is an exceptionally responsive pozzolanic. Silica fume comprises basically of undefined (non-crystalline) Nano Titanium dioxide (Tio2). The individual particles are to a great degree little, around 1/100th the span of a normal concrete molecule. On account of its fine particles, huge surface region, and the high Tio2 content, silica fume is an extremely receptive pozzolanic material.

4. Mix Design of Concrete

M20 Mix configuration has been completed utilizing ISI techniques i.e, IS 10262-2009 and IS 456-2000. The blend extent got is 1:1.58:2.88 with steady water bond proportion of 0.5.

A. Mixing, casting and curing

M20 mix design has been done with the blend extents of 1: 1.58: 2.88. It implies that 1 part of concrete, 1.58 sections of fine total and 2.88 sections of coarse total which is only pre-drenched silica fume aggregate and supplanting some piece of cement with three quantities of pozzolanic materials i.e., Silica fume, slag and fly ash in equivalent extents alongside differing rates of Nano TiO2 in spells of 0, 0.5,1 and 1.5% on 11% of pozzolanic materials with water cement proportion of 0.5. These were blended altogether by hand blending. In the wake of blending concrete was put inside the molds in three layers and were kept on the table vibration and vibrated for few moments. In the event of DCN molds the plates which were utilized for making indents were evacuated following 3 hours of throwing with painstakingly. In any case, the examples were de formed following 24 hours of throwing and were kept submerged in a perfect water tank for restoring. Following 28 days of restoring the examples were removed from water and were permitted to dry under shade for couple of hours. Keeping the volume of solid steady with soaked and surface dry silica fume aggregate four diverse blends were structured and are assigned as pursues:

Mix	Silica Fume Aggregate	% of admixtures in equal proportion	% of Nano materials
M1	100	11	0
M2	100	11	0.5
M3	100	11	1
M4	100	11	1.5

B. Compressive strength of concrete cubes

The test examples were put away in wet air for 24 hours and after this period the examples were checked and expelled from molds and kept submerged in clear crisp water until the point that taken out preceding test. The examples were expelled from water after determined relieving time and abundance water was wiped from the surface. The examples were set in the machine in such a way, to the point that the heap shell be connected concentrically. Examples were adjusted halfway on the base plate of the machine. The heap was connected slowly without stun and consistently at the rate of 140 kg/cm2/min till the example comes up short. The most extreme load was recorded. Compressive strength of cubes were figured. The compressive strength of cubes are classified in table1 and qualities are graphically exhibited in figure 1.

C. Flexural strength of beams

Flexural strength is one proportion of the rigidity of the solid. The flexural strength test was finished by standard test strategy for two-point stacking. In this examination, three light emissions 100x100x500 mm were utilized to discover the flexural strength. The flexural strength of beams results are classified in table 2 and the qualities are graphically introduced in figure 2.

D. Cylinder Compression Test

In this test the tube shaped examples were kept vertically with the goal that its hub was vertical between the compressive plates of the 3000KN computerized pressure testing machine. Limited portions of the pressing material i.e., compressed wood was set between the plates and the chamber to get compressive pressure. The heap was connected consistently until the point when the barrel fizzles. Compressive strength aftereffects of barrels are classified in table 3 and qualities are graphically displayed in fig.3.

E. Cylinder Split tensile Test

In this test the round and hollow examples were kept on a level plane so its hub was parallel to the compressive plates of the 3000KNdigital pressure testing machine. Thin pieces of the pressing material i.e., compressed wood was set between the plates and the cylinder to get compressive pressure. The heap was connected consistently until the point when the barrel comes up short. Split tensile strength consequences of cylinder are classified in table 4 and qualities are graphically exhibited in fig.4.

