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Prediction Of Strength Parameters Of Poly Propylene Fiber Reinforced Concrete Using Multiple Regression Analysis (Mra)

K. Sagar[1], K.Ashok[2], G. Vijay Kumar[3]
[1,2,3] Assistant Professor, Department of civil Engineering Sree Chaitanya College Of Engineering, AUTONOMOUS Approved by AICTE, (Affiliated by JNTUH) Hyderabad, Telangana, India.

Abstract- — This investigation explains the effect of addition of polypropylene fibers and Nano Silica into concrete. This investigation is divided into two phases. First Phase deals with calculations of Compressive and Split Tensile strength. Here we have done compressive strength tests for calculating the optimum percentage of Nano Silica with variation from0% to 3% of cement which is replaced with cement in concrete. Now polypropylene fiber is added to concrete from 0% to 1.4% of cement and those specimens were tested for compressive and Split Tensile strength and obtained the maximum percentage of fiber at which strengths maximum. In second phase, a modal equation is developed using Multiple Regression Analysis (MRA) for compressive and Split Tensile strength based on experimental results which are found in phase one. By using obtained modal equations we will calculate Predicted strength and their residuals and their graphical representation is shown.

Keywords- Nano Silica, polypropylene fibers, water absorption, Mechanical properties, Multiple Regression Analysis.

I. INTRODUCTION

Concrete is one of the versatile heterogeneous materials, engineering science has ever known. With the appearance of concrete engineering science has touched highest peak of technology. Concrete could be a material with which any shape will be cast and with equal strength or rather more strength than the traditional building stones. It's the fabric of choice where strength, performance, durability, impermeability, fire resistance and abrasion resistance are required.

1.1 Fiber Reinforced Concrete:

To increase the strength of concrete away of introduction of fibers in concrete is being employed. These fibers act as crack arrest or sand forest all the propagation of the cracks. These fibers are uniformly distributed and randomly arranged. This concrete is called as fiber reinforced concrete. The most reasons for adding fibers to concrete matrix is to boost the post cracking response of the concrete,i.e., to boost its energy absorption capacity and apparent ductility, and to produce crack resistance and crack control.

1.1.1 Properties of Fiber Reinforced Concrete:

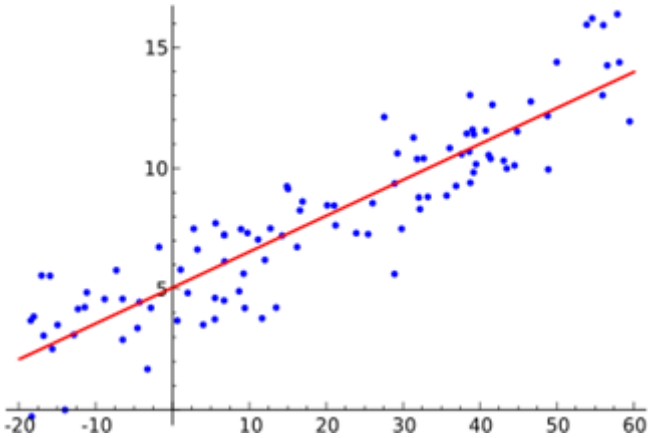
Properties of concrete is tormented by many factors like properties of cement, fine aggregate, coarse aggregate. A side from this, the fiber concrete is affected from the following factors.

1. Kind of fiber
2. Aspect ratio
3. Quantity of fiber
4. Orientation of fiber

1.2 Linear Regression:

In statistics, regression toward the mean could be a linear approach to modeling the connection between a scalar response (a dependent variable) and one or more explanatory variables (or independent variable). In case of one explanatory variable, it is named as simple statistical regression. In case of more than one explanatory variable, the method is named multiple statistical regressions. This term is distinct from multivariate regression toward the mean, where multiple correlated dependent variables are predicted, instead of one scalar variable. In simple regression, the relationships are modeled using linear predictor functions whose unknown model parameters are estimated from the information. Such models are called models. A scatter plot can be a helpful tool in determining the strength of the relation between two variables. A valuable numerical measure of association between two variables is the correlation coefficient, which is a value between -1and1 indicating the strength of the association of the observed data for the two variables.

