IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Vol. 08, Issue 4 (April. 2018), ||VI|| PP 67-73

Effect of Silica Fumes and Polypropylenefibres on Strength Of Concrete

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ABSTRACT: Concrete Is The Main Component Of Today's Constructions. Typically Concrete Consists Of Mixture Of Cement, Sand And Coarse Aggregate. Manufacturing Of Cement Creates Pollution Which Possess Threat To Living Beings. Hence Need For Safer Cement Alternative Materials Is Increasing. Silica Fume Is One Such Alternative Material Obtained As A By-Product In Ferrosilicon Alloy And Silicon Production That Predominantly Contains Silica. Hence In The Present Study An Attempt Is Made In Replacing Cement With Silica In Different Proportions In Concrete To Obtain An Optimum Percentage Of Silica Fumes For Effective Use In Concrete.Also Polypropylenefibres Are Used As Secondary Reinforcement In The Concrete Under Study. The Study Showed That Use Of 5% Silica Fumes In Combination With 0.2% Polypropylenefibres In Concreteresulted In 17% Increase Ofcompressive Strength In Comparison To Conventional Concrete.

KEYWORDS: Silica Fumes, Polypropylenefibres, Concrete.

Date of Submission: 23-03-2018 Date of acceptance: 07-04-2018

I. INTRODUCTION

Developing Countries Like India Involve Construction Of Huge Infrastructure That Require Good Quality Concrete. This Huge Infrastructure Requires Concrete In Huge Quantities That In Turn Involves In Production Of Tons Of Cement. Production Of Cement Results In Pollution Caused Due To Emission Of Co_2. It Is Reported That About 7% Of Worldwide Emissions Of Co_2 Is From Cement Industry [1,2]. This Poses A Serious Threat To Environment. Also The Need For High Strength Sustainable Concrete Has Increased For Construction Of High Rise Buildings And High Speed Transportation Systems.This Led To Search For Alternative Materials. Various Researchers Had Tried Using Industrial, Agricultural And Aqua-Agricultural Wastesas Supplements To Cement In Concrete [3].

Use Of Fly Ash As A Supplement To Cement Resulted In A Good Quality And Durable Concrete [3, 4]. Researchers Had Reported That Use Of 10-15 % Rice Husk Ash In Self Compacting Concrete Had Resulted In Increase In Strength, Workability And Self-Compactibility Of Concrete [5]. Partial Replacement Of Cement With Waste Glass Powder Showed An Improvement In Strength Of Concrete [6]. Ceramic Waste Powder Also Showed An Increase In Strength And Durability Aspects Of Concrete Upon Replacing Cement [7].

Silica Fume Is One Of Industrial By-Productwhich Is Obtained From Ferrosilicon Alloy And Silicon Production. It Predominantly Consists Of Silica, Which Is The Key Ingredient In Concrete That Is Responsible For Its Strength. Hence In The Present Study An Attempt Is Made In Replacing Cement In Concrete With Silica In Different Proportions. Polypropylene Fibres Are Used As Secondary Reinforcement In Concrete Under Study. The Present Study Highlights The Increase In Strength Of Concrete With Replacement Of Cement With Silica And Addition Of Polypropylene Fibres.

Materials Used In The Study

Ordinary Portland Cement Available In The Local Market Is Used In The Investigation. The Properties Of Cement Are Determines As Per The Tests Specified In Is: 12269- 1987 And The Results Are Presented In Table 1.

Locally Available River Sand Is Used As Fine Aggregate In The Present Investigation. The Sand Is Free From Clay, Silt And Organic Impurities. The Fine Aggregate Used Confirms To The Standard Specifications As Per Is: 2386-1963. The Properties Of Fine Aggregate Are Presented In Table 2.
Machine Crushed Angular Granite Metal Of 20mm Nominal Size From The Local Source Is Used As Coarse Aggregate. The Coarse Aggregate Is Tested To Determine Its Physical Properties And The Test Results Are Presented In Table 3.