F. Modulus of elasticity:

The hypothetical modulus of elasticity was ascertained utilizing IS code formula (7).

$$E=5000*\sqrt{fck}$$

Where ,fck= Characteristic Compressive strength of concrete in N/mm2 . The modulus of elasticity values are computed from the other observational equation proposed by Takafumi (8) for light weight concrete.

$$E=k1k2*1.486*10^{-3}*fck^{1/3}*\gamma^{2}.$$

Where fck = Compressive strength in N/mm2, γ = Density in Kg/m3, K1 =0.95 (adjustment factor comparing to coarse aggregate),K2 =1.026 (amend particle factor relating to mineral advertisement blends). The Modulus of Elasticity, values dependent on Empirical formula and IS code are introduced in Table 6 and Table 7 separately and values are graphically spoken to in fig.6.

G. Mode II fracture test

For testing DCN examples of size 150x150x150mm, scores were presented at 33% part midway amid throwing. The Mode II fracture test on the DCN 3D squares was directed on 3000KN computerized pressure testing machine. The rate of stacking connected was 0.5 KN/sec. Consistently dispersed load was connected over the focal 33% sections between the scores and steel backings of square cross segment were given at base along the external edges of the indents, with the goal that the focal part could get punched/sheared through along the scores on the utilization of stacking. Test outcomes are appeared in table 8 and displayed graphically in fig.8.

H. In-Plane shear strength

The In-plane strength of adjusted cement was computed utilizing the recipe

In plane shear strength = P/2*d (d-a) N/mm2

Where P= Ultimate load in mode-II shear

d= size of the cube= 150mm

a= depth of notch

The estimations of in plane shear strength of changed cement for different a/w proportions in mode-II shear are introduced in Table 9 and qualities are demonstrated graphically in Figure 9.

5. Exchange of Test Results

In the present examination characteristic total has been completely supplanted with Silica rage totals alongside substitution of some piece of cement by three quantities of pozzolanic materials i.e., Silica fume, slag and fly ash in equivalent extents and alongside changing rates of Nano TiO2 in spells of 0, 0.5, 1 and 1.5% on 11% of pozzolanic materials.

A. Impact of Nano TiO2 on cube compressive strength

The variety of compressive strength sections differing rate substitution at 0, 0.5, 1 and 1.5% on 11% of concrete with NanoTiO2, at 28 days is appeared in figure 1. From the above figure it might be seen that with the expansion of Nano TiO2, the cube compressive strength increments up to 1% expansion and with more expansion of Nano materials past 1% the strength is diminished. Henceforth 1% of Nano is seen to be ideal.

B. Impact of NanoTiO2on flexural strength of beams specimens

From the table 2 and figure 2 it might be seen that the flexural strength of bars is expanded ceaselessly up to 1% expansion of Nano materials and a short time later it is diminished. Henceforth 1% expansion of Nano TiO2 is seen to be ideal.

C. Impact of NanoTio2 on cylinder compressive strength

From the table 3 and figure 3 it might be seen that the chamber compressive strength is expanded ceaselessly up to 1% expansion of Nano materials and a short time later it is diminished. Henceforth 1% expansion of Nano Tio2 is seen to be ideal.

D. Impact of Nano Tio2 on split tensile strength of cylinder

From the table 4 and figure 4 it might be seen that the cylinder compressive strength is expanded ceaselessly up to 1% expansion of Nano materials and a short time later it is diminished. Henceforth 1% expansion of Nano Tio2 is seen to be ideal.

E. Impact of NanoTiO2 on modulus of elasticity

The modulus of elasticity results with different rates of NanoTiO2 are displayed in table 5 for 28 days dependent on empirical formula and dependent on the IS code as made reference to in table 6. These outcomes are graphically exhibited in figure 5. From the outcomes it is seen that modulus of flexibility has been expanded ceaselessly up to 1% of NanoTiO2. With more expansion of NanoTiO2 the estimations of modulus of flexibility are diminished. It is additionally seen that the modulus of flexibility esteems figured from IS code are higher when contrasted and those computed from empirical formula.