1.3 Simple and Different Straight Relapse:



1.4 Aim sand Objectives of the study:

- To calculate the optimum percentage of Nano Silica for the partial replacement of cement.
- To calculate the percentage of Polypropylene Fiber where Compressive and Split Tensile strength is maximum.
- To develop a modal equation for compressive and Split Tensile strength by using Multiple Regression Analysis (MRA) based on experimental results (input data).
- To find the Predicted strength with the use of above obtained modal equations.
- To develop the graphical representation between dependent and independent variables.

II. EXPERIMENTAL PROGRAM:

2.1 Materials used:
The materials used for polypropylene fiber reinforced concrete are Normal Portland Cement, sand with specific gravity of 2.65, Coarse Aggregate having Fineness Modulus of 6.98, Nano Silica with particle size of 5-10nm and Polypropylene fiber of 900 kg/m^3 density.

Table1: Properties of NanoSilica

State	Dispersed in water
Active Nano content (%W/W)	40-41.5%
$P^H(20^0C)$	9.4-10
Specific Gravity	1.3-1.32
Particle Size	5-10nm

Table2:Properties of Polypropylene fiber

Fiber	Polypropylene
Density Kg/m^3	900
Elastic Modulus(GPA)	3.5-6.8
Tensile Strength(MPA)	550-700
Length(mm)	12

2.2 Mixing and Curing:
The procedures for mixing the fiber-reinforced concrete involved the subsequent. Firstly, the Coarse aggregate and sand were placed in an exceedingly cement mixer and dry mixed for 1 min. Secondly, the cement was spread and dry mixed for 1 min. Now Nano Silica is added to cement with Optimum percentage. Thirdly, the blending water was slowly added and mixed for two min. After which, fiber was added to concrete with varying from0 to 1.4%ofcement and mixed for 3 min. Lastly, the freshly mixed fiber-reinforced concrete was fed into the cube moulds of size 150mm x 150mm x 150mm for the compressive and cylinders for Split tensile test specimens measuring150mmdiameterwith30cmheight.

After the feeding operation, each of the specimens was allowed for 24hrs before remolding, stored in lime water at 23 8C for 28 days, sore moved and kept at temperature until the time of testing. After 28 days all the specimens were tested for Compressive and Split Tensile strength.

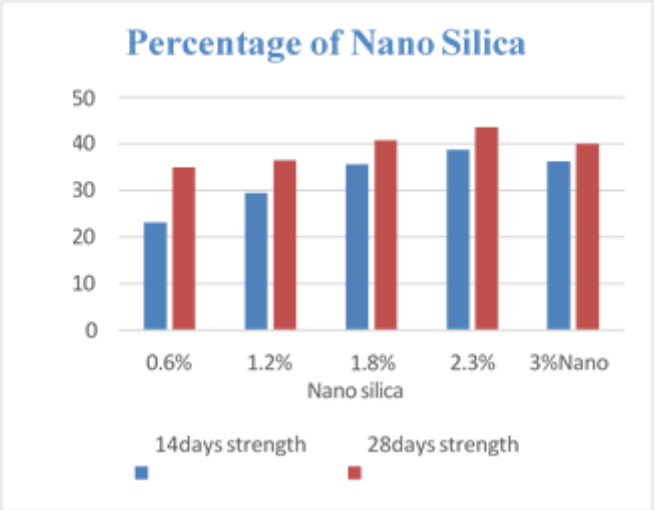
2.3 Compressive test and split tensile test:
The specimens were tested in accordance with IS 516:1969 the testing was done on Compression testing machine of 3000 KN. The machine has the power to manage the speed of loading with control valve. The machine has been calibrated to required standards. The specimen is placed on the CTM and is tightly fixed in order that the specimen mustn't move. After this, load was applied on the cube and cylinders by pressing the ON button. Slowly the load is increased up to a point where specimen gets cracked and load is recorded.

