IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

EFFECT ON STRENGTH PARAMETERS OF BINARY BLEND AND TERNARY BLEND CONCRETE CONTAINING GGBS AND FLY ASH WITH VARYING PERCENTAGE OF POLYMER

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Abstract - At present in India, about 960 million metric tons of solid waste is being generated annually as byproducts during industrial, mining, municipal, agricultural and other processes. Advances in solid waste management resulted in alternative construction materials as a substitute to traditional materials. The main objective of this thesis is to investigate the strengthening effects of polymer material on ternary blended concrete by incorporating (30%) Fly ash and (50%) GGBS. The workability properties of polymer modified concrete were also investigated. Adopted polymer includes the Styrene-butadiene-rubber (SBR) latex varied at the rate of 2%, 3% and 4% by weight of cementitious material. The strength properties considered for the study are Compressive strength, flexural strength and Tensile strength of concrete. The strength properties of ternary blend concrete are compared with strength properties obtained for conventional concrete and binary blend concrete with GGBS and fly ash individually in the mix.

Key Words: **Polymer, GGBS, Fly ash Compressive strength, Tensile strength, Regression Analysis.**

I.INTRODUCTION

Concrete is the most extensively and widely used building material for construction all over the world. Concrete can be produced by regionally accessible constituents; wide variety of structural configurations can be casted using concrete, and it requires minimum maintenance during entire service life. It is attractive in many applications because it offers considerable strength at a relatively low cost. To get the high strength for concrete by reducing the water content can achieve by adding the chemical admixture like water reducing agents to concrete. In some cases high strength requirement is not sufficient even other properties also to be enhanced like durability, low permeability and good workability. The production of every one tone of Portland cement, releases the same amount of carbon dioxide into the atmosphere. For this purpose pozzolanic materials are incorporating in to concrete like fly ash, silica, GGBS those are called as supplementary cementitious materials (SCMs). Incorporation of these SCMs not only enhance the properties

of concrete they also reduces the cement content in concrete. The reduction of cement content means it minimize the environment impacts caused in cement production process and most of these materials are industrial by-products, problems with disposal also can be solved. SCMs are added to batch immediately or during mixing to modify one or more of the properties of concrete in fresh and hardened state. The use of SCMs as partial replacement to cement in concrete is common practice in modern concrete technology. For this study secondary data has been collected. From the website of KSE the monthly stock prices for the sample firms are obtained from Jan 2010 to Dec 2014. And from the website of SBP the data for the macroeconomic variables are collected for the period of five years. The time series monthly data is collected on stock prices for sample firms and relative macroeconomic variables for the period of 5 years. The data collection period is ranging from January 2010 to Dec 2014. Monthly prices of KSE -100 Index is taken from yahoo finance.

II.OBJECTIVE OF THE STUDY

Following are the objectives of this experiment:

- To investigate Strength parameters of concrete containing Fly ash and GGBS.
- To compare the strength parameters of concrete with different mix proportions of Fly ash and GGBS with the conventional control mix of concrete subjected to elevated temperature.
- To determine the Residual strength of concrete mix containing Fly ash and GGBS and comparing those with the conventional control mix.
- To determine compressive strength equation using Regression analysis.

III.MATERIALS AND METHODS

3.1 Cement: OPC 43 grade with specific gravity 3.15 was used conforming to IS: 8112: 2013.

3.2 Fine aggregates: The fine aggregate (M-sand) which was used for experimental works where locally obtained. Based on experimental results it belonged to Zone-I. The specific gravity of fine aggregates (M-sand) was found to be 2.65.

3.3 Coarse aggregates: Locally available 20mm down sized coarse aggregates where used for experimental works. The specific gravity based on experimental results was found to be 2.88.

3.4 GGBS and Fly ash: GGBS and Fly ash is produced from Balaji concrete Belagavi specific gravity is 2.85.

3.5 SBR Latex Polymer: SBR Latex Polymer specific gravity at 1.22.

3.6 Mix Design: The results are obtained using IS 10262–2009 code, mix design is carried out for M40 grade of concrete. The mix proportion obtained for M40 grade concrete is 1: 2.05:2.82 for water cement ratio of 0.364.

IV.EXPERIMENTAL TEST PROCEDURE

Table-1 Mix id description

MIX ID	DESCRIPTION
M0	Control mix contains only basic ingredients used M-sand as F.A.
MB1	(50% CEMENT +50% GGBS) +1% SP
MB2	(50% CEMENT +50% GGBS) +1% SP+2% POLYMER
MB3	(50% CEMENT +50% GGBS +1% SP+3% POLYMER
MB4	(50% CEMENT +50% GGBS) +1% SP+4% POLYMER
MB5	(70% CEMENT +30% FLYASH) +1% SP
MT1	(20% CEMENT +50% GGBS +30% FA) +1% SP
MT2	(20% CEMENT +50% GGBS +30% FA) +1% SP+2% POLYMER
MT3	(20% CEMENT +50% GGBS +30% FA) +1% SP+3% POLYMER
MT4	(20% CEMENT +50% GGBS +30% FA) +1% SP+4% POLYMER

V.EXPERIMENTAL TEST RESULTS AND DISCUSSION

5.1 WORKABILITY RESULTS

Slump test was carried out on all these mixes. Control mix has shown more slump. But all proposed mixes have satisfactory slump values.