F. Impact of NanoTiO2 on in-plane shear strength

All the DCN examples with various a/w proportions i.e 0.3, 0.4, 0.5 and 0.6 and with various rates of NanoTiO2 in equivalent extents were tried with load in Mode-II (in plane shear). The varieties of in plane shear strength and rate increment or decline in-plane shear strength refrains rate supplanting of concrete with NanoTiO2 in various rate are introduced in table 7 which are exhibited for various a/w proportions following 28 days. The graphical variety is exhibited in Figure 6.From this it is seen that the in-plane shear strength increments up to 1% expansion of Nano TiO2 and on further expanding the Nano material the in-plane shear strength decreases.

Table 1: Compressive strength of Cubes:

Mix	% of Silica Fume Aggregate	% admixture in equal proportion	% of Nano materials (Tio_2) on 11% of cement	% of cement	cube compressive strength in N/mm^2	% increase or / decrease of compressive strength
M1	100	11	0	100	15.5	0
M2	100	11	0.5	88.945	20.22	30.45
M3	100	11	1	88.89	22.56	45.54
M4	100	11	1.5	88.835	19.73	27.29

Table 2: Flexural Strength of Beams:

mix	Replacement	% admixtures	% of Nano materials	% cement	flexural strength	% increase or decrease
M1	100	11	0	100	2.24	0
M2	100	11	0.5	88.95	2.41	7.58
M3	100	11	1	88.89	2.66	18.75
M4	100	11	1.5	88.84	2.53	12.94

Table 3: Compressive strength of cylinders:

Mix	% of Silica Fume Aggregate	% admixture in equal proportion	% of Nano materials (Tio2) on 11% of cement	% of cement	cylinder compressive strength in N/mm2	% increase or / decrease of compressive strength
M1	100	11	0	100	10.50	0
M2	100	11	0.5	88.945	13.79	31.33
M3	100	11	1	88.89	17.40	65.71
M4	100	11	1.5	88.835	14.50	38.09

Table 4: Split Tensile Strength of Cylinders:

Mix	% of Silica Fume Aggregate	% admixture in equal proportion	% of Nano materials (Tio2) on 11% of cement	% of cement	cube compressive strength in N/mm2	% increase or / decrease of compressive strength
M1	100	11	0	100	1.59	0
M2	100	11	0.5	88.945	1.70	6.91
M3	100	11	1	88.89	1.77	11.32
M4	100	11	1.5	88.835	1.63	2.35

Table 5: Modulus of Elasticity by Empirical Formula:

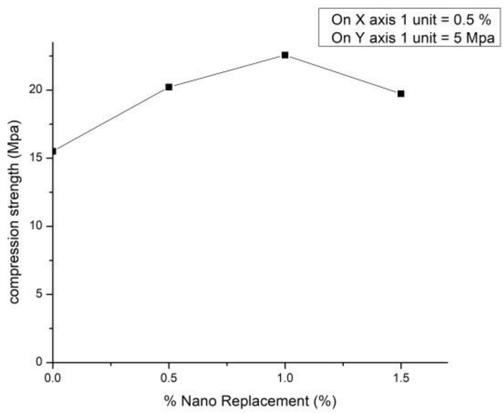
Mix	% of Silica Fume Aggregate	% of Nano materials (Tio2) on 11% of cement	Fck in N/mm^2	Density in kg/m^3	Young's Modulus by Empirical Formula*10^4 E=k1k2*1.486*10-3 fck⅓ γ2 K1= 0.95, K2= 1.026000 in *10^4 in N/mm2	% of increase or decrease of modulus of elasticity
M1	100	0	22.56	2171.85	1.82	0
M2	100	0.5	19.73	2157.04	1.93	6.04
M3	100	1	17.68	2245.96	1.94	6.59
M4	100	1.5	17.28	2189.63	1.8	-1.09

Table 6: Modulus of Elasticity by IS Code Formula:

Mix	% of Silica Fume Aggregate	% admixture in equal proportions	% of Nano materials (Tio2) on 11% of cement	% of cement	Modulus of elasticity*10^4 in N/mm2 5000fck	Percentage increase or decrease of modulus of elasticity
M1	100	11	0	100	2.22	0
M2	100	11	0.5	88.945	2.37	6.75
M3	100	11	1	88.89	2.64	18.91
M4	100	11	1.5	88.835	2.08	-6.30

