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EFFECT OF NANO SILICA ON STRENGTH AND DURABILITY

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ABSTRACT:

Due to fast industrialization and urbanization in the country lot of infrastructure trends are taking place. This system is turned lead questions to mankind to solve the troubles generated by using this growth. The problems described are acute scarcity of production substances, growth the productiveness of waste and different products commonly M30 concrete is used for maximum of the constructional works. Thus in this research M30 concrete is taken and nano silicon oxide powder is employed. Nano technology is an emerging field of interest for civil engineering utility. A few of the nano substances presently used in concrete, nano-silica very own greater pozzolanic nature. It has the functionality to react with the unfastened lime inside the route of the cement hydration and bureaucracy extra C-S-H gel giving strength, impermeability and durability to concrete. Present paper investigates the e□ects of addition of nano silica in normal strength of concrete

The present research deals with Partial alternative cement through nano silica powder as partial replacements in concrete at associate increment of 50 on every occasion. i.e 0%, 5%, 10%, 15%, 20%. Cubes, Cylinders and beams were casted and examined at seven, 28,56 and 90 days aged. The results had been compared with the outcomes of concrete specimens with 0% of nano silica.

Key words: M30 grade, nano silica, C-S-H gel

I.INTRODUCTION

Concrete is the most appreciably used in production material in the international. In current years, researchers have centered on the improvement of concrete great concerning its mechanical and sturdiness residences. These can be completed by the application of the supplementary cementitious substances. Out of these supplementary cementations materials, silica fume is the one of the waste substances this is being produced in tones of commercial enterprise waste in line with year in our country. The first attempting out of silica fume in Portland-cement-based definitely concretes become performed in 1952. The biggest downside to exploring the houses of silica fume have

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turn out to be a loss of fabric to check with. Early research used an luxurious additive referred to as fumed silica, an amorphous shape of silica made with the aid of manner of manner of combustion of silicon tetrachloride in a hydrogen-oxygen flame.

silicon oxide fume but, could be a terribly nice pozzolanic material. It's far a byproduct of producing silicon steel or ferrosilicon alloys. One of the maximum useful uses silica fume is in concrete. Due to its chemical and physical residences; it's miles a really reactive pozzolanic material. Concrete containing silica fume has very immoderate strength and could be very long lasting. Lately Nano technology has been introduced in Civil Engineering programs. One of the most used nano material is Nano oxide (NS). that's the primary Nano product that has modified the small oxide. The advancement made via the have concrete at nano scale has proved that nano silica is a lot better than silica fume utilized in conventional concrete.

NANOMATERIALS- USE IN CONCRETE

Nano substances are very small sized substances with particle length in nano metres. These materials are very effective in changing the homes of concrete on the ultrafine degree by the virtue in their very little size. The small length of the debris additionally method an additional ground area (Alireza Naji Givi, 2010). Because the fee of a pozzolanic reaction is proportional to the floor location available, a faster response may be finished. Best a small percent of cement can be changed to obtain the desired consequences. These nano materials enhance the power and permeability of concrete via filling up the minute voids and pores inside the microstructure. The usage of nanosilica in concrete mix has validated outcomes of proven consequences of increase in the compressive, tensile and flexural energy of concrete. It devices early and therefore usually requires admixtures at some point of mixture layout. Nano-silica combined cement will generate nano-crystals of C-S-H gel after hydration.

NANO SILICA

Silicon dioxide nano particless, additionally known as silica nano particles or nano silica, are the basis for a super deal of biomedical research because of their stability, low toxicity and capacity to be functionalized with diverse molecules and polymers.

Nano-silica debris are divided into P-type and S-kind in line with their structure. The P-type debris are characterized through numerous nano pores having a pore price of zero.Sixty one ml/g. The S-kind particle has as an alternative smaller ground place. The P-type nano-silica particles show off a higher ultraviolet reflectivity whilst in contrast to the S-kind. Silicon belongs to dam P, length three on the equal time as oxygen belongs to dam P, duration 2 of the periodic table.

