PRIDICTION OF COMPRESSIVE STRENGTH OF CEMENT BY USING REGRESSION TECHNIQUE WITH PARTIAL REPLACEMENT OF HYLAM POWDER IN CEMENT MORTAR

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ABSTRACT

This paper presents the comparison of results i.e., (compressive strength of cement) by the experimental study and Regression model to evaluate the possibility of utilizing the hylam powder as a partial replacement in cement mortar. The remarkable increase in the production of hylam and its disposal in an ecofriendly manner is increasingly becoming a matter of global concern. Hylam powder is a waste produced from hylam sheets at the time of fabrication (Cutting, Making holes and polishing process) is used as a partial replacement in cement. A total 63cement cube were casted and tested for 3,7& 28days of seven mortar mix (i.e. 0%, 3%, 5%, 7%, 10%, 13% & 15% of Hylam powder was replaced by weight of cement). The results show that incorporation of the hylam powder yields to the increase of strength at the age (28 days) in comparison with that of a control mortar.

KEYWORDS

Hylam powder, OPC, Ennore sand, Compressive strength, and Regression Analysis

1. INTRODUCTION

Due to the demand of the building materials mainly in the past decades and also by increasing the growth of the population which causes chronic shortages of materials, these become a very big challenge to civil engineers to convert the industrial wastes to be useful building and construction materials. Accumulating of unmanaged wastes especially in developing countries. Recycling of wastes as a building material. The need of reducing the carbon foot print associated to cement production drove much research towards the study of by-products to be used as supplementary cementitious materials (SCMs). Many previous researches [1–15] undertaken obtained valuable results to use the industrial wastes in various forms of concrete production. For instance, the use of waste rubber, glass powder, and rice husk ash in concrete mix or cement mortar has received conscribe attention over the past years. Some researches carried out in the past used wood ash wastes as a replacement for cement in concrete mixes [1, 2]. Significant research has been directed towards the utilization of rice husk ash (RHA) as SCM [3]. S.Popovics [16], augments Abrams model, a widely used equation relating the water cement ratio of concrete to its compressive strength with the additional variables such as slump, and uses least square regression to determine equation coefficients. Using this technique improved strength prediction.

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2. EXPERIMENTAL PROGRAM

2.1. Materials

In this study, Ordinary Portland cement grade 43, Ennore sand as a Fine aggregate and Hylam powder as partial replacement of cement was used in this test. Specific gravity of Ennore sand: 2.65.

2.1.1. Cement

Ordinary Portland cement with 43 Grade has taken in this study the physical properties are given in table.1

Table.1 Physical properties of Ordinary Portland Cement

S.No	Properties	Results
1	Specific Gravity	3.12
2	Initial Setting Time	55Minutes
3	Finial Setting Time	225Minutes
4	Soundness	2mm
5	Fineness	225m^2/kg
6	Consistency	30%
7	Compressive Strength	N/mm^2
A	3 Days	23
B	7 Days	33.12
C	28 Days	43.08

2.1.2. Ennore sand

The standard sand shall be obtained from Ennore Tamilnadu .The specific gravity of sand 2.65 and it has in the forms of three grades which have shown in Figure1.

Grade1 (2mm-1mm) Grade 2 (1mm-0.5mm) Grade 3 (0.5mm -0.09mm)

Figure 1. Grades of Ennore Sand

2.1.3. Hylam

Hylum is thermo setting plastic is obtained by the step-growth polymerization of resin with weaved cloth and stream will be applied in hydraulic pressure heaters (200-220kg/cm^2) to form sheets. Phenol, Formaldehyde, Methanol & Cardanol are the raw materials used to preparation of resin. Resin + Weaved cotton cloth = Fabricated Hylum sheet. It is tough & Versatile Engineering materials used to Electrical & Mechanical purposes It is light in weight, good electrical insulator & resistance to water and chemical. Its applications are prefabricated wall panels, Partitions Cavity, False Ceiling, Cavity Flooring, under deck insulation etc... Specific gravity of Hylum powder was: 1.75.