Table 1. Properties Of Cement

Property	**Value**
Normal Consistency	33%
Setting Times a. Initial(Minutes) b. Final(Minutes)	 50 180
Specific Gravity	3.15
Soundness (Le-Chatlier Test) (Mm)	1.30
Compressive Strength Of Cement (28days) (Mpa)	53
Specific Surface Area (M^2/Kg)	320

Table 2:Properties Of Fine Aggregate

Property	**Value**
Specific Gravity	2.67
Bulk Density (Kg/M^3) a. Loose State b. Dense State	 1600 1750
Fineness Modulus	2.674
Zone	Ii

Table 3. Properties Of Coarse Aggregate

Property	**Value**
Bulk Density(Kg/M^3)	1400 (Loose State) 1574 (Dry Rodded)
Specific Gravity(G)	2.704
Fineness Modulus	7.55

Micro Silica Or Silica Fume Is The Most Commonly Used Mineral Admixture In High Strength Concrete. Silica Fume Consists Primarily Of Amorphous (Non-Crystalline) Silicon Dioxide (Sio_2). The Individual Particles Are Extremely Small, Approximately 1/100th The Size Of An Average Cement Particle. Because Of Its Fineness In Fine Particle Sizes, Large Surface Area, And The High Silicon Dioxide (Sio_2) Content, Silica Fume Is A Very Reactive When Used In Concrete.The Chemical Composition And Physical Nature Of Silica Fumes Are Shown In Table 4.

Table 4.Properties Of Silica Fumes

Property	**Value**
A. Physical Property	
Specific Surface Area	15000 To 30000 Kg/M^2
Physical State	Micronized Powder
Odor	Odorless
Appearance	White Color Powder
Color	White
Pack Density	0.76 Gm/Cc
P^h Of 5% Solution	6.90
Specific Gravity	2.63
Moisture	0.058%
Oil Absorption	55 Ml / 100 Gm
Specific Surface Area	15000 To 20000kg/M^2

B. Chemical Properties	
Silica (SiO_2)	99.886%
Alumina (Al_2O_3)	0.043%
Ferric Oxide (Fe_2O_3)	0.040%
Titanium Oxide (TiO_2)	0.001%
Calcium Oxide (Cao)	0.001%
Magnesium Oxide (Mgo)	0.000%
Pottasium Oxide (K_2O)	0.001%
Sodium Oxide (Na_2O)	0.003%
Loss On Ignition	0.015%

Recron-3s Is A Discrete, Discontinuous Short Fibre Made Up Of Polypropylene, That Can Be Used In Concrete To Control And Arrest Cracks. It Arrests Shrinkage Cracks In Concrete And Increases Resistance To Water Penetration, Abrasion And Impact. It Makes Concrete Homogenous And Also Improves The Compressive Strength, Ductility And Flexural Strength Together Proving The Ability To Absorb More Energy. Use Of Uniformly Dispersed Polypropylenefibres Reduces Segregation And Bleeding And Also Results In A More Homogeneous Mix Of Concrete. Recron3s Is Meant For Secondary Reinforcement Only.

II. PREPARATION OF SPECIMENS

Conventional Concrete

Mixing

Mixing Of Ingredients Is Done In Pan Mixer. The Cementitious Materials Are Thoroughly Blended And Then The Aggregate Is Added And Followed By Gradual Addition Of Water And Mixing. Polypropylenefibresand Sp430 Are Also Added Carefully. Polypropylenefibres Are Mixed In Varying Proportions Of 0.1 %, 0.2 %. Wet Mixing Is Done Until A Mixture Of Uniform Color And Consistency Is Achieved Which Is Then Ready For Casting.

Casting And Curing

The Iron Moulds Are Cleaned And Mineral Oil Is Applied On All The Sides Of The Mould. The Moulds Are Placed On A Level Platform. The Well Mixed Concrete Is Filled Into The Moulds By Vibration With Needle Vibrator. The Samples Are Left For 24 Hours For Initial Setting And Then Are Removed From Moulds And Then Placed In Curing Tank For 7 Days And 28 Days.

