Variation In Compressive Strength of Concrete For Different Concrete Mix Grades Using Different Proportions of Nano Silica

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I. INTRODUCTION

1.1 Concrete:

Concrete is composite material manufactured using fine aggregate, coarse aggregate, water and cement the properties of concrete will change with the percentages of coarse and fine aggregate mix proportions of materials, water content and temperature.The cement reacts with the water and other ingredients to form hard rock like material. Concrete generally required vibration to reach every part of the corners of shuttering to avoid leakages and honey combs etc.Most concretes used are Portland cement concrete, when aggregate is mixed together with dry Portland cement and water, the mixture forms fluid slurry that is easily poured and molded into shape.

Fig1.1: laying of concrete

1.2Types of concrete

[1] High strength concrete
[2] Stamped concrete
[3] High performance concrete
[4] Self consolidating concrete
[5] Vacuum concrete
[6] Pervious concrete
[7] Cellular concrete
[8] Light weight concrete
[9] Polymer concrete

1.2cement

Cement is produced by dry and wet processes; the strength of the cement and properties mainly depends on the compounds Tricalcium silicate (C_3S), Dicalcium silicate(C_2S), Tricalcium aluminate(C_3A), Tetracalcium alumino ferrite (C_4AF) called as bogue compounds

Table 1.1 : bogues compoundsTable 1.2: bogues compounds

Name of compound	Formula	Abbreviation
Tricalcium Silicate	3 CaO.SiO2	C3S
Dicalcium Silicate	2 CaO.Sio2	C2S
Tricalcium aluminate	3 Cao.Al2O3	C3A
Tetracalcium aluminoferrite	4 CaO.Al2O3.Fe2O3	C4AF

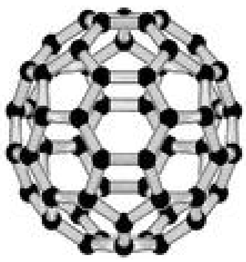
Type of oxide	%
CaO	60-67
SiO2	17-25
Al2O3	3.0-8.0
Fe2O3	0.5-6.0
MgO	0.1-4.0
Alkalies (K2O, Na2O)	0.4-1.3
SO3	1.3-3.0

1.3 Nanomaterials

Nanomaterials are materials of which a single unit is sized (in at least one dimension) between 1 to 1000 nanometres (10^{-9} meter) but usually is 1 to 100 nm. Nanotechnologies involve designing and producing objects or structures at a very small scale, on the level of 100 nanometres (100 millionth of a millimetre) or less. As nanotechnology develops, nanomaterials are finding uses in healthcare, electronics, cosmetics, textiles, information technology and environmental protection.

1.5 structures of Nanomaterials

- carbon nanotubes
- Graphene
- cone sheet
- Fullerene
- Nano Cone



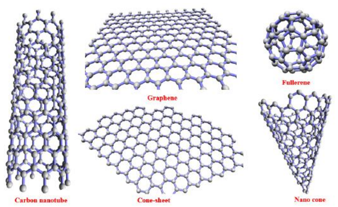


Fig 1.2: typical structure of nanomaterial's

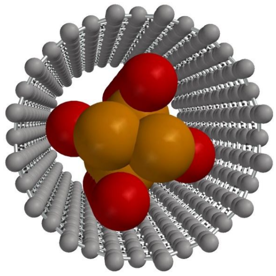
Fig 1.3: types of nanomaterial's

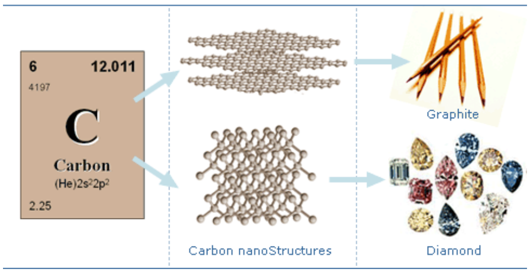
1.5 physical properties of nanomaterials

1. size and shape
2. size distribution
3. surface morphology
4. structure
5. solubility

1.6chemical properties of nanomaterials

1. molecular structure
2. composition of nano materials
3. phase identity
4. zeta potential
5. physical structure
6. reactive sites
7. hydrophilicity





structure of nano materials

1.7 Objective of the Study

The main objectives of the present study are as mentioned below:

- To study the effect of nano-silica on the compressive strength of concrete.
- variation in strength with age of concrete
- To study the microstructure of the hardened cement concrete.
- To explain the change in properties of concrete, if any, by explaining the microstructure.