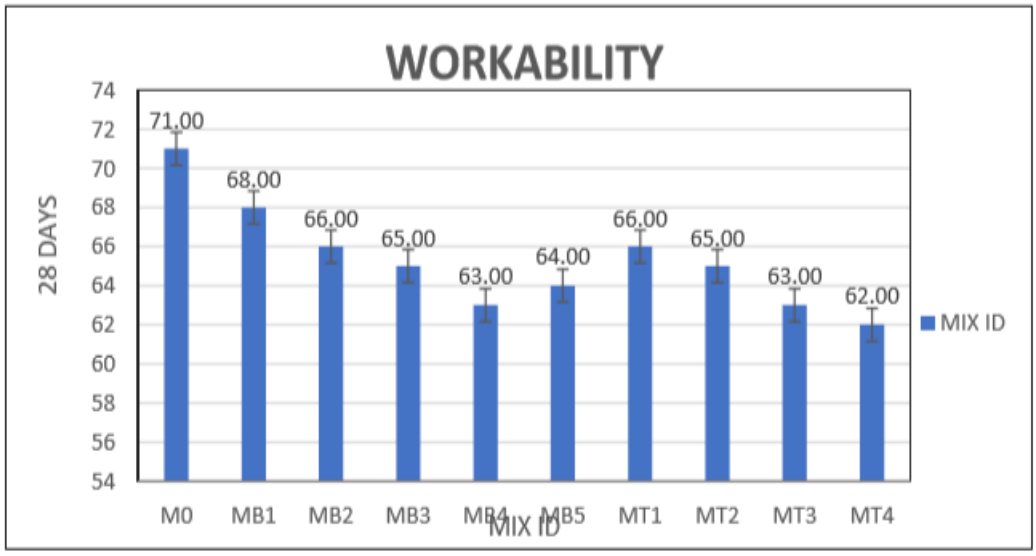

Chart-1: Variation in Slump

5.2 COMPRESSIVE STRENGTH TEST RESULTS

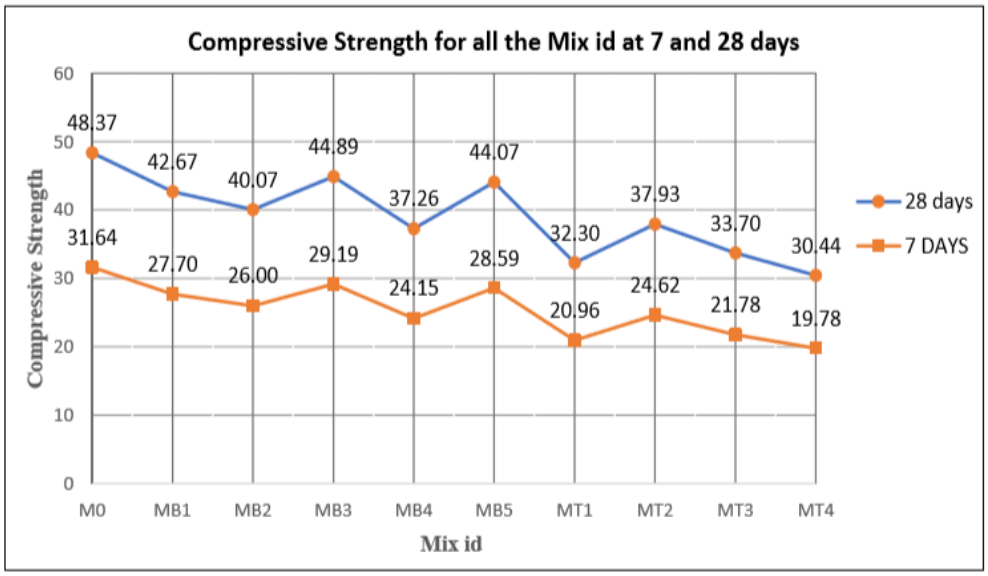

Chart-2: Variation of Compressive strength at 7 days and 28 days for all the Mixes.