Modified Concrete

In Modified Concrete, Cement Is Replaced By Silica Fumes Added In Varying Proportions Of 5%, 10%, 15% And 20%. Also Polypropylenefibres Are Added In Varying Proportions Of 0.1% And 0.2% Along With Sp430 Admixture To The Above Mixture. The Process Of Mixing, Casting And Curing Are Done In Similar Fashion To That Of Conventional Concrete.

Testing Of Specimens

The Specimens Obtained After Curing For 7 Days And 28 Days Are Then Tested For Flexural Strength, Compressive Strength And Split Tensile Strength According To The Procedure Given By Is: 516-1959. The Results Of Compressive Strength, Split Tensile Strength And Flexural Strength Tests Performed On Conventional Concrete And Concrete With Varying Proportions Of Polypropylenefibres Are Presented In Table 5. Table 6 Shows The Results Obtained From Strength Tests Carried Out On Modified Concrete With 5% Silica Fumes And Varying Proportions Of Polypropylene Fibres. Table 7 Presents The Results Obtained From Compression Test, Split Tensile Test And Flexural Strength Test Carried Out On Modified Concrete With 10% Silica Fumes And Different Proportions Of Polypropylenefibres. Results Of Strength Tests On Modified Concrete With 15% Silica Fumes And Polypropylenefibres In Different Proportions Are Tabulated In Table 8. Table 9 Presents The Results Of Strength Tests On Samples Of Modified Concrete And Different Proportions Of Polypropylenefibres.

Table 5. Compressive Strength, Split Tensile Strength And Compressive Strength For Conventional Concrete And Concrete With Polypropylenefibres In Varying Proportions

Strength	**0% Polypropylenefibre**		**0.1% Polypropylenefibre**		**0.2% Polypropylenefibre**		**0.3% Polypropylenefibre**	
	7 Days (Mpa)	**28 Days**	**7 Days (Mpa)**	**28 Days (Mpa)**	**7 Days (Mpa)**	**28 Days (Mpa)**	**7 Days (Mpa)**	**28 Days (Mpa)**

		(Mpa)						
Compressive Strength	33.28	49.18	35	50.59	36.88	52	34.6	50
Split Tensile Strength	2.54	3.68	2.69	3.8	2.83	3.96	2.6	3.75
Flexural Strength	3.63	4.56	4.13	5.83	4.92	6.42	4.05	5.77

Table 6. Compressive Strength, Split Tensile Strength And Compressive Strength For Modified Concrete With 5% Silica Fumes And Polypropylenefibresin Varying Proportions

Strength	**0% Polypropylenefibre**		**0.1% Polypropylenefibre**		**0.2% Polypropylenefibre**		**0.3% Polypropylenefibre**	
	7 Days (Mpa)	**28 Days (Mpa)**	**7 Days (Mpa)**	**28 Days (Mpa)**	**7 Days (Mpa)**	**28 Days (Mpa)**	**7 Days (Mpa)**	**28 Days (Mpa)**
Compressive Strength	34.1	49.3	35.3	50.59	40.29	57.8	34.8	49
Split Tensile Strength	2.83	4.24	2.97	4.38	3.11	4.52	2.9	4.29
Flexural Strength	3.68	4.86	4.28	5.92	5.26	6.69	4.22	5.9

Table 7. Compressive Strength, Split Tensile Strength And Compressive Strength For Modified Concrete With 10% Silica Fumes And Polypropylenefibresin Varying Proportions

Strength	**0% Polypropylenefibre**		**0.1% Polypropylenefibre**		**0.2% Polypropylenefibre**		**0.3% Polypropylenefibre**	
	7 Days (Mpa)	**28 Days (Mpa)**	**7 Days (Mpa)**	**28 Days (Mpa)**	**7 Days (Mpa)**	**28 Days (Mpa)**	**7 Days (Mpa)**	**28 Days (Mpa)**
Compressive Strength	34.36	50.1	36	53	39.6	55.9	35.5	52
Split Tensile Strength	2.96	4.19	3.22	4.27	3.53	4.34	3.2	4.22
Flexural Strength	3.74	5.12	4.42	6.23	5.58	6.96	4.4	6.2