II. LITERATURE SURVEY

OM. Suganya, S.K. Sekar made astudy on the effect of nano silica onmechanical properties of concreteIncreasing the usage of fly ash in concrete helps in: i) Improving thestrength of concrete with colloidal Nano silica in concrete. Modulus of elasticity of concrete is almost equalin both the cases: (i) 2% of Nano silica in concrete, (ii) 2% of Nano silica with 30% of fly and the results obtained are M30 grade of concrete with Nano silica increases the compressive strength by 44%, 54%, by means of reducing the cost of cement by using fly ash.Split tensile strength of concrete achieved 46% more than conventional concrete by theaddition of 1% Nano silica. Similarly 1% of Nano silica with cement replacement by 30% flyash increases 30% more strength than conventional concrete. Increasing the % of fly ash inconcrete reduces the split tensile strength of concrete.Modulus of elasticity of M30 grade of Nano concrete is 2.88 times more than conventionalconcrete. The strength properties of Nano concrete increases with age such as 56 and 90 dayswhen fly ash is used for cement replacement.

R. Sakthivel, Dr. N. Balasundaram done Experimental investigation on behaviour of nano concrete, Nano-Silica is used as a partial replacement for cement in the range of 2.5%, 3%, and 3.5% for M25 mix. Specimens are casted using Nano-Silica concrete. Laboratory tests were conducted to determine the compressive strength, split tensile and flexural strength of Nano-Silica concrete at the age of 7 and 28 days. Results indicate that the concrete, by using Nano-Silica powder, was able to increase its compressive strength. However, the density is reduced compared to standard mix of concrete. The replacement of cement with 3% Nano-Silica results in higher strength and reduction in the permeability than the controlled concrete. The replacement of cement with Nano-Silica more than 3% results in the reduction of various properties of Nano-Silica concrete. That the compressive strength of concrete initially increased up to 3% of Nano-Silica and with further increase in the Nano-Silica content the compressive strength ofconcrete decreases. Concrete containing lower percentages (3%) of Nano-Silica possess higher values of compressive strength than that of controlled concrete.A considerable increase in flexural strength and split tensile strength of Nano-Silica concrete was observed compared to controlled concrete. Based on the experimental results, use of Nano-Silica as partial replacement of cement in small quantities is advantageous on the performance of concrete. Nano-Silica added in small quantities can improve the strength and permeability resistance. It can also be concluded that the permeability of concrete decreases with the increase in the percentage of Nano-Silica up to 3% due to the effect of Nano-Silica filling the voids in concrete.

III. METHODOLOGY

1. Mix Design of nano silica concrete of M25 and M30 grade.
2. Mixing of concrete and determination of its fresh properties in terms of flowability, passing ability and segregation resistance by using Slump flow, V-funnel and L-box apparatus.
3. Casting of standard specimens to determine compressive, tensile, flexural strengths and fracture energy.
4. Casting of standard specimen to determine compressive, tensile, flexural strengths and fracture energy incorporatingreplacing the cement with nano silica of 0.15%, 0.3%, 0.45%, 0.6%, 0.75% and 1% for grade of M25 and M30
5. Testing of standard specimens for strength determination after 7days, 14 days and 28 days.

