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Assessment of Influence on Mechanical Properties of M_{40} Grade of Concrete by using Polypropylene Fiber and Nano-Silica Liquid

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Abstract- **This is the aeon of reformation and it can be more reform by using eco-friendly construction material i.e. Nano-silica liquid (in order to intensify the compressive strength of concrete as well as concurrently devaluate in the creep and shrinkage of concrete) and Polypropylene fiber in it (to elevate the flexural strength of concrete). In this study the strength parameters of concrete of M-40 grade can be analyzed by replacing cement by affix dissimilar percentages of Nano-Silica Liquid , 0%, 5% and 10% of by weight of cement and Polypropylene fiber with 0%, 0.50% and 1% by volume of cement in concrete. Strength Properties studies involve compressive strength, flexural strength. All the mixes were cured and tested with the compressive strength test as well as flexural strength test for 7 days, 14 days and 28days. The results acquired from tests is to be compared with the traditional concrete mix. The study shows that the use of waste material like Nano-silica liquid in concrete is feasible.**

Keywords: Nano-Silica Liquid (NS),Polypropylene Fiber(PPF,) Compressive strength (CS), Flexural strength (FS).

1. INTRODUCTION

Now a days, infrastructure projects are increased at a very swift rate. Which leads to the production of cement at incredible rate. A huge amount of energy is consumes in the production of cement, that releases the magnanimous amount of CO_2 as a chief sources of air pollution. For the production of ordinary Portland cement it consumes natural resources like limestone, as well as Argillaceous product and there is a instant need to economize the use of cement. Large amount of solid waste is produced in forms of silica fume and recron fiber. Polypropylene fibers compose through the fibrillation of polypropylene in order to control the plastic shrinkage of concrete polypropylene fiber added to concrete as an secondary reinforcement. Some test program has been conduct which shows increased in compressive strength of concrete by adding Nano-silica liquid in it The addition of Nano-silica Liquid in concrete is efficient for improving its compressive strength simultaneously Polypropylene Fiber able to enhance its Flexural Strength as well as helps in reducing the drying shrinkage in concrete and improving the abrasion resistance. Nano-Concrete also improve the bond strength with the reinforcing steel, and reducing the permeability in concrete. For workability and flexural strength of fiber reinforced Nano-silica concrete, nano-silica content used were 0%, 5% and 10% by replacement of weight of cement and polypropylene fiber used 0% ,0.5% and 1% by volume of cement. The aim of this study is to evaluate the feasibility of using waste material like Nano-silica and polypropylene fiber. In this Research work, a suitable mix proportion with polypropylene fibers and Nano-silica in concrete that elevates the strength. Nano-silica liquid and Polypropylene Fiber are one of the materials that are considered as a waste material which could have a promising future in construction industry. Pietro Di Maida (2017**)** Nanosilica-based treatment by means of the sol-gel process was successfully conducted on macro-synthetic PP fibres in order to improve the interaction area at the interface between the synthetic fibres and the concrete matrix. Rahul Dogra and Ankit (2016) his study result shows that the partial replacement of 10% silica flume with cement can giving most extreme conceivable compressive strength with polypropylene fiber. R. Karthi & Dr. P. Chandrasekaran (2014) Concluded that the Compressive strength of the silica fume concrete with polypropylene fibers has increased by 10.63%, then Conventional concrete**.**

2. RESEARCH METHODOLOGY

In the present research work cement has been partially replaced by Nano-Silica Liquid and Polypropylene Fiber in M40 Grade of concrete. The replacement levels are 0%, 5% and 10% by weight of cement. The properties investigated are workability, compressive strength, flexural strength. The specimens of standard cubes (150mm×150×mm×150mm), and standard beams (150mm×150mm×700mm) were cast from different mixes having different replacements levels of PPF and NS. The specimens were cured in water for required time.

3.MATERIAL & THEIR PROPERTIES

3.1 CEMENT

An OPC 43 grade Ultra Tech Cement was used in this study. The physical properties were found using respective IS codes. The properties are given in table below:-

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Table1: - Properties of Cement

Property of cement	Results
Normal Consistency	32 (%)
Initial Setting Time	50
Final Setting Time	250
Specific gravity	3.11

3.2 *Fine Aggregate*:-
The sand used in this research work acquired from natural river passing through 4.75mm I.S. Sieve The properties of sand obtained using respective codes are given in table below. shown in Table-2

Table: 2-Properties of Sand

Property of Sand	Results
Fineness Modulus	3.2
Zone	II
Water Absorption	1.2(%)
Specific Gravity	2.67

3.3 Coarse Aggregate:-
In this research work locally available crushed aggregate of sizes 20mm and 10mm were used. The aggregates were tested and following results were obtained:- shown in Table 3

Table: 3-Properties of Coarse aggregate

Property of Aggregate	Results
Specific Gravity	2.72
Water Absorption	0.5%
Bulk Density	1585
Fineness Modulus	2.55

3.4 Nano-Silica Liquid-
Nano-SiO_2 has been found to improve concrete workability and strength, to increase resistance to water penetration, and to help control the leaching of calcium, which is closely associated with various types of concrete degradation. Nano-SiO_2 was found to be more efficient in enhancing strength than silica fume. The raw material of polypropylene is derived from monomeric C_3H_6 which is purely hydrocarbon.