III. RESULTS:

i. Compressive strength test to find optimum percentage of Nano Silica:

Table3: Optimum% of Nano Silica

Mix	%of Nano Silica	Strength (14days)	Strength (28days)
1	0.6	23.14	34.91
2	1.2	29.47	36.45
3	1.8	35.64	40.82
4	2.3	38.78	43.56
5	3	36.25	39.97

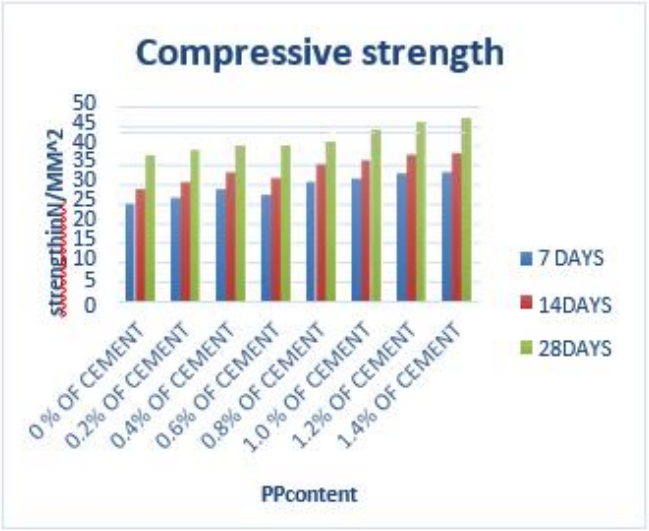


Graph1: Optimum%ofNanoSilica

ii. Compressive Strength Test:

Table4: Compressive Strength Test results:

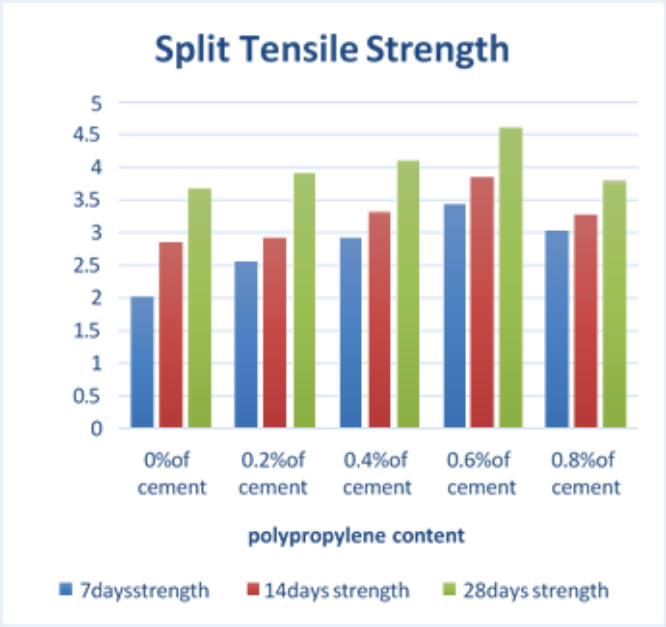
PP content (%)	7days	14days	28days
0	24.86	28.59	37.29
0.2	26.39	30.35	38.93
0.4	28.69	32.99	39.88
0.6	27.54	31.67	40.07
0.8	30.6	35.19	41.16
1.0	31.37	36.08	43.92
1.2	32.51	37.39	45.84
1.4	33.28	38.27	47.26



Graph2:Compressive Strength values

Table5:Split Tensile Strength

PP content (%)	7days	14days	28days
0	2.02	2.85	3.68
0.2	2.56	2.94	3.92
0.4	2.94	3.34	4.12
0.6	3.46	3.86	4.63
0.8	3.03	3.28	3.81



Graph3: Split Tensile Strength values

IV. DEVELOPMENT OF MODAL EQUATION USING MULTIPLE REGRESSION ANALYSIS:

Multiple Linear Regression modal is developed with compressive strength and split tensile strength as dependent variable and, Polypropylene fiber content and days of curing as the independent variables.(Polypropylene fiber and Curing days are taken on X axis
, Compressive and Split tensile strength are taken on Y axis).