Table 3.1: proportion of M25 concrete mixes

Grade	Description	Designation	Silica content (%)
M25	Plain concrete	PC25	0.0%
M25	0.15% nano silica concrete	P25-0.15	0.15%
M25	0.30% nano silica concrete	P25-0.30	0.30%
M25	0.45% nano silica concrete	P25-0.45	0.45%
M25	0.60% nano silica concrete	P25-0.60	0.60%
M25	0.75% nano silica concrete	P25-0.75	0.75%
M25	1% nano silica concrete	P25-1	1%

Table 3.2: proportion of M30 concrete

Grade	Description	Designation	Silica content (%)
M30	Plain concrete	PC30	0.0%
M30	0.15% nano silica concrete	P30-0.15	0.15%
M30	0.30% nano silica concrete	P30-0.30	0.30%
M30	0.45% nano silica concrete	P30-0.45	0.45%
M30	0.60% nano silica concrete	P30-0.60	0.60%
M30	0.75% nano silica concrete	P30-0.75	0.75%
M30	1% nano silica concrete	P30-1	1%

IV. RESULTS AND DISCUSSION

The following mixes were prepared to find the properties of nano silica concrete with and without silica. M25, M30 mix's are used and the proportions of results are shown in terms of graphs and tables.

Table 5.2: proportion of M30 concrete mixes

Grade	Description	Designation	Silica content (%)
M25	Plain concrete	PC25	0.0%
M25	0.15% nano silica concrete	P25-0.15	0.15%
M25	0.30% nano silica concrete	P25-0.30	0.30%
M25	0.45% nano silica concrete	P25-0.45	0.45%
M25	0.60% nano silica concrete	P25-0.60	0.60%
M25	0.75% nano silica concrete	P25-0.75	0.75%
M25	1% nano silica concrete	P25-1	1%

Table 5.3 : compressive strengths of M25 grade concrete

Type of mix	7days strength(MPa)	14days strength(MPa)	28days strength(MPa)
PC25	21.30	25.72	32.72
P25-0.15	22.10	27.10	33.10
P25-0.30	24.70	30.44	34.56
P25-0.45	26.10	32.10	36.10
P25-0.60	28.77	33.64	37.72
P25-0.75	29.98	34.10	39.13
P25-1	33.57	35.89	40.12

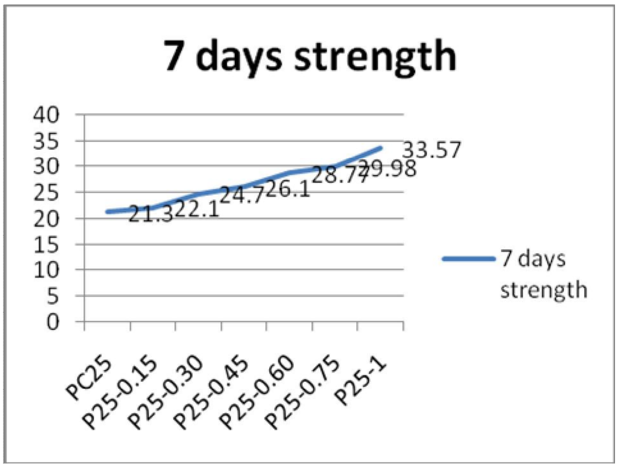


Chart 5.1: compressive strength of M25 grade with different % of nano silica for 7days