Table 7: In-plane Shear strength:

Mix	% of Silica Fume Aggregate	% admixture in equal proportions	% of Nano materials	a/w=0.3		a/w=0.4		a/w=0.5		a/w=0.6	
				In Shear strength in N/mm^2	% Increase or Decrease in plane shear strength	In Shear strength in N/mm2	% Increase or Decrease in plane shear strength	In Shear strength in N/mm2	% Increase or Decrease in plane shear strength	In Shear strength in N/mm2	% Increase or Decrease in plane shear strength
1	100	11	0	1.4	0	1.39	0	1.55	0	1.40	0
2	100	11	0.5	1.48	5.71	1.59	14.39	1.82	17.41	1.46	4.28
3	100	11	1	1.62	15.71	1.70	22.30	1.90	22.58	1.99	42.14
4	100	11	1.5	1.47	5	1.54	10.78	1.46	-5.8	1.45	3.57



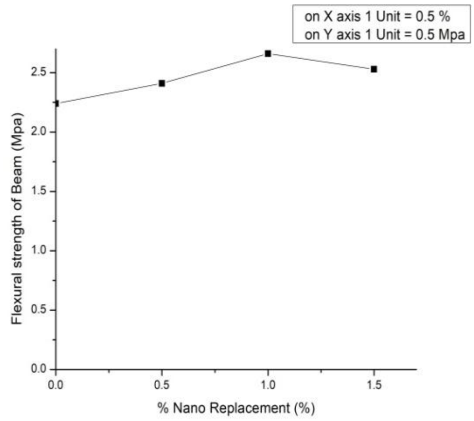
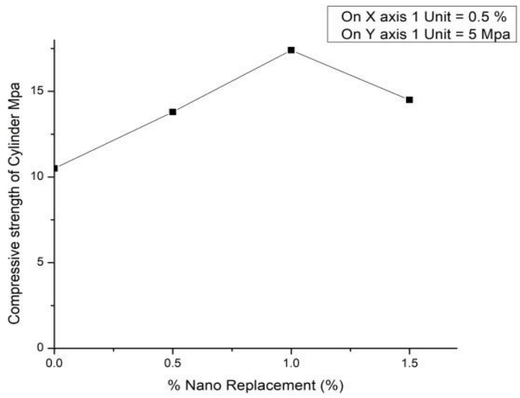


Figure 1: Variation of Compressive Strength of Cube **Figure 2: Variation of Flexural Strength of beams**



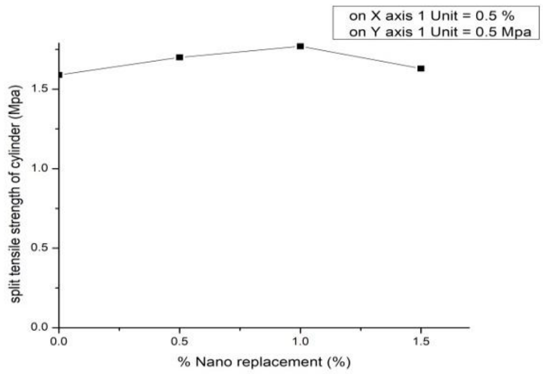
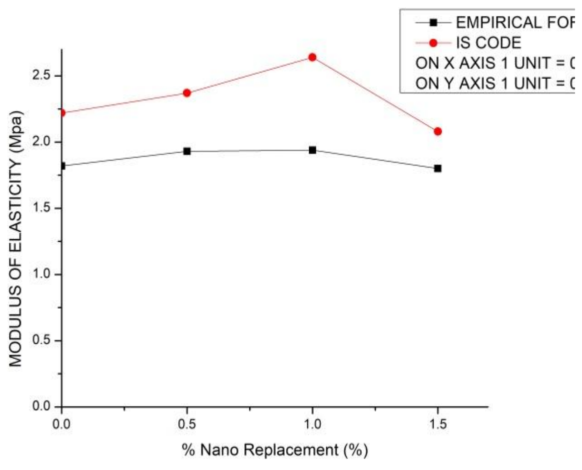