Compressive strength of after 7days of curing and in range of 20 N/mm2 to 32 N/mm2 with control mix (M0) shows max value of 31.64 N/mm2 and ternary blend (MT4) shows least value of 19.78 N/mm2 these values are in the accepted range of 66% of 28 days compressive strength. 28 Days compressive strength was in the range of 30.44 MPa to 48.37 MPa including binary and ternary blend concrete mixes. Mix MB3 has shown a peak value of 44.89 N/mm2and mix MT4 has shown a lower strength of 37.26 N/mm2 while MB3 is the acceptable range (for M40 concrete) MB4 is not accepted for M40 concrete. In case of ternary blend mixes, there is further drop in compressive strength in all mixes ,None of the mixes have shown a strength above 40 N/mm2 Mix MT2 has shown a peak strength of 37.93 N/mm2 mix MT4 performed poorly producing a strength of 30.44 N/mm2.Thus Mixes MB1, MB3 and MB5 have performed better in binary blend concrete .And mix MT2 performed better compared to other ternary blend concrete but still it has not shown strength of M40 concrete as the objective is to develop a concrete containing admixtures which can produce M40 concrete more economically compared with control mix, mixes MB1, MB3 and MB5 are recommended Ternary blend with both admixtures GGBS and FA have not shown encouragement results.

5.3 Split Tensile Strength Test Results

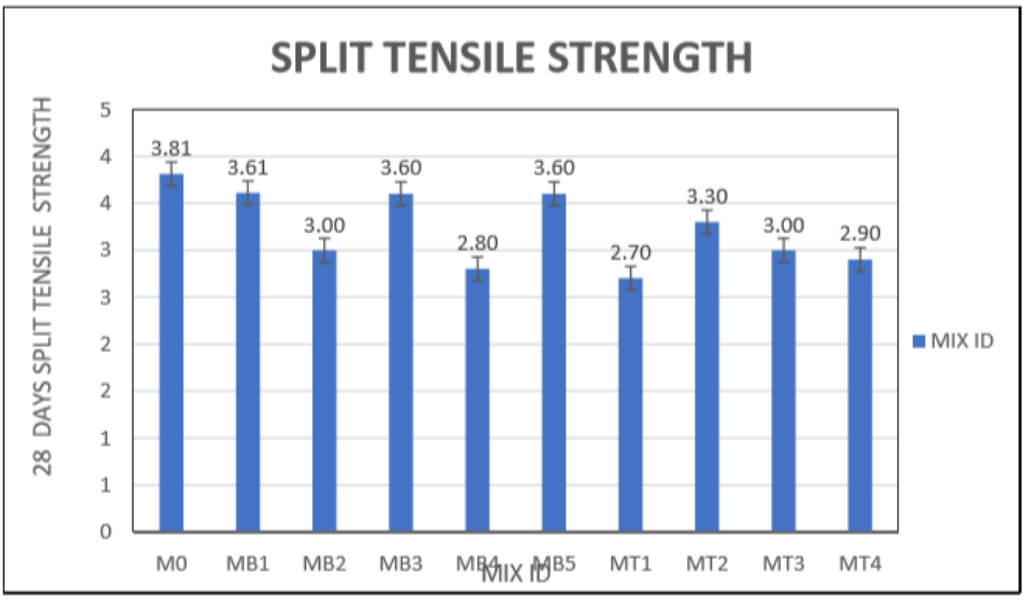

Chart-3: Variation of Split tensile strength at 28 days for all the Mixes.

28 Days Tensile strength was in the range of 2.90 MPa to 3.81 MPa including binary and ternary blend concrete mixes. Mix MB1 has shown a peak value of 3.61N/mm2 and mix MT1 has shown a lower strength of 2.70 N/mm2 while MT4 is the acceptable range (for M40 concrete) MB4 and MT4 is not accepted for M40 concrete. In case of ternary blend mixes, there is further drop in Tensile strength in all mixes, Mix MB1 has shown a peak strength of 3.61N/mm2 mix MT1 performed poorly producing a strength of 2.70N/mm2. Thus except Mix MB4 all have performed better in binary blend concrete. And mix MT2 performed better compared to other ternary blend concrete. but still it has not shown strength of M40 concrete as the objective is to develop a concrete containing admixtures which can produce M40 concrete more economically compared with control mix, mixes MB1, MB3 and MB5 are recommended. Ternary blend with both admixtures GGBS and FA have not shown encouragement results.