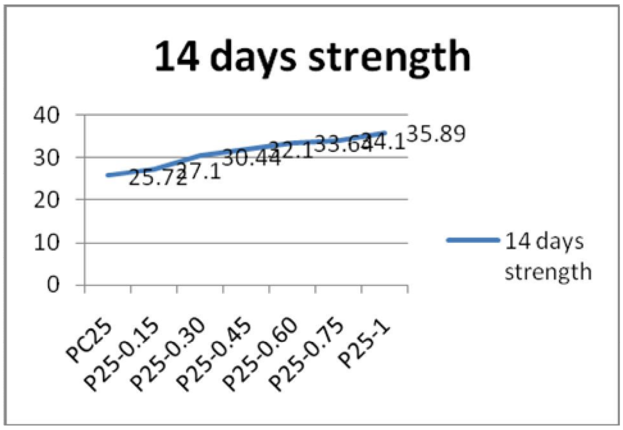


Chart 5.2: compressive strength of M25 grade

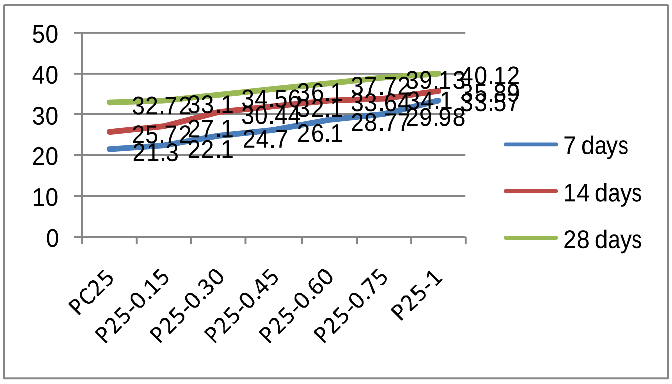


Chart 5.4: compressive strength of M25 grade with different % of nano silica

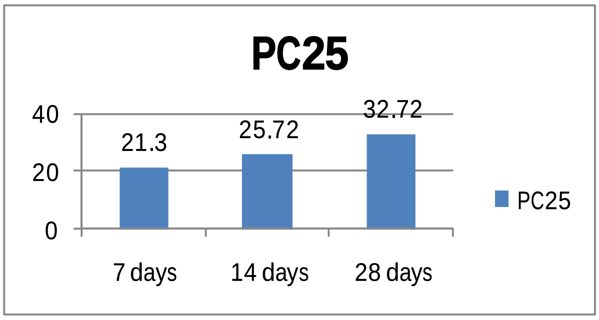


Chart 5.5: compressive strength of M25 grade

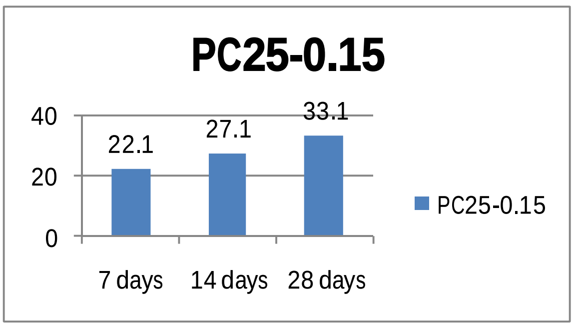


Chart 5.6: compressive strength of M25 grade for silica 0.15%

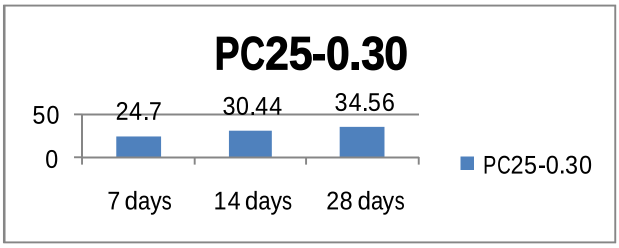


Chart 5.7: compressive strength of M25 grade for silica 0.30%

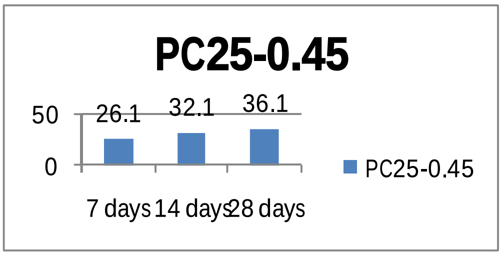


Chart 5.8: compressive strength of M25 grade for silica 0.45%

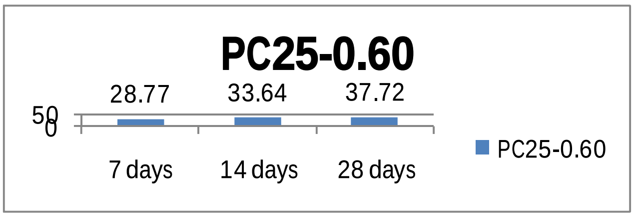