Table 8. Compressive Strength, Split Tensile Strength And Compressive Strength For Modified Concrete With 15% Silica Fumes And Polypropylenefibresin Varying Proportions

Strength	**0% Polypropylenefibre**		**0.1% Polypropylenefibre**		**0.2% Polypropylenefibre**		**0.3% Polypropylenefibre**	
	7 Days (Mpa)	**28 Days (Mpa)**	**7 Days (Mpa)**	**28 Days (Mpa)**	**7 Days (Mpa)**	**28 Days (Mpa)**	**7 Days (Mpa)**	**28 Days (Mpa)**
Compressive Strength	33.48	48.88	34	48.73	37.33	49	33	48.2

Split Tensile Strength	2.4	3.68	2.52	3.89	2.64	4.1	2.44	3.6
Flexural Strength	3.92	5.32	4.36	6.02	5.42	6.64	4	5.2

Table 9. Compressive Strength, Split Tensile Strength And Compressive Strength For Modified Concrete With 20% Silica Fumes And Polypropylenefibresin Varying Proportions

Strength	**0% Polypropylenefibre**		**0.1% Polypropylenefibre**		**0.2% Polypropylenefibre**		**0.3% Polypropylenefibre**	
	7 Days (Mpa)	**28 Days (Mpa)**	**7 Days (Mpa)**	**28 Days (Mpa)**	**7 Days (Mpa)**	**28 Days (Mpa)**	**7 Days (Mpa)**	**28 Days (Mpa)**
Compressive Strength	32.14	46.66	34.2	47.3	35	48	33	46.5
Split Tensile Strength	2.3	3.82	2.35	3.75	2.4	3.96	2.2	3.55
Flexural Strength	3.62	5.53	4.24	5.76	5.21	6.32	4	5.34