5.4 Shear Strength Test Results

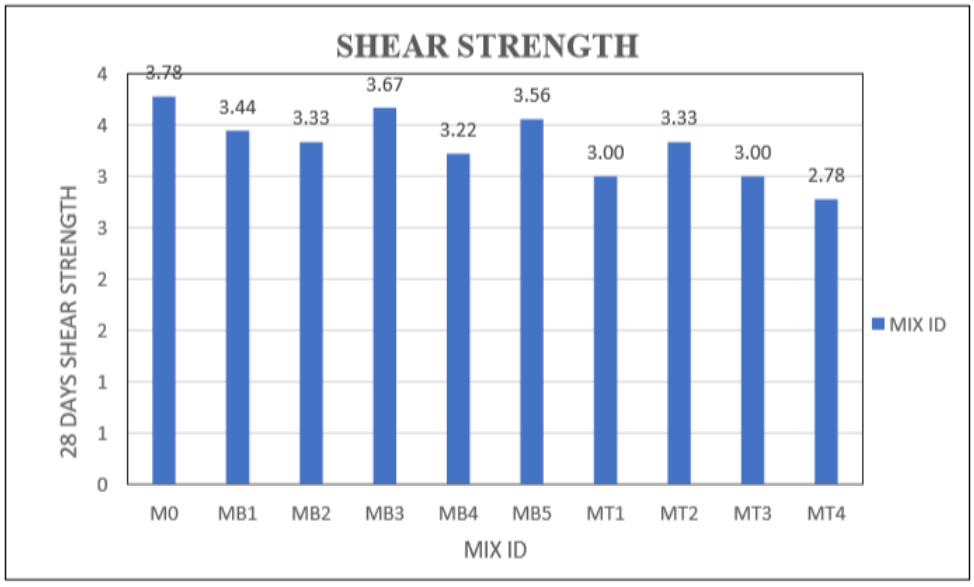

Chart -4: Variation of Shear strength at 28 days for all the Mixes

28 Days Shear strength shows encouragement result for both binary and ternary blend concrete. MB3 shows peak value 3.67 N/mm2 compared to all Mixes in both binary and ternary blend concrete. In this binary blend shows good result compared to ternary blend concrete where as in ternary blend MT2 shows high strength 3.33N/mm2 as compared to other ternary Mixes. And MT4 shows least value 2.78N/mm2 and not reaches the M40 strength.

It has been noted that the strength of the shear continues to increase linearly as the replacement of M sand increases up to 60 percent replacement of Natural sand with M sand, further replacement of M sand leads to a decrease in strength. The shear strength at 60 percent replacement of natural sand with M sand provides us maximum strength relative to other M sand replacement variations. The shear strength at 60 percent replacement of natural sand with M sand provides up to 23.89 % higher resistance compared to standard blend. When natural sand is completely replaced by M sand, the shear strength decreases, but the strength corresponding to this variation is greater than the design strength (M30 Mix). Overall, 60 percent replacement of natural sand by M sand has been

noted to offer maximum strength in all parameters of the strength test. When complete replacement of natural sand by M sand is performed, force at 100 percent replacement is lower than the replacement of 60 percent, but almost in line with the desired proportion of the mix. It was also noted that samples undergoing 60 days of chloride attack showed less strength to ordinary curing that is not subject to acid attack.

5.5 ULTRASONIC PULSE VELOCITY AND REBOUND HAMMER TEST RESULTS

Table-2 Ultrasonic Pulse Velocity Test

1)Ultrasonic Pulse Velocity					
Mix Id	Specimen	Weight (kN)	Time of Travel (µs)	Intensity m/s	REMARKS
M0	1	8.90	30	4839	EXCELLENT
	2	9.10	31	4849	EXCELLENT
MB1	1	8.95	33.5	4478	GOOD
	2	8.88	31	4839	EXCELLENT
MB2	1	8.96	33.5	4478	GOOD
	2	9.25	30	5000	EXCELLENT
MB3	1	9.24	33	4545	EXCELLENT
	2	9.00	33.5	4478	GOOD
MB4	1	8.95	35	4286	GOOD
	2	9.25	33.5	4478	GOOD
MB5	1	9.14	30	5172	EXCELLENT
	2	8.72	31	5000	EXCELLENT
MT1	1	8.42	33.5	4348	GOOD
	2	8.44	31	4396	GOOD
MT2	1	8.70	33.5	4167	GOOD
	2	8.74	30	4169	GOOD
MT3	1	8.84	33	4528	EXCELLENT
	2	8.72	33.5	4529	EXCELLENT
MT4	1	8.46	35	4167	GOOD
	2	7.96	33.5	4478	GOOD

Rebound hammer and ultrasonic pulse velocity. Rebound hammer was in the range of 30 rebound no to 44 rebound no including binary and ternary blend concrete mixes. Mix MB3 has shown a peak value of 46 rebound No and mix MT4 has shown a lower strength of 30 rebound no while MB3 is the acceptable range (for M40 concrete) MB4 is not accepted for M40 concrete. In case of ternary blend mixes, there is further drop in compressive strength in all mixes, none of the mixes have shown strength above 40 rebound No mix MT2 has shown peak strength of 38 rebound No mix MT4 performed poorly producing strength of 30 rebound No. Thus mixes MB1, MB3 and MB5 have performed better n binary blend concrete .and mix MT2 performed better compared to other ternary blend concrete but still it has not shown strength of M40 concrete as the objective is to develop a concrete containing admixtures which can produce M40 concrete more economically compared with control mix, mixes MB1, MB3 