Chart 5.9: compressive strength of M25 grade for silica 0.60%

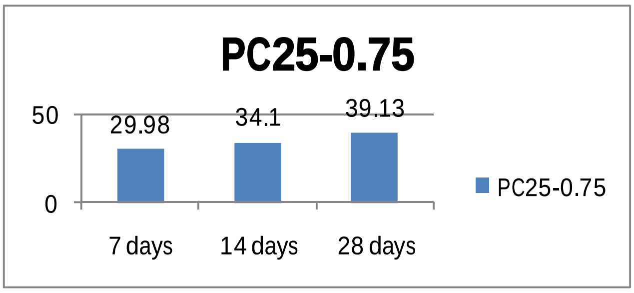


Chart 5.10: compressive strength of M25 grade for silica 0.75%

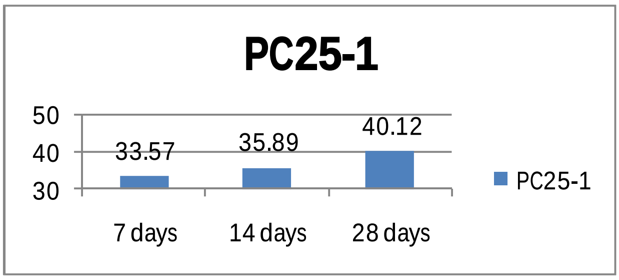


Chart 5.11: compressive strength of M25 grade for silica 0.75%

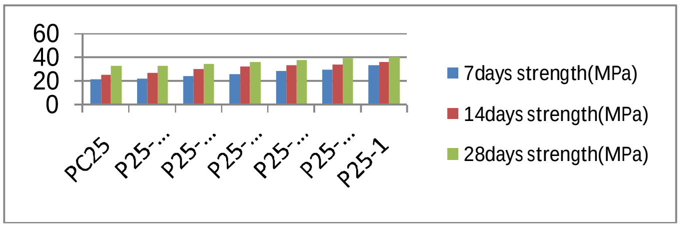


Chart 5.12: compressive strength of M25 grade for different silica%

Table 5.4: proportion of M30 concrete mixes

Type of mix	7days strength(MPa)	14days strength(MPa)	28days strength(MPa)
PC30	24.60	28.10	35.67
P30-0.15	27.10	29.97	38.87
P30-0.30	28.90	33.12	42.14
P30-0.45	29.10	35.67	44.56
P30-0.60	32.66	38.12	47.10
P30-0.75	37.10	40.23	50.21
P30-1	41.67	43.44	53.16

