PREDICTION OF COMPRESSIVE STRENGTH OF MORTAR BY USING REGRESSION TECHNIQUE WITH PARTIAL REPLACEMENT OF USED FOUNDRY SAND WITH NATURAL SAND IN MORTAR

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Abstract: These days, the generation of construction materials is diminishing the regular assets which built up a need to discover the new powerful and practical materials for the development work. This paper presents the regression analysis to anticipate the compressive strength of Mortar. Used foundry sand generated from metal casting industry as waste material. Usage of utilized foundry sand in mortar can be the most ideal route for the use of waste in construction activity. Used foundry sand is replaced with the natural sand and the conduct of mortar is observed at 7 and 28 days. A total 30 mortar cubes were casted and tested at 7 and 28 days of five mortar mix i.e. 0%,25%,50%,75%.100% of used foundry sand was replaced by weight of natural sand) .The outcomes demonstrated that consolidation of the used foundry sand respects increment compressive quality with the age (28 days) in examination with the regular mortar. In the wake of expanding the amount of used foundry sand in mortar the compressive quality shows steady decrease.

Keywords: Used Foundry sand, Cement, Natural Sand, Compressive strength and Regression Analysis

I. INTRODUCTION

In India, solid industrial waste generation rate is very much high during the last decades.Nowadays, the construction materials are reduced so we are in need to find out the new alternative materials for construction work. Mortar is a widely used material in construction work. Due to high demand of materials which causes shortages of natural materials, these turn in to a major challenge for researcher to utilize wastes as an effective construction material. Research to study the properties of waste materials and finding the best way to utilize waste is needed. Numerous past investigations undertaken got valuable results for the utilization of wastes in making concrete, paver block, mortar etc. Utilization of waste in mortar has increased considerably over the previous years. Some researches carried out a gainful utilization of foundry sand in replacement of natural sand. Critical research work has been portrayed towards the important utilization of foundry sand as characteristic sand. River sand has been the most broadly used fine aggregate in Mortar and overuse of river sand has prompted different unsafe outcomes on this tremendous normal resource. Utilization of modern squanders like glass fibre, fly ash, and hypo sludge and foundry sand in Sustainable Mortar can tackle the issues of their disposal. Using regression analysis to foresee the compressive strength of mortar in deficiency of time is a compelling strategy utilized nowadays.

II. EXPERIMENTAL PROGRAM

Following are the details and sources of the materials:

2.1 Source of Materials

In this study, Ordinary Portland cement grade 53, Used foundry sand, Natural sand was used in this test and the sources of materials are given in Table 1

Table 1 Sources of Materials

Experimental Materials	Source
Used Foudry Sand	Rhino Machines Pvt Ltd., GIDC, V.U. Nagar, Anand
Natural Sand	Bodeli, Gujarat
Cement	Locally available OPC 53 Grade

2.1.1 Cement

Ordinary Portland cement with 53 Grade has taken in this study the chemical properties are given in Table 2

Table 2 Chemical properties of Cement

Properties	Results (%)
Lime (CaO)	62.00
Silica (SiO_2)	22.00
Magnesium oxide (MgO)	5.00
Aluminum (Al_2O_3)	1.00
Calcium sulphate ($CaSO_4$)	4.00

(Source :Geo Test House, Vadodara)

2.2.2 Used foundry sand

The used foundry sand shall be obtained from Rhino Machines Pvt Ltd., GIDC, V.U. Nagar, Anand. The Physical and Chemical properties of the used foundry sand given in Table 3

Table 3 Physical and Chemical properties of Used Foundry Sand

Properties	Results
Specific Gravity	2.18
Fineness Modules	1.12
Water absorption (%)	0.20
Moisture content (%)	2.00
Silicon dioxide (SiO_2)(%)	57.32
Aluminum oxide (Al_2O_3)(%)	16.64

(Source :Geo Test House, Vadodara)

2.2.3 Natural sand

Following table natural sand shall be obtained Bodeli, Gujarat. The Physical properties of natural sand given in Table 2.3

Table 4 Physical properties of Natural sand

Properties	Results
Specific Gravity	2.68
Fineness Modules	2.64
Water absorption (%)	1.20
Moisture content (%)	0.16

(Source :Geo Test House, Vadodara)

III. METHODS

Following is the test done on the Mortar:

3.1 Compressive strength test

Cube specimens of size 7.06 x 7.06 x 7.06 cm of 1:3 proportions, using natural sand as specified by IS: 650 (1966) as Fine aggregate, tested under compression test guideline. Specimen of mortar containing 0%,25%,50%,75%,100% of Used Foundry Sand by weight of Natural Sand were prepared respectively A,A1,A2,A3,A4. Water = (P/4+3.0) % of combined weight of cement and sand .The test was performed at the age of 7, and 28 days. The strength reported was the average of three specimens for each Batch mixture. The strength of the mortar with different percentages of Used Foundry Sand was predicted by regression analysis at 28 days on the basis of 7 days.