Table: 4- Properties of Nano-Silica Liquid

S. No.	Specification	Values
1-	Specific Gravity	2.20
2-	Bulk Density	40
3-	Moisture (%)	<1.5
4-	Loss on ignition	<1.5
5-	Surface Area(m^2/g)	200
7-	P^H value	3.8 – 4.3

3.5 Polypropylene Fiber-
Polypropylene Fiber is 100% synthetic fiber.It is formed by 85% of polypropylene It is a bi-product of petroleum. Polypropylene fibers use in this research of 12 mm long and 18 micrometer in diameter size and Specific gravity is 0.91.

Table:5- Properties of Polypropylene Fiber

S. No.	Specification	Values
1-	Tenacity(gm/den)	3.5 to 5.5
2-	Bulk Density(g/cc)	0.91
3-	Melting Point(^{0}C)	170
4-	Moisture regain(%)	0%
5-	Elongation at break(%)	10 - 45
6-	Softening Point(^{0}C)	140
7-	Thermal Conductivity	6.0

3.6 Water-
Potable water available from natural sources free from deleterious materials was used for mixing as well as for curing of all the mixes tried in this investigation.

4. MIX DESIGN

The mix design was done using IS: 10262-2009 and IS: 456--2000.

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The calculated proportion for 1m3 is given below:-

Table-6 Mix Proportion for M 40 Concrete

Mixes	Raw Materials (kg/m³)					
	W/C Ratio	Cement	Sand	Aggregate	Nano-Silica Liquid(%)	Polypropylene Fiber(%)
M_1	0.42	463.5	530.27	1153.13	0	0
M_2	0.42	440.3	530.27	1153.13	5	0.5
M_3	0.42	417.15	530.27	1153.13	10	1

5. RESULTS

5.1 Workability-

The slump test were conducted as per IS: 1199-1959 to determine the workability of fresh concrete mix having different percentage of Polypropylene Fiber 0%, 0.5% 1% by volume of cement and Nano-Silica Liquid as 0%, 5%, 10% by weight of cement. During the whole research work the water to cement ratio was kept 0.42. From the research, it was concluded that adding Nano-Silica Liquid and Polypropyener Fiber in .he whole research work the water to cement ratio was kept 0.42. From the research, it was concluded that adding Nano-Silica Liquid and Polypropyener Fiber in concrete increases the workability in concrete mix

5.2 Compressive Strength-

63 cube specimen of concrete were prepared incoperated with 0%, 5%, 10%, of Nano-Silica Liquid and 0%, 0.5%, 1% of Polypropylene Fiber of size 150x150x150 mm, cured and tested for 7, 14 and 28 days as per IS: 516-1959. The testing results were obtained are shown in Table 7 and graphical represented shown in Figure 1. From the above test results, it can be concluded that th. highest compressive strength was achieved by replacement 10% of Cement with 10% of Nano-Silica Liquid and 1% of Polypropylene Fiber in it and it is found out about 49.53 N/mm^2 compared with 44.59N/mm^2 for the control mix after 28 days of curing. This case study clearly shows that Compressive strength of the Nano-concrete with polypropylene fibers were increased by 11.6%.

Table -7 Compressive Strength Test

Mix	PPF (%)	NS (%)	W/C Ratio	Compressive Strength(N/mm^2)		
				7 Days	14 Days	28 Days
1	0	0	0.42	31.67	35.78	44.59
2	0.50	5	0.42	32.94	37.22	46.12
3	1.0	10	0.42	33.67	38.01	49.53