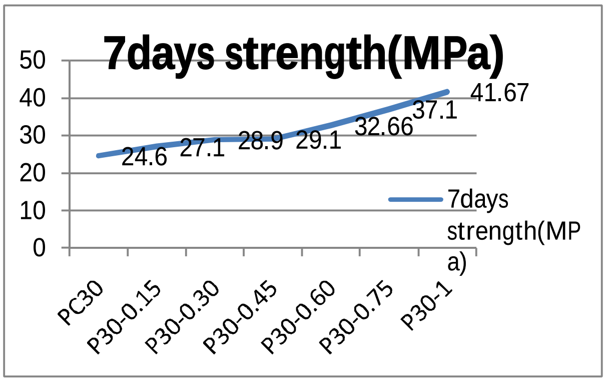


Chart 5.13: compressive strength of M30 grade for 7days

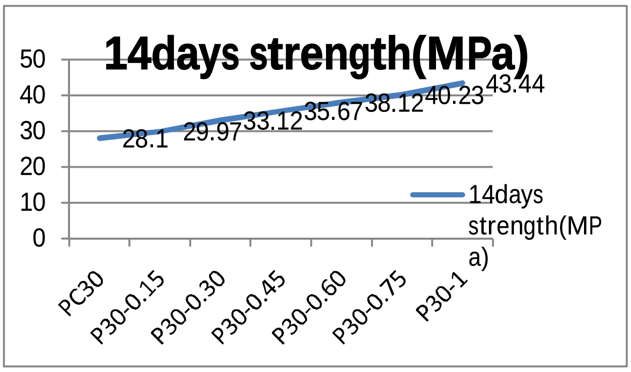


Chart 5.14: compressive strength of M30 grade for 14days

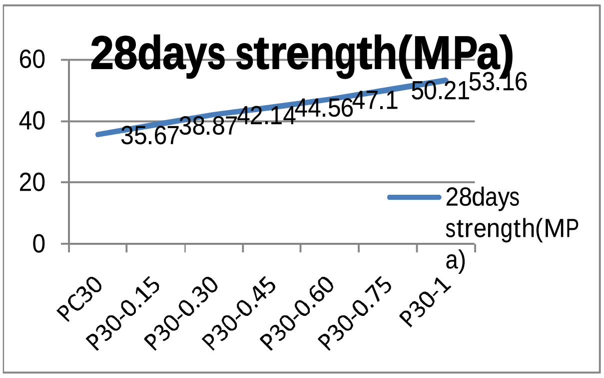


Chart 5.15: compressive strength of M30 grade for 28days

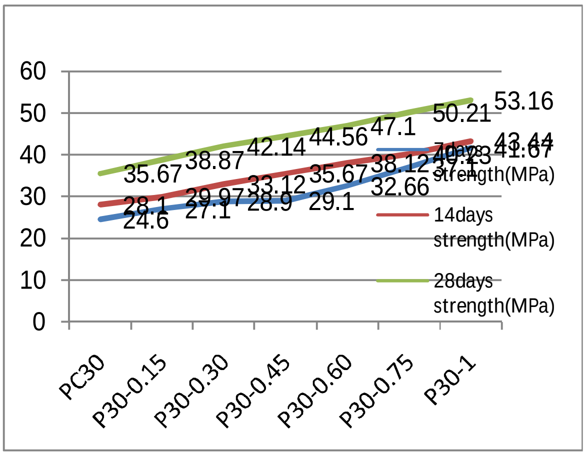


Chart 5.16: compressive strength of M30 grade for different silica %

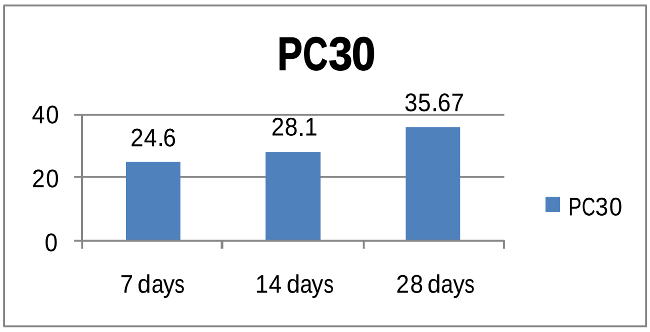


Chart 5.17: compressive strength of M30 grade for different days

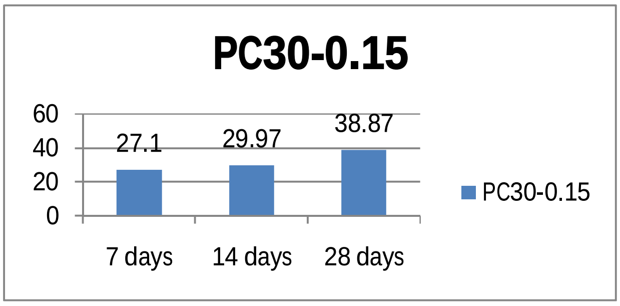


Chart 5.18: compressive strength of M30 grade for different days for silica content-0.15%

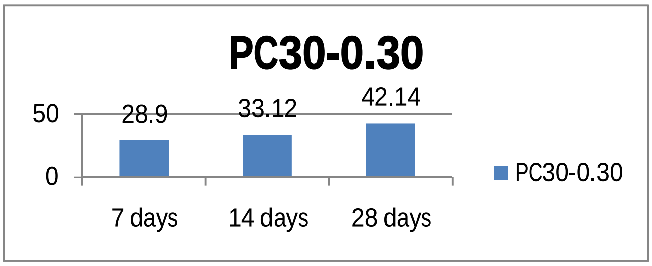


Chart 5.19: compressive strength of M30 grade for different days for silica content-0.30%

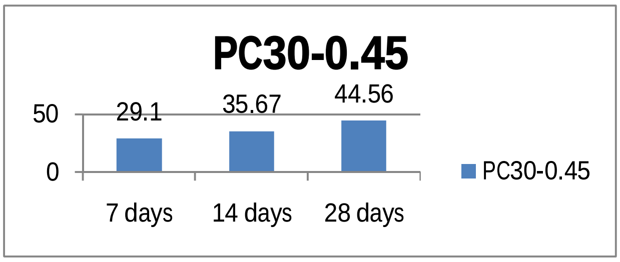


Chart 5.20: compressive strength of M30 grade for different days for silica content-0.45%