IV. EXPERIMENTAL RESULTS AND DISCUSSION

The Figure.1 represents the compressive strength of different percentage of Used Foundry Sand added in mortar at 7days and 28days. The optimum replacement of the Used Foundry Sand in the cement mortar is 25%. The compressive strength decreases at 50%,75%,100%.The Figure.2 represents the comparison between Observed compressive strength and Predicted compressive strength. Predicted compressive strength from the regression equations as shown in Table 5.

$y = -0.3008x^2 + 7.258x - 24.391$ …….(1)

Where, y= Compressive Strength of the mortar cube at 28 days (N/mm^2)

x= Compressive Strength of the mortar cube at 7 days (N/mm^2)

4.1.1 Polynomial Regression Relationship Model

A Polynomial regression analysis describes the relationship of a variable X and variable Y. Variable X denote compressive strength of mortar at 28 days and variable Y denote compressive strength of mortar at 7 days. The polynomial regression model in figure 1 is polynomial regression for mortar which is the relationship between the value of mortars compressive strength at 28 days and 7 days with the equation $y = -0.3008x^2 + 7.258x - 24.391$ this figure is close to the value of 1, it means to have a strong

correlation between the variable X and variable Y.

Following figure 1 shows the polynomial regression relationship of compressive strength of mortar.

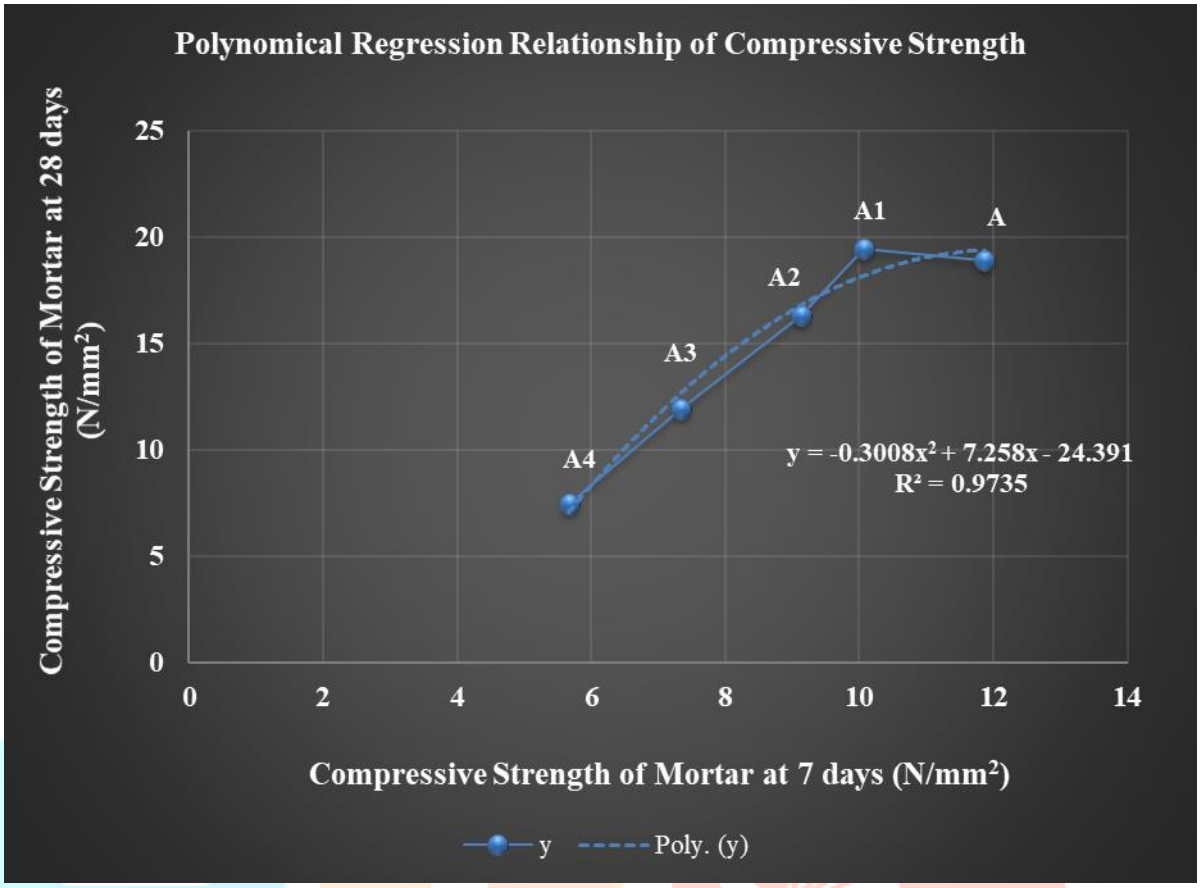

Figure 1. Polynomial Regression Relationship between the Compressive strength of mortar at 7 days and 28 day

Following Table 5 shows the observed compressive strength and predicted compressive strength at 28 days.