Table 2 Chemical properties of Hylum Powder

Constituent	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO
Compositions (%)	29.8	26	2.25	9.45	8.32

3. METHODS

3.1 Compressive strength test

Cube specimens of size 7.06 x 7.06 x 7.06 cm of 1:3 proportions, using standard sand as specified by IS: 650 (1966) as Fine aggregate, tested under compression (Grade of cement indicates their compressive strength at the end of 28 days of curing).Specimen of mortar containing 0%, 3% 5%, 7%, 10%, 13% & 15% of Hylam powder by weight of cement were prepared. Water = (P/4+3.0) percent of combined weight of cement and sand .The test was performed at the age of 3, 7, and 28 days. The strength reported was the average of three specimens for each Mixture. The strength of the cement with different percentages of Hylam powder was predicted by regression analysis by using MINITAB Software. Compressive strength had taken as response and Age of the specimen & Cement had taken as a predictor.

Thermal conductivity is the quantity of heat transmitted through a unit thickness in a direction normal to a surface of unit area due to a unit temperature gradient under steady state conditions. Conductivity coil consists of two circular disks these are made with cement mortar and attached together with no space between them. On these disks grooves are made at depth of 2 to 4mm at center of disks. On these groove mica sheet is inserted by providing it with two electrodes which will act as a conducting material. Three wires are inserted inside and outside of the circular disk to record the temperature differences on the meter gauge.

4. EXPERIMENTAL RESULTS AND DISCUSSION

The Figure.2 represents the compressive strength of different percentage of Hylam powder added in cement mortar and age of cement. The optimum replacement of the Hylam power in the cement mortar is 5%. The compressive strength decreases at 7%, 10%, 13% & 15%.The Figure.3 & 4 represents the Predicted compressive strength from the regression equations. The regression equation was found from data as shown in table 3.

$$Y = -71.7 + 0.478\,A + 0.511\,C \text{---------- Eq-1}$$
$$R^2 = 0.78$$
$$Y = 4.462 + 0.1119C \quad (3\text{Days}) \text{ ---------- Eq-2}$$
$$R^2 = 0.691$$
$$Y = 8.018 - 0.1373C \quad (7\text{Days}) \text{ ---------- Eq-3}$$
$$R^2 = 0.897$$
$$Y = -4.797 - 0.2623C \quad (28\text{Days}) \text{ ----------Eq-4}$$
$$R^2 = 0.842$$

Where Y= Compressive Strength of the cement cube (N/mm^2)
A= Age of the specimen i.e., (3, 7&28days)
C= Cement.(Grams)

Table 3 Observed compressive strength and predicted Compressive Strength

Observed Compressive strength(N/mm^2)	Age(Days)	Cement(Grams)	Hylam Powder(Grams)	Sand(Grams)	Predicted Compressive strength(N/mm^2)
23.00	3	200	0	600	32.04
33.12	7	200	0	600	33.95
43.08	28	200	0	600	43.98
25.40	3	194	6	600	28.97
33.62	7	194	6	600	30.86
45.14	28	194	6	600	40.91
27.00	3	190	10	600	26.92
33.96	7	190	10	600	28.86
46.52	28	190	10	600	38.86
23.55	3	186	14	600	24.88
29.98	7	186	14	600	26.79
35.61	28	186	14	600	36.82
21.26	3	180	20	600	21.81
27.34	7	180	20	600	23.72
29.00	28	180	20	600	33.75
17.34	3	174	26	600	18.74
24.25	7	174	26	600	20.65
26.34	28	174	26	600	30.68
14.73	3	170	30	600	16.69
22.37	7	170	30	600	18.6
24.57	28	170	30	600	28.63