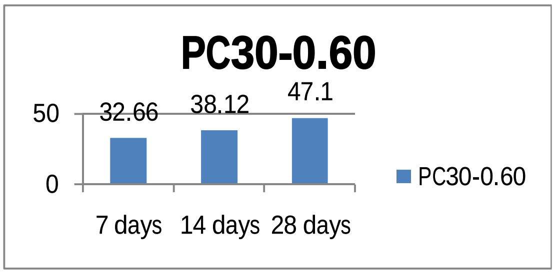


Chart 5.21: compressive strength of M30 grade for different days for silica content-0.60%

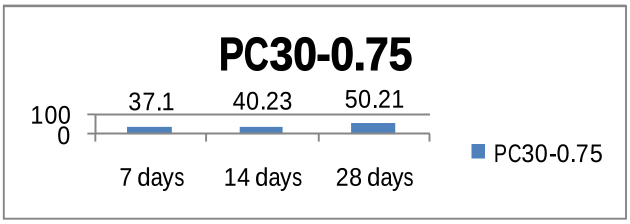


Chart 5.22: compressive strength of M30 grade for different days for silica content-0.75%

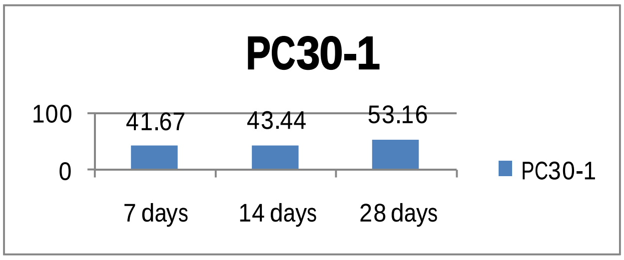


Chart 5.23: compressive strength of M30 grade for different days for silica content-1%

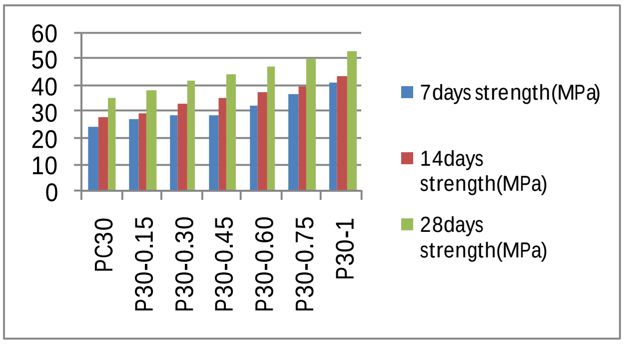


Chart 5.24: compressive strength of M30 grade for different days for different silica content

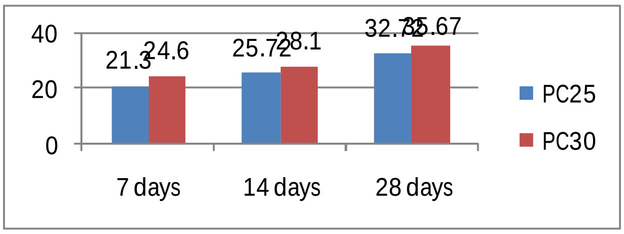


Chart 5.25: compressive strength of M25, M30 grade for different days

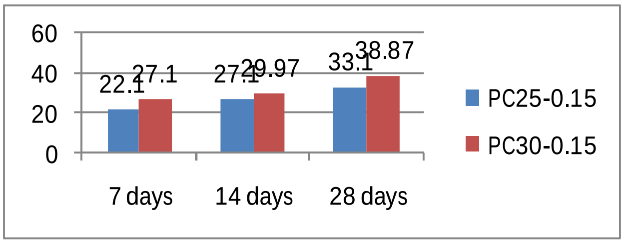


Chart 5.26: compressive strength of M25, M30 grade for different days silica 0.15%