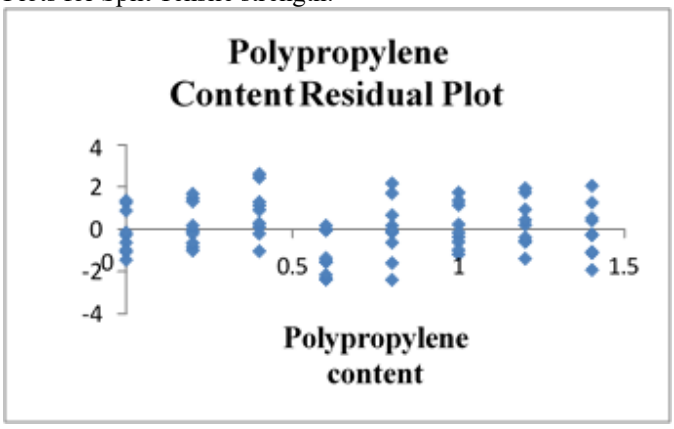
Final Obtained Equations by using MRA are:

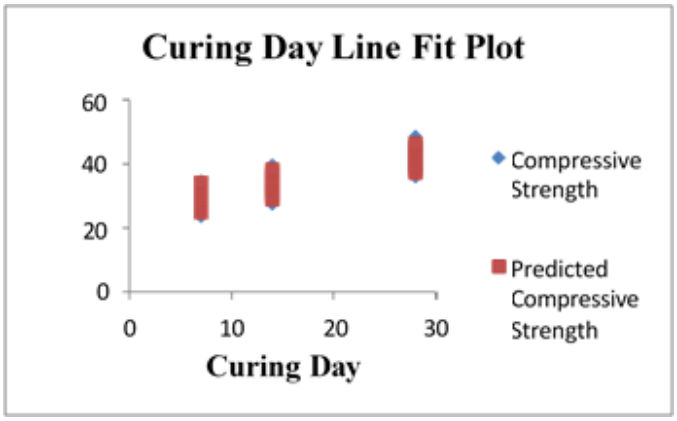
1. Compressive Strength = 20.77 + 66.2 (polypropylene fiber content) + 0.58(curing days)
2. Split Tensile Strength = 2.035 + 0.945 (polypropylene fiber content) + 0.058143 (curing days)

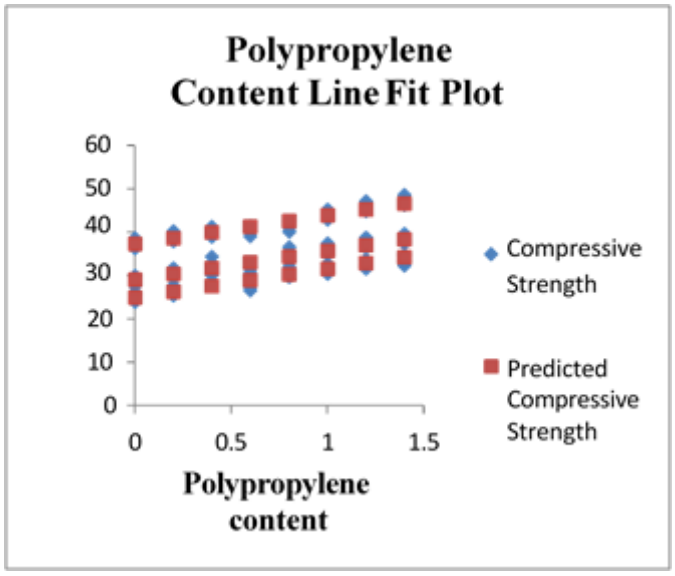
Outputs:

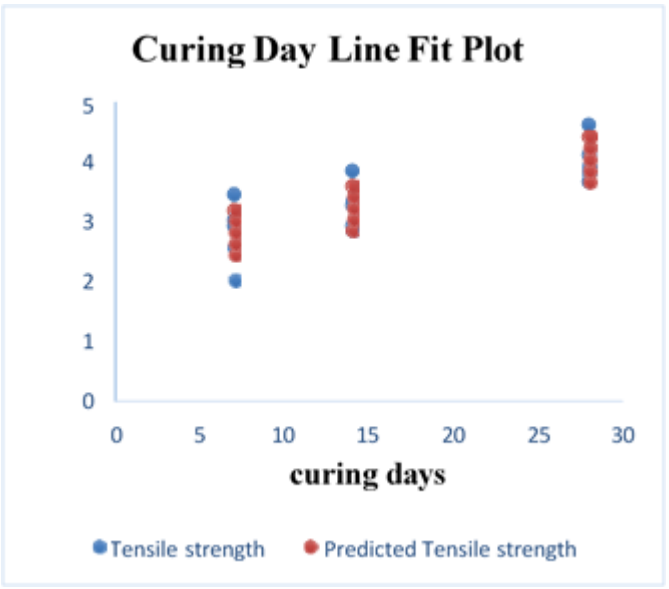
Regression Statistics	Compressive Strength	Split Tensile Strength
Multiple R	0.979674	0.889959
R Square	0.959762	0.792026
Adjusted R Square	0.958595	0.757364
Standard Error	1.246027	0.328674
Observations	72	15

Plots for Split Tensile strength:

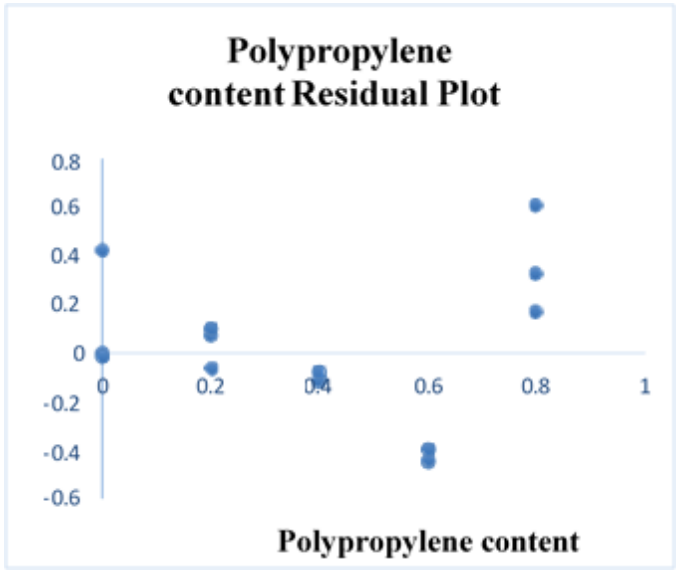


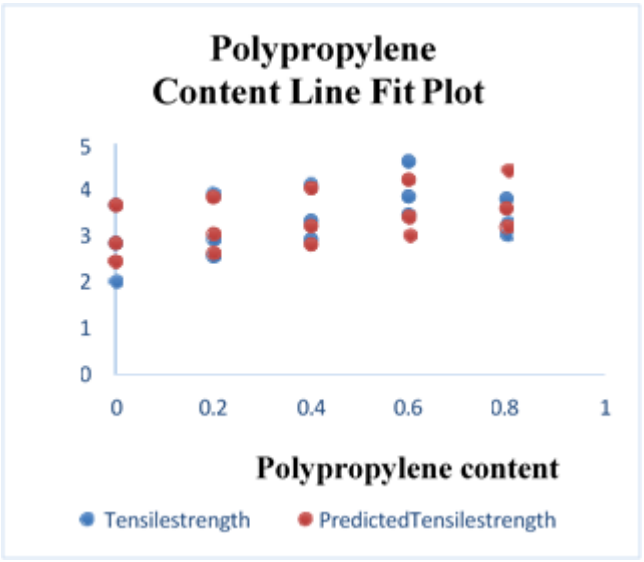






Plots for Compressive strength:





V. CONCLUSIONS:

- This study clearly shows that Compressive strength and Split Tensile strength of the Nano-concrete incorporated with polypropylene fibers is increased as compared to conventional concrete by 26.73% at 1.4% polypropylene fiber.
- Optimum percentage of Nano silica is found to be 2.3% which is a cement replacement.
- From the graphs and tables of compressive strengthandsplitTensilestrengthfor7,14 and 28 days, we

can observe that increase in polypropylene content increases the compressive strength. The increase in strengthismorefrom1%PPfiber Addition compared to the Increase of strengthupto0.8%.

- The model developed for compressive strength is having accuracy in terms of R square as 0.95.
- The model developed for split Tensile strength is having accuracy in terms of R square as 0.79.

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