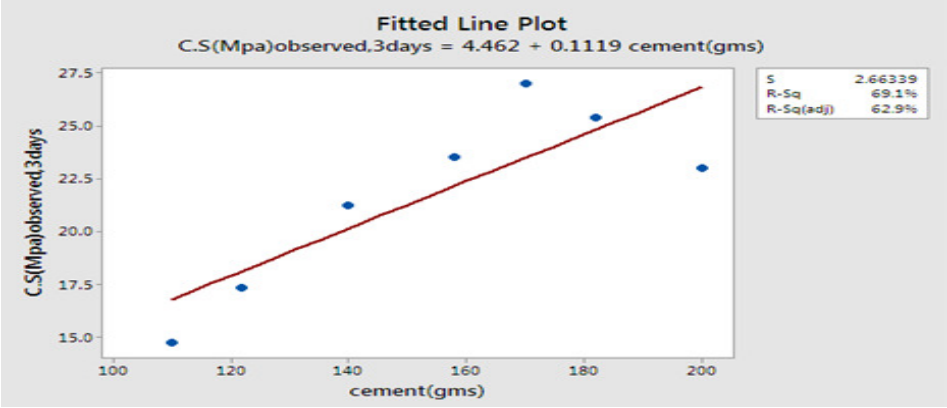

Figure1. Relation between 3days compressive strength & cement

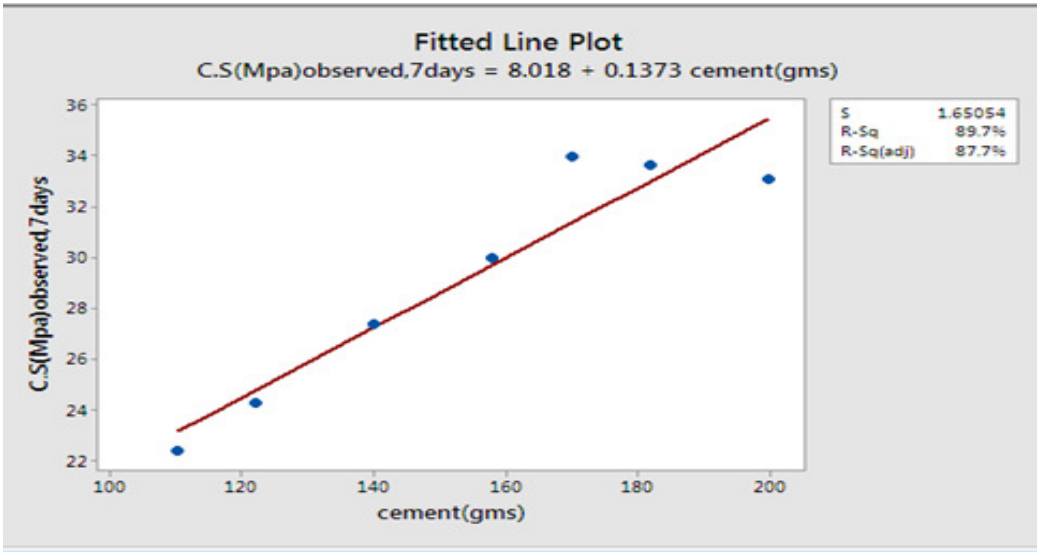

Figure2. Relation between 7days compressive strength & cement

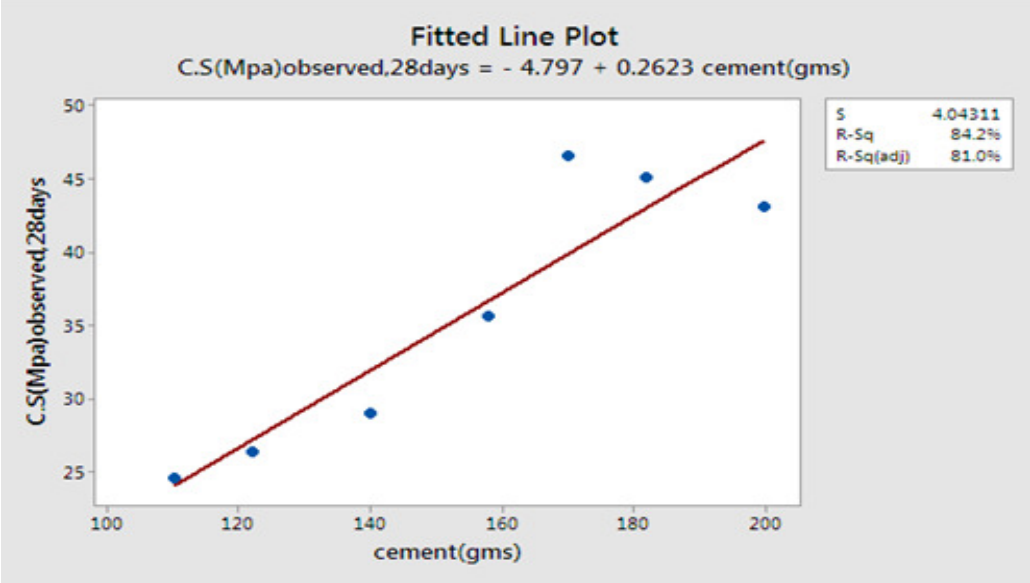

Figure3. Relation between 28days compressive strength & cement

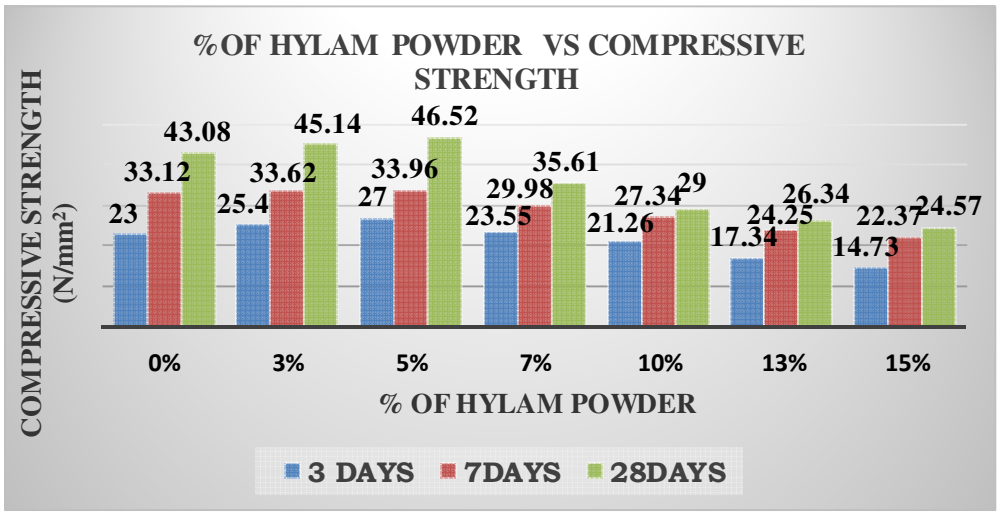

Figure 4. Observed compressive strength with different % of Hylum powder

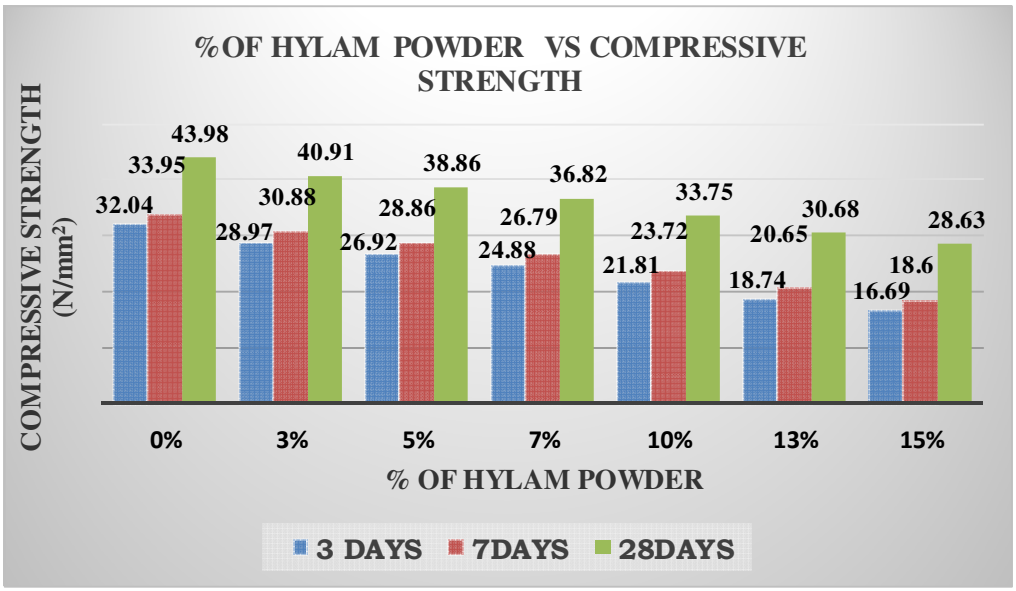