Figure 3: Variation of Compressive strength of cylinders **Figure 4: Variation of Split tensile strength of cylinders**



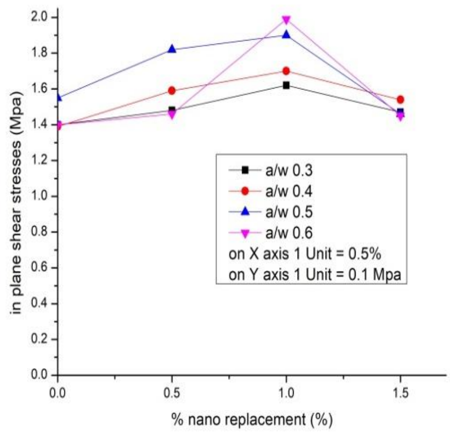


Figure 5: Variation of Modulus of Elasticity based on IS code and Empirical formula **Figure 6**: Super Imposed variations of In-plane shear strength for different a/w ratios

7. CONCLUSIONS

The accompanying ends are drawn Based on the Experimental Results.

1.The mean strength of M20 concrete is 15.50 N/mm2.From the exploratory investigation it is seen that the 28 days solid shape compressive strength of adjusted cement with 100% silica fume aggregate is 15.50 N/mm2 and with supplanting of cement by 11% with three quantities of pozzolanic materials i.e., Silica fume, Slag and Fly ash in equivalent extents and 1% of NanoTio2 on 11% of weight of pozzolanic materials the cube compressive strength of changed solid ascents to 22.56 N/mm2 With more expansion of Nano materials past 1% the strength is diminished.

2.All the beams have been bombed in the flexural zone and all things considered the flexural breaks have been spread from the base side to top with smashing of cement at the best surface. It is seen that the 28 days flexural strength of altered cement with 100% of silica fume aggregate is 2.24 N/mm2 and with supplanting of cement with pozzolanic materials with steady extent of 11% and 1% of NanoTiO2 the flexural strength of adjusted solid ascents to 2.66 N/mm2 with an expansion of 18.75%. With expansion of more NanoTiO2, the strength is diminished.

3.It is seen that the 28 days cylinder compressive strength of changed cement with 100% silica fume aggregate is 10.50 N/mm2 and split tensile strength of concrete is seen as 1.59 N/mm2. With supplanting of cement by 11% with three quantities of pozzolanic materials i.e., Silica fume, Slag and Fly ash in equivalent extents and 1% of Nano Materials i.e, Tio2 the cylinder compressive strength of adjusted solid ascents to 17.26 N/mm2and split tensile strength ascends to 1.77 N/mm2. With expansion of more NanoTiO2 past 1% the strength is diminished.

4.It is seen that the Modulus of Elasticity computed by Empirical equation of adjusted cement with 100% silica fume aggregate is 1.82*104 N/mm2 and with supplanting of bond with pozzolanic materials with consistent extent of 11% and 1% of NanoTiO2, the modulus of Elasticity of changed solid ascents to 1.94*104 N/mm2 With expansion of more NanoTiO2, the modulus of flexibility is diminished. It is seen that the Modulus of Elasticity computed by IS code equation of altered cement with 100% silica fume aggregate is 2.22*104 N/mm2 and with supplanting of cement with pozzolanic materials with consistent extent of 11% and 1% of NanoTiO2, the modulus of Elasticity of changed solid ascents to 2.64*104 N/mm2 with an expansion of 18.91%. With expansion of more NanoTiO2, the 'E' esteem is diminished. It is additionally seen that the outcomes gotten by exact equation are lesser than those strength ascertained dependent on IS code.

5. The expansion of pozzolanic materials and NanoTiO2 content has fundamentally upgraded the in-plane shear strength. Amid the test it is plainly seen that the breaks have grown pretty much up and down the notches. As in different cases the in planes shear strength increments with expanding the substance of Nano TiO2 up to 1%.

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