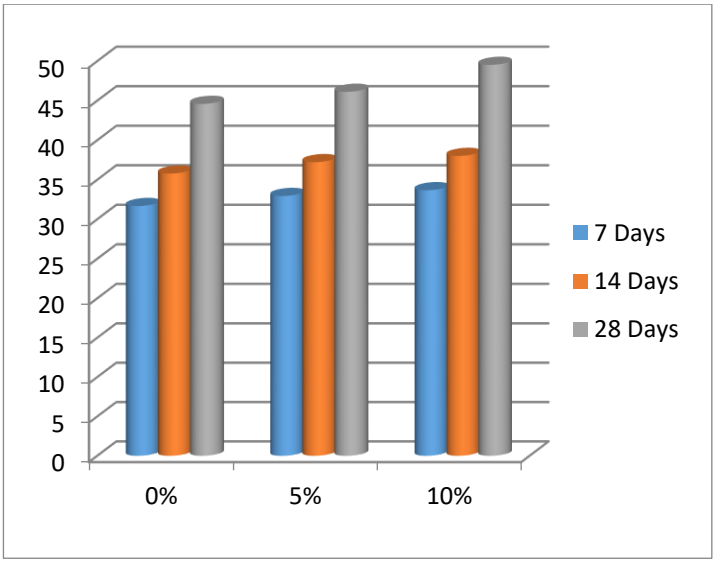

Fig 1. Compressive Strength Test

5.3 Flexural Strength:-

Standard beam of size 15cm x 15cm x 70cm were casted, cured, tested under one point loading to study the flexural strength of concrete is carried out as per 516:1959. Cubes were prepared, cured and tested for 7, 14 and 28 days.

After curing the test results were obtained are shown in Table 8 and graphical represented shown in Figure 2. From the above test results, it can be concluded that the flexural strength of concrete with 10% replacement of cement with Nano-Silica Liquid and Polypropylene Fiber elevates the strength of concrete mix. Highest compressive strength was achieved by replacement 10% of Cement by 10% of Nano-Silica Liquid and 1% of Polypropylene Fiber in it and it is found that strength about 5.8 N/mm^2 as compared to 4.96 N/mm^2 for the control mix after 28 days of curing. This case study clearly shows that Flexural strength of the Nano-concrete with polypropylene fibers were increased by 16.4%.

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Table-8 Flexural Strength Of Concrete

Mix	PPF (%)	NS (%)	W/C Ratio	Flexural Strength(N/mm^2)		
				7 Days	14 Days	28 Days
1	0	0	0.42	3.92	4.26	4.96
2	0.50	5	0.42	4.75	5.12	5.58
3	1.0	10	0.42	4.89	5.2	5.8

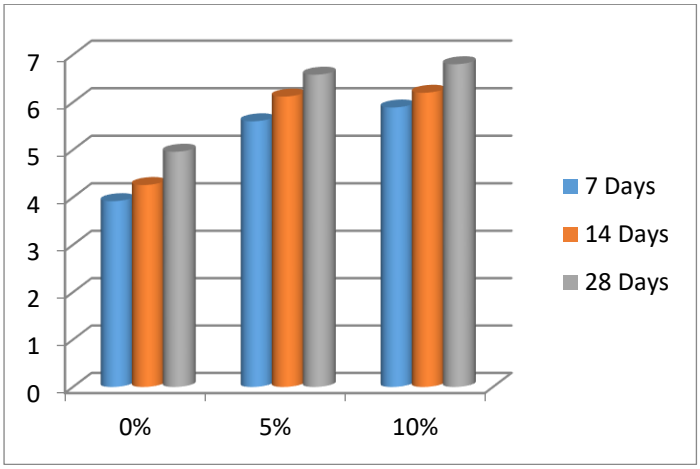

Fig 2- Flexural Strength Test

6. CONCLUSION

- This case study clearly shows that Compressive strength of the Nano-concrete incoperated with polypropylene fibers were increased by 11.6% and the flexural strength also increased by 16.4% as compared to Conventional Concrete.
- Maximum Substitution of Polypropylene Fiber is 1% and Nano-Silica Liquid is 10% in order to Maximise the strength.
- The deflection limit of concrete can be elevate by addition of polypropylene fibers (PPF) and also enhance the material ductility.
- Addition of polypropylene fiber improves the tension stiffening effect and also elevate the bond stress in concrete.
- Flow characteristics are reduce by adding of polypropylene fibers in concrete mix and it also diminishes segregation and bleeding in the concrete blends.
- At 28 days the compressive strength of concrete increases. The strength decreases when we add beyond 10% of Nano-Silica Liquid

7. FUTURE WORK

From the experimental study it is clear indicated that using Nano-silica liquid and Polypropylene Fiber in concrete elevates the strength parameters. Following parameters will be study in future work-

- ✓ Study should be done in proportion zone i.e how much cement can be replaced by adding Nano-Silica Liquid and Polypropylene.
- ✓ More efforts can be done on analysing the flexural behaviour of Nano-Concrete.
- ✓ Trial of concrete mix should be done with Copper Slag.
- ✓ More efforts can be done on analysing the flexural behaviour of Nano-Concrete.
- ✓ Trial of concrete mix should be done with seawater.
- ✓ Better admixture should be searched in order to enhance the strength.

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