Table 5 Observed compressive strength and Predicted compressive strength

Mortar Specimens	Cement (Grams)	Natural Sand (Grams)	Used Foundry Sand (Grams)	Observed Compressive strength (N/mm^2) At 7 Days	Observed Compressive strength (N/mm^2) At 28 Days	Predicted Compressive strength (N/mm^2) At 28 Days
A	200	600	0	11.87	18.94	19.37
A1	200	450	150	10.07	19.47	18.19
A2	200	300	300	9.14	16.34	16.81
A3	200	150	450	7.34	11.94	12.67
A4	200	0	600	5.67	7.47	7.09

Following Figure 2. shows the Observed vs Predicted compressive strength

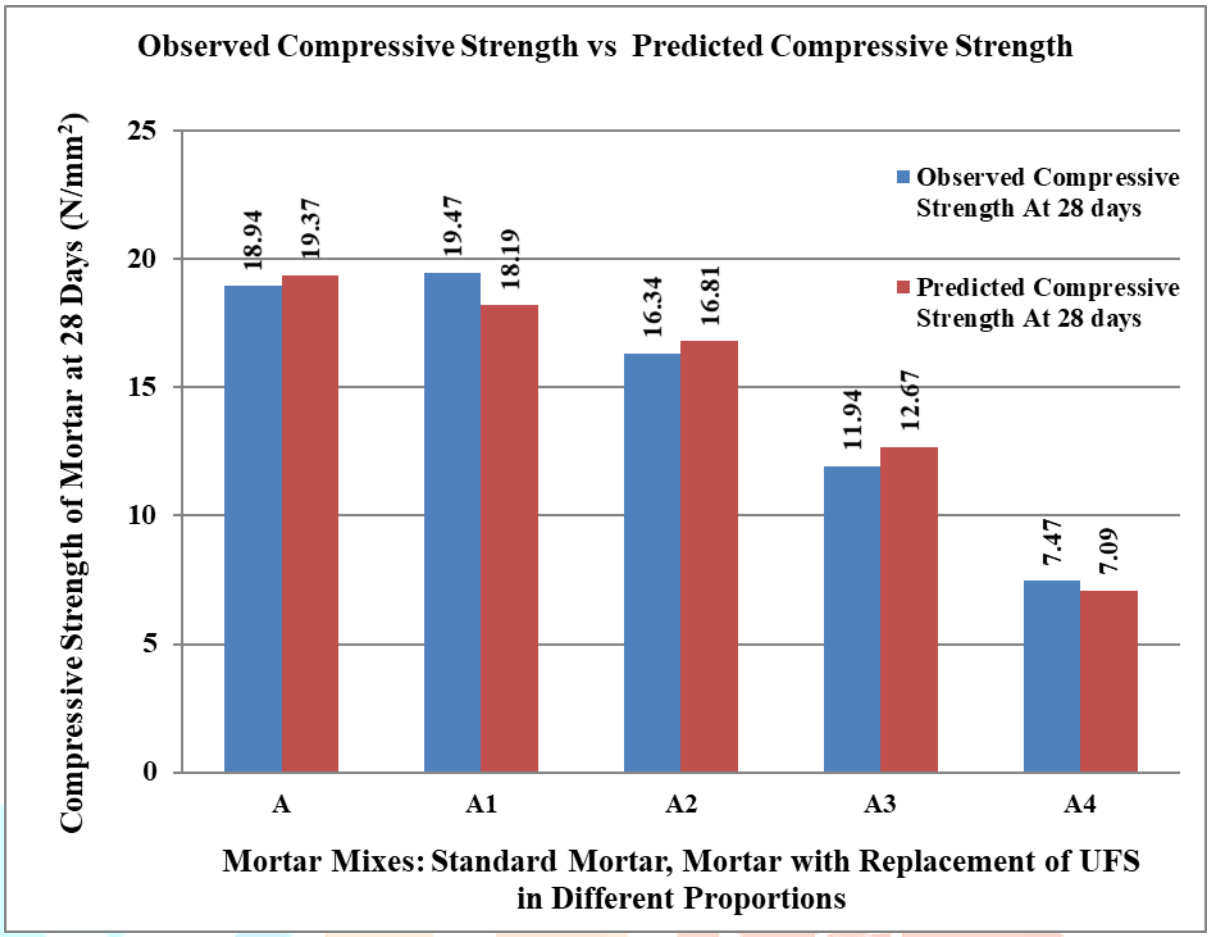

Figure 2. Observed compressive strength and Predicted compressive strength

V. CONCLUSION

Based on the experimental research following conclusions are drawn:

- The incorporation of Used Foundry Sand in mortar improved compressive strengths in comparison to that conventional mortar.
- When compared to the strengths of conventional mortar and Used Foundry Sand based mortar exhibits more strength. When 25% of Used Foundry Sand was replaced by Natural Sand.
- On the basis of Polynomial Regression analysis the $R^2 = 0.9735$ which is close to the value of 1,this may equation use for the prediction of 28 days compressive strength of different mixes on the basis of 7 days compressive strength.

VI. ACKNOWLEDGMENT

The Author thankfully acknowledge Prof. (Dr.) Indrajit Patel, Prof. (Mrs.) Reshma L. Patel, Dr. Jyeshkumar Pitroda, B.V.M. Engineering College, Vallabh Vidyanagar, Gujarat, India for their motivational support to carry out this research.

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