Figure5.Predicted compressive strength with different % of Hylum powder (From Eq-1)

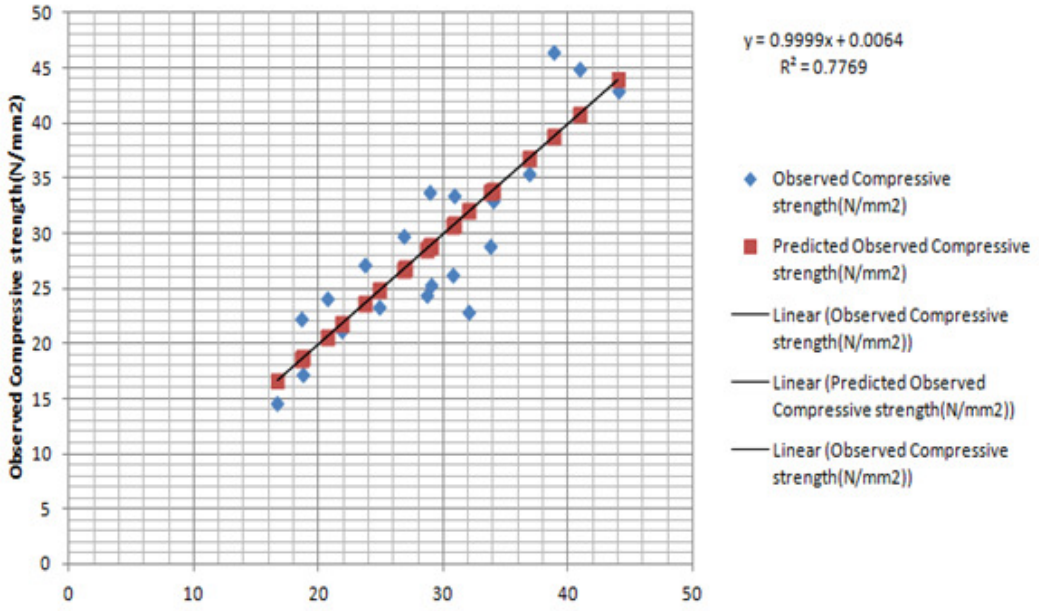

Figure6 Predicted Compressive Strength(N/mm2)

5. CONCLUSIONS

- The incorporation of Hylam powder yields mortars with improved strengths in comparison to that control mortar.
- When compared to the strengths of cement mortar and cement mortar with hylam powder by Partial replacement of cement exhibits more strength. When 5% of hylam powder was replaced.
- The R^2 Values for the incorporating of hylum powder were 0.691, 0.89.7 & 0.842 for the prediction of 3days, 7days & 28days compressive strength of different mixes in spite of variations in the results. When the cement taken as an independent variable.
- When the Age of the specimen & cement taken as an independent variables found that the R^2=0.78.
- Conductivity of control cement mortar is 1.638 W/m ^{0}C and for 5% hylam powder is 1.247 W/m ^{0}C

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