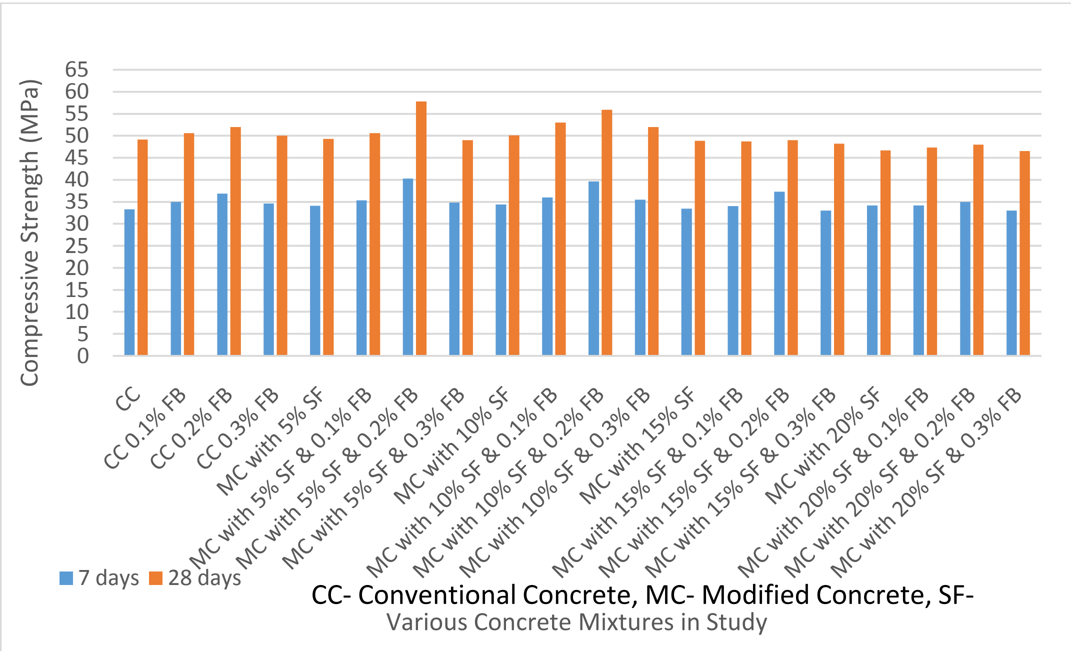

Fig 1. Comparison Of Compressive Strengths Of Various Concretes In The Study

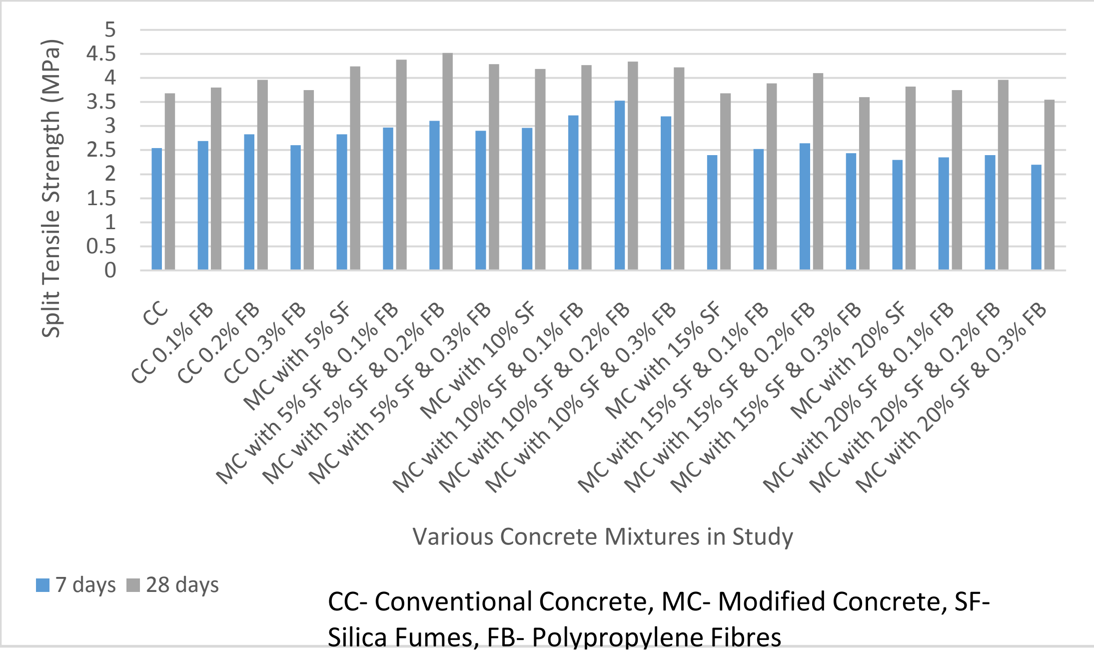

Fig 2. Comparison Of Split Tensile Strengths Of Various Concretes In The Study

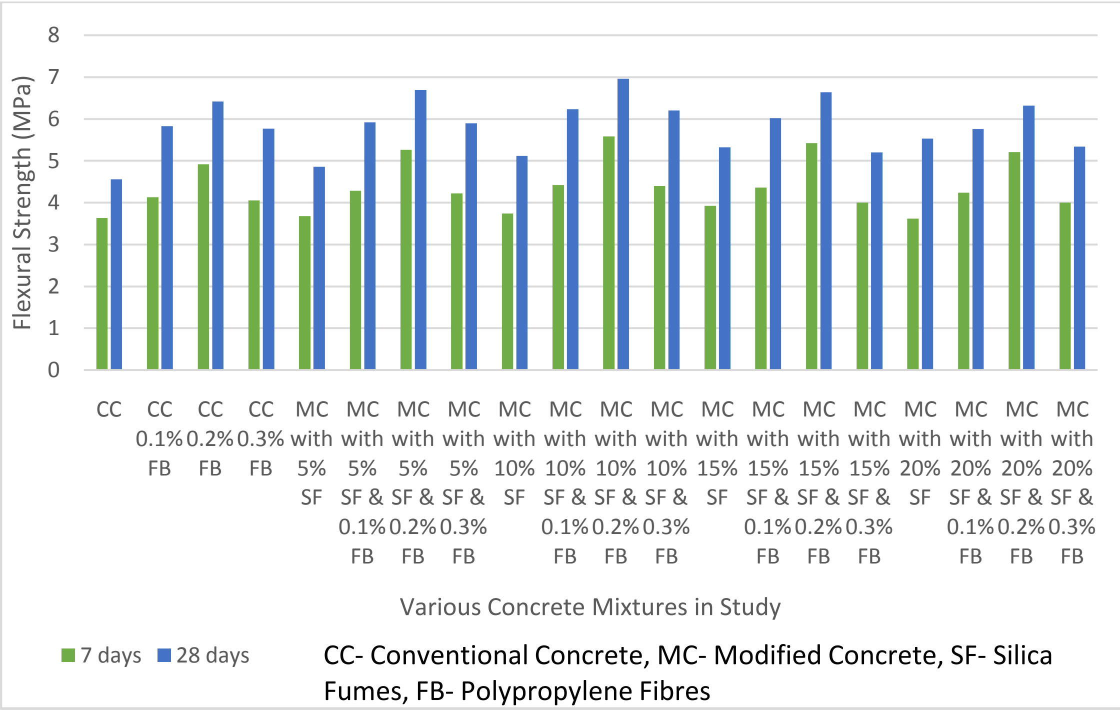

Fig 3. Comparison Of Flexural Strengths Of Various Concretes In The Study

III. DISCUSSION

From Figure 1, It Can Be Seen That The Modified Concrete With 5% Silica Fumes And 0.2% Polypropylenefibres Showed Higher Compressive Strength In Comparison To Other Concrete Mixtures. Also From Figure 2, Modified Concrete With 5% Silica Fumes And 0.2% Fibres Resulted In Higher Split Tensile Strength When Compared To Other Concrete Mixtures. In Contradiction To The Previous Percentage Of Silica Fumes And Fibres, Modified Concrete With 10% Silica And 0.2% Fibres Showed Higher Value Of Flexural Strength Than The Other Concrete Mixtures Under Study. Also It Can Be Seen That The Strength Values Increased With Increase In Percentage Of Silica Fumes Upto 5% And Thereafter The Strength Values Decreased. The Increase In Strength Can Be Attributed To The Reaction Between Calcium Present In Cement, Water And Silica In Silica Fumes Which Results In Formation Of Calcium Silicate Hydrate Gel That Binds The Concrete Resulting In Higher Strengths.

Also, It Can Be Seen From Figures 1, 2 And 3 That Use Of 5% Silica Fumes Along With 0.2% Fibres Resulted In About 17% Increase In Compressive Strength, 22% Increase In Split Tensile Strength And 46% Increase In Flexural Strength In Comparison To Conventional Concrete Under Study.

IV. CONCLUSIONS

From The Study Carried Out On Conventional Concrete And Modified Concrete With Varying Proportions Of Silica Fume And Polypropylenefibres, It Can Be Concluded That

- Use Of 5% Silica Fumes In Combination With 0.2% Polypropylenefibres Showed A Reasonable Increase In Strength In Comparison To Conventional Concrete.
- Use Of Silica Fumes In Concrete Not Only Increases The Strength But Also Handles Well The Waste Disposal Problem Faced By Industries.

Hence Use Of Silica Fumes In Concrete Along With Fibres Not Only Increases The Strength Of Concrete But Also Reduces The Waste Disposal Problem.

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S Bhanu Prasanth " Effect of Silica Fumes and Polypropylenefibres on Strength Of Concrete "IOSR Journal of Engineering (IOSRJEN), vol. 8, no. 4, 2018, pp. 67-73.