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NANO SILICA

CHEMICAL AND PHYSICAL PROPERTIES OF NANO SILICA

Chemical composition	
Chemical symbol	SiO2
CAS NO	7631-86-9
GROUP	Silicon 14 Oxygen 16
Electronic configuration	Silicon [Ne] $2s^23p^2$ Oxygen [He] $2s^22p^4$

CHEMICAL COMPOSITION

Element	Content (%)
Silicon	46.83
Oxygen	53.33

OBJECTIVE AND SCOPE OF THE STUDY

The major objectives of the existing examine are as referred to below:

1. To take a look at the effect of nano-silica at the compressive energy of concrete.

2. To have a look at the microstructure of the hardened cement concrete.

3. To offer an reason for the change in houses of concrete, if any, through explaining the micro structure

SCOPE OF WORK

The existing observes includes combo design based totally on the recommendations as in line with Indian preferred code IS 10262-2009. The nano-silica used is imported from a supplier. The use of any shape of admixture is exactly prohibited in the blend format. The water content has been saved consistent to facilitate a better comparison for

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considered one of a type samples. The compressive strength measurements are finished for 7-day and 28-day and the FESEM evaluation has been performed for 28-day best. The scale of the nano silica changed into diagnosed the usage of Particle length Analyser.

II. LITERATURE REVIEW

Ali Nazari et.al. (2011)

He studied the combined impact of Nano SiO2 particles and GGBFS on homes of concrete. They used nanosilica with 3% b.W.C. Alternative and 45% b.W.C. GGBFS, which suggests advanced break up tensile electricity. An improvement inside the pore shape of SCC with silica particles was found. Apart from this hello have studied the impact of ZnO2 nano debris on SCC concrete with consistent w/c ratio of 0.4.

The Resultss showed that through growing the content material of fantastic plasticizer flexural power decreases. Upto 4% b.W.C. Of ZnO2 content material an growth in the flexural electricity of SCC become recorded. In another experiment the identical creator studied effect of Al_2O_3 nano particles on the homes of concrete. The resultss showed that cement could get replaced up to 2% for improving mechanical properties of concrete, but Al_2O_3 nano particless decreased percentage water absorption of concrete. XRD evaluation of the sample showed that there may be more speedy formation of hydrated product. Christo Ananth et al.[6] discussed about E-plane and H-plane patterns which forms the basis of Microwave Engineering principles.

Comiletti et.al. (2012)

This study investigated the effect of micro and nano CaCO3 on the early age properties of ultra-high performance concrete (UHPC) cured in cold and normal field conditions. The micro CaCO3 was added from 0 to 15% b.w.c. and nano CaCO3 was added at the rate of 0, 2.5 and 5% b.w.c. Results show that by incorporating nano and micro CaCO3 the flow ability of UHPC is higher than the control mix which increases the cement replacement level.

The mixture containing 5% nano CaCO3 and 15% micro CaCO3 gives shortest setting time at 10 °C and at 20°C the highest 24 hrs compressive strength is achieved by replacing cement with 2.5% nano and 5% micro CaCO3 and highest compressive strength at 26 days was achieved at 0% nano and 2.5% micro CaCO3.

H. Li et.al. (2006)

He studied the abrasion resistance of concrete blended with nano particles of TiO2and SiO2 nano particles along with polypropylene (PP) fibers. It was observed that abrasion resistance can be improved considerably by addition of nano particles and PP fibers. Also the combined effect of PP fiber + Nano particles shows much higher abrasion

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resistance than with nano particles only. It was found that abrasion resistance of nano TiO2 particles is better than nano SiO2 particles. Also relationship between abrasion resistance and compressive strength is found to be linear.

III. EXPERIMENTAL PROGRAMME

MATERIALS:

CEMENT:

Cement is a binder, a substance applied in production that units and hardens and can bind distinctive substances together. The most essential styles of cement are used as a difficulty inside the manufacturing of mortar in masonry, and of concrete that is a aggregate of cement and an combination to shape a robust constructing material.

Ordinary Portland cement 53 grade

The normal Portland cement of 53grade is used in accordance with IS: 12269-1987.

Properties of this cement have been examined and listed under.

1. Fineness of cement = five%
2. Specific gravity if cement = 3.02
3. Standard Consistency of cement = 33%
4. Initial placing time = 50mins
5. Final setting time = Not extra than 10 hours.

AGGREGATES:

Construction combination, or definitely "mixture", is a big elegance of coarse particulate fabric utilized in manufacturing, together with sand, gravel, Crushed stone, and slag, recycled concrete and geo-synthetic aggregates. Aggregates are the maximum mined materials in the global.

COARSE AGGREGATE:

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Crushed stone combination of 20mm size is added from nearby quarry. Aggregates of duration greater than 20mm length are separated by means of using sieving. Tests are carried so that you can find out the

• Specific gravity = 2.98

• Fineness modulus = 7.5

FINE AGGREGATE:

Locally to be had glowing sand, unfastened from natural be counted variety is used. The end result of sieve assessment confirms it to Zone-II (in step with IS: 383-1970).The tests are finished and outcomes are proven underneath.

• Specific gravity = 2.3

• Fineness modulus = 3.06

NANO SILICA

Silicon dioxide nano particles, additionally known as silica nano particles or nano silica, are the basis for notable deal of biomedical studies due to their stability, low toxicity and capacity to be functionalized with various molecules and polymers.

ADMIXTURE

To acquire workability of Concrete, Sulphonated napthalene polymer based totally definitely notable plasticizer Conplast SP430 inside the form of a brown liquid proper away dispersible in water, Use of superplasticizer lets in the bargain of water to the quantity as much as 30 percent without reducing the workability, in evaluation to the

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possible reduction up to 15 percent in case of plasticizers. The use of superplasticizer is practiced for production of flowing, self leveling, self compacting, and for production of excessive electricity and high basic performance concrete.

Conplast SP430

MIX DESIGN FOR M30 GRADE CONCRETE

Final trial mix for M30 grade concrete is 1:1.86:2.89 at w/c of 0.50

Quantity of material Required:

GRADES OF CONCRETE	CEMENT(OPC53) (kg/m3)	NANO SILICA	FINE AGGREGATES (kg/m3)	COARSE AGGREGATES (kg/m3)	WATER CONTENT (Liters/m)
M30	202.6386	22.3614	417.60	646	112.2555
Addition of extra 10%	222.90246	24.59754	459.36	710.6	123.48105

IV. RESULTS AND ANALYSIS

A. MATERIAL PROPERTIES

CEMENT:

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Sl.no	Test	Results	IS code used	Acceptable limit
1	Specific gravity of cement	3.10	IS:2386:1963	3 to 3.2
2	Standard consistency of cement	6mm at 32% w/c	IS:4031:1996	w/c ratio 28%-35%
3	Initial and final setting time	45 mins and 10 hours	IS:4031:1988	Minimum 30mins and should not more than 10 hours
4	Fineness of cement	4.00%	IS:4031:1988	<10%

COARSE AGGREGATES:

Sl.no	Test	Results	Is code used	Acceptable limit
1	Fineness modulus	6.8	IS:2386:1963	6.0 to 8.0mm
2	Specific gravity	2.95	IS:2386:1963	2 to 3.1mm
3	Porosity	46.83%	IS:2386:1963	Not greater than 100%
4	Voids ratio	0.8855	IS:2386:1963	Any value
5	Bulk density	1.50g/cc	IS:2386:1963	-
6	Aggregate impact value	35.5	IS:2386:1963	Less than 45%
7	Aggregate crushing value	27.5%	IS:2386:1963	Less than 45%

FINE AGGREGATES:

Sl.no	Test	Result	Is code used	Acceptable limits
1	Fineness modulus	4.5	IS:2386:1963	Not more than 3.2 mm
2	Specific gravity	2.43	IS:2386:1963	2.0 to 3.1
3	Porosity	36.6%	IS:2386:1963	Not greater than 100%
4	Voids ratio	0.577	IS:2386:1963	Any value
5	Bulk density	1.5424	IS:2386:1963	-
6	Bulking of sand	4.0%	IS:2386:1963	Less than 10%

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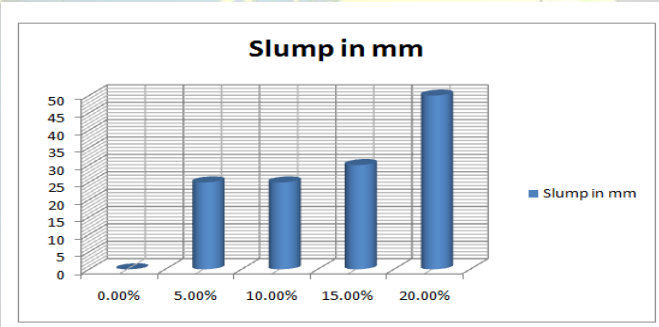
CONCRETE TESTS

B. TESTS ON FRESH CONCRETE:

SLUMP CONE TEST:

S.no	%Replacement of nano silica	Slump in mm
1	0.00%	0
2	5.00%	25
3	10.00%	25
4	15.00%	30
5	20.00%	50



COMPACTION FACTOR TEST

S.no	%Replacement of nano silica	Compaction factor
1	0.00%	0.98
2	5.00%	0.96
3	10.00%	0.94
4	15.00%	0.90
5	20.00%	0.86

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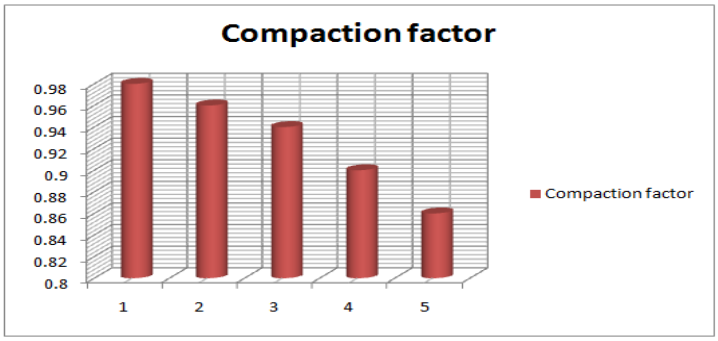
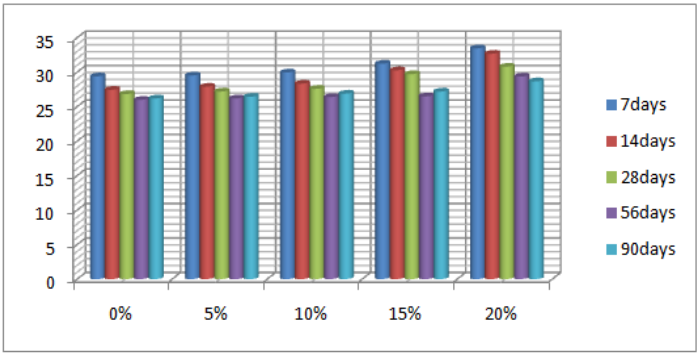


C. TESTS ON HARDENED CONCRETE:

1. COMPRESSIVE STRENGTH:

S.no	% Replacement of nano silica	Compressive strength of concrete				
		7days	14days	28days	56days	90days
1	0.00	29.40	29.52	29.96	31.24	33.46
2	5.00	27.46	27.90	28.34	30.28	32.68
3	10.00	26.84	27.20	27.60	29.72	30.80
4	15.00	26	26.20	26.40	26.50	29.38
5	20.00	26.20	26.45	26.90	27.20	28.68



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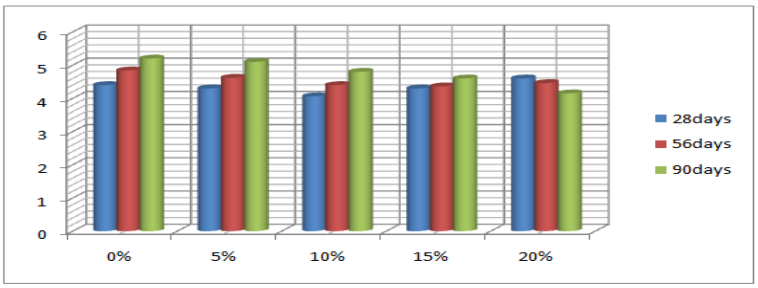
2. SPLIT TENSILE STRENGTH OF CONCRETE

S.no	% Replacement Of Metakaolin	Split Tensile Strength Of Concrete		
		28days	56days	90days
1	0.00%	4.40	4.84	5.20
2	5.00%	4.30	4.62	5.10
3	10.00%	4.06	4.40	4.80
4	15.00%	4.30	4.36	4.60
5	20.00%	4.60	4.46	4.15



3. FLEXURAL STRENGTH

S.no	% Replacement Of Metakaolin	`Flexural Strength Of Concrete		
		28days	56days	90days
1	0.00%	3.15	3.50	4.20
2	5.00%	3.20	3.65	4.10
3	10.00%	3.39	3.85	3.90
4	15.00%	3.60	4.20	4.30
5	20.00%	4.01	4.60	4.80

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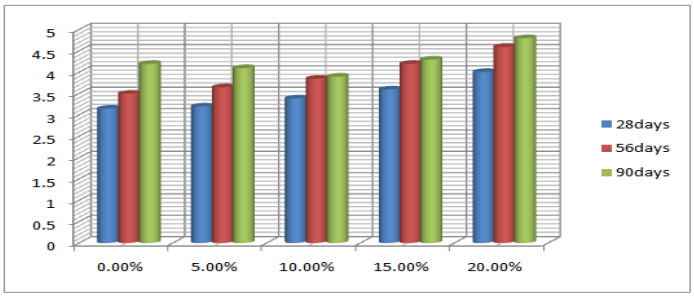
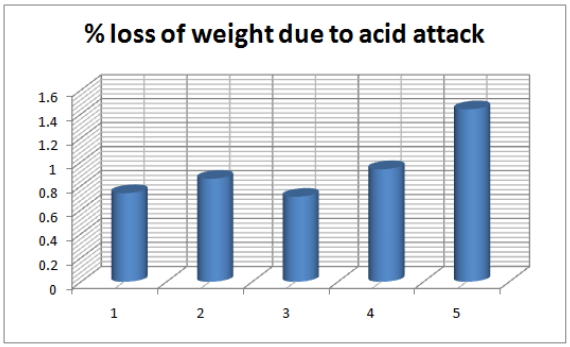
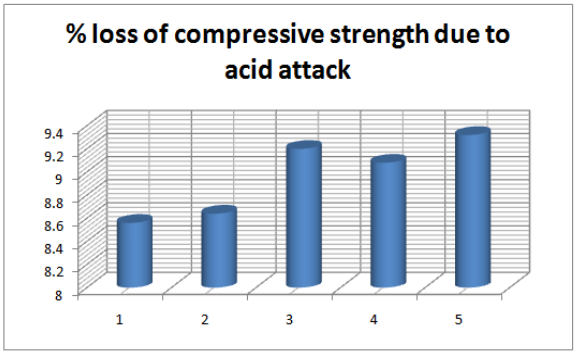


D. DURABILITY

ACID ATTACK

Sl.no	% replacement	Initial weight of cube after 28days curing in grams	Final weight of cubes after 90days curing in grams	% loss of weight due to acid attack	Compressive strength of cube after 28days curing	Compressive strength of cubes after 90days curing	% loss of compressive strength due to acid attack
1	0.00%	2355	2337	0.74	29.96	27.40	8.56
2	5.00%	2335	2315	0.86	28.34	25.90	8.64
3	10.00%	2265	2249	0.71	27.60	25.06	9.20
4	15.00%	2230	2209	0.94	26.40	24.00	9.08
5	20.00%	2394	2360	1.44	26.90	24.40	9.32





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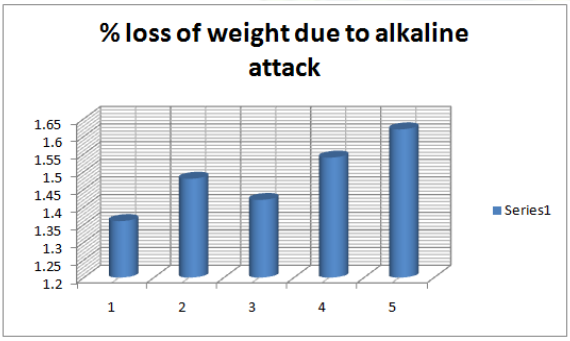
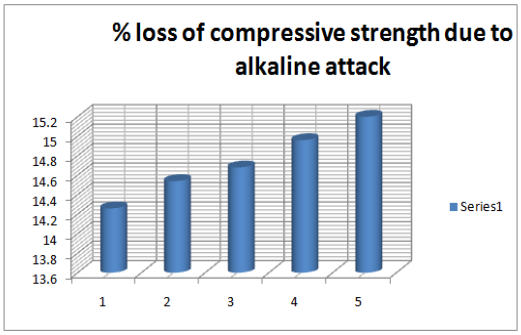
ALKALINE ATTACK

Sl. No	% replacement	Initial weight of cube after 28days curing in grams	Final weight of cubes after 90days curing in grams	% loss of weight due to alkaline attack	Compressive strength of cube after 28days curing	Compressive strength of cubes after 90days curing	% loss of compressive strength due to alkaline attack
1	0.00%	2286	2255	1.36	29.96	25.69	14.26
2	5.00%	2340	2305	1.48	28.34	24.22	14.54
3	10.00%	2280	2248	1.42	27.60	23.55	14.68
4	15.00%	2310	2275	1.54	26.40	22.45	14.96
5	20.00%	2296	2259	1.62	26.90	22.81	15.20





SULPHATE ATTACK TEST

Sl.no	% replacement	Compressive strength of cube after 28days curing	Compressive strength of cubes after 90days curing	% loss of compressive strength due to sulphate attack
1	0.00%	29.96	24.31	18.86
2	5.00%	28.34	23.12	18.42
3	10.00%	27.60	22.72	17.68
4	15.00%	26.40	21.80	17.42
5	20.00%	26.90	22.12	17.77

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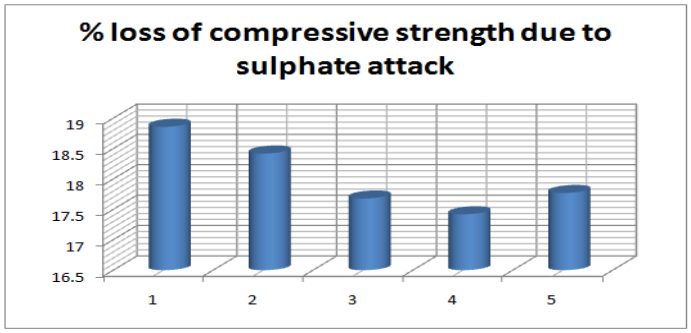

V. CONCLUSIONS

The following conclusions are made based on the above study:

The following conclusions are made based at the above study:

1. A study of relevant papers display that concrete mixed with Nano SiO2 units quicker in comparison to everyday concrete. Since, the combination layout is carried out without the resource of supperplasticizers, the mix dried up speedy which affected the compaction of the combination the usage of mechanical vibration. Lumps of the combination could be seen all through the mixing of concrete. With growth in percent of Nano SiO2 the compaction receives more difficult. This is the reason for degradation in its pleasant. It is really useful to apply superplasticizers with nano silica.

2. The material residences of the cement, pleasant aggregates and coarse aggregates are inside the applicable limits as in line with IS code hints so we can use the materials for research.

3. Slump value for the M30 grade concrete increases with increasing in the share of nano silica so the concrete become not potential.

4. Compaction thing price of concrete decreases with boom in the percentage of nano silica and the maximum values of compaction thing became observed at normal concrete with out a substitute.

5. The compressive strength of concrete is decreases with boom in the proportion of nano silica in concrete and maximum at 0% of nano silica and is the most reliable fee for 7days curing, 28days curing, 56days curing, 90days curing.

6. Split tensile power for the cylindrical specimens is most at 20% alternative of nano silica for 28days curing, 56days curing.

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7. The flexural energy of copper slag concrete is also most at 20% of nano silica for 28days curing, 56days curing, 90days curing.

8. The percentage loss of weight and percentage loss of compressive power is will increase first of all upto 3% of nano silica after which decreases and increases with in increasing the percentages in all cases in sturdiness studies in metakaolin concrete. Percentage of compressive energy loss due to sulphate assault decreases with growth in the share of nano silica. So, the concrete including nano silica is long lasting upto 20% alternative.

9. The Nano SiO2 brought to the mixture crammed up the pores in among the C-S-H gel, consequently, making the microstructure extra compact and uniform.

So the replacement of 20% of nano silica has suitable consequences so it's far usually useful for higher energy values in M30 grade of concrete.

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