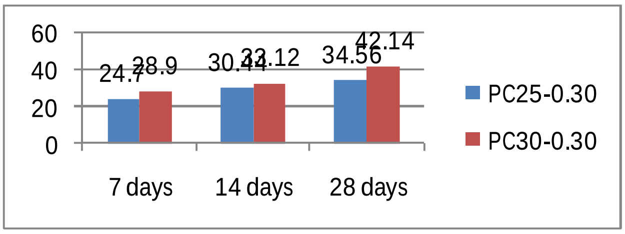


Chart 5.27: compressive strength of M25, M30 grade for different days silica 0.30%

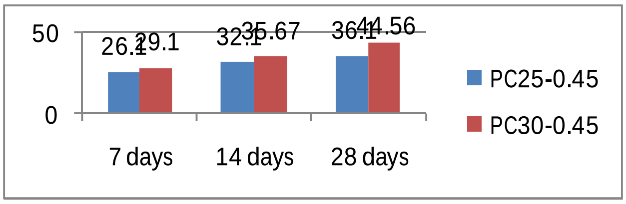


Chart 5.28: compressive strength of M25, M30 grade for different days silica 0.45%

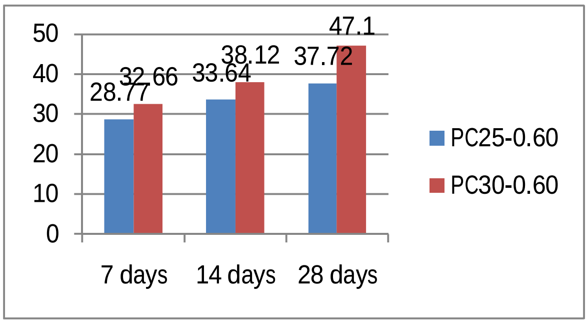


Chart 5.29: compressive strength of M25, M30 grade for different day's silica 0.60%

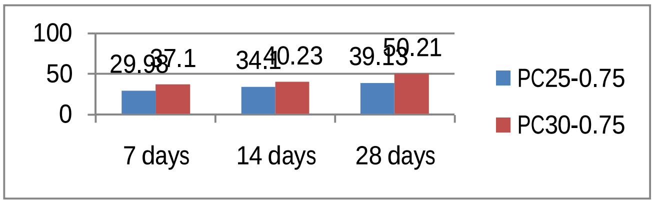


Chart 5.30: compressive strength of M25, M30 grade for different day's silica 0.75%

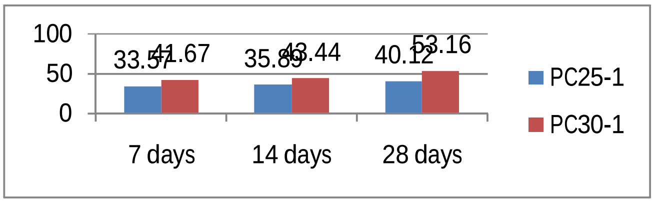


Chart 5.31: compressive strength of M25, M30 grade for different day's silica 1%

V. CONCLUSIONS

From the present study the following conclusions were drawn the silica used in this study are 200 mm long and replacing the cement with nano silica of 0.15%, 0.3%, 0.45%, 0.6%, 0.75% and 1% for grade of M25 and M30.

1. It is observed that the compressive strength is been increased with the increase in the silica content in different grades.
2. 7 days, 14 days and 28 days are increased with the increase in the silica content from 0.15% to 1%.
3. the compressive strengths are found to be increased with the age for 14 days and 28 days by 20.75% and 53.17% for PC25
4. the compressive strengths are found to be increased with the age for 14 days and 28 days by 14.22% and 45% for PC30
5. the compressive strengths are found to be increased with the age for 14 days and 28 days by 22.57% and 53.12% for PC30-0.45
6. the compressive strengths are found to be increased with the age for 14 days and 28 days by 14.22% and 38.32% for PC25-0.45
7. the compressive strengths are found to be increased with the age for 14 days and 28 days by 16.92% and 31.10% for PC25-0.6
8. The compressive strengths are found to be increased with the age for 14 days and 28 days by 16.71% and 44.21% for PC30-0.6.
9. The partial replacement of the cement by nano silica and nano particles is found to be effective in increasing the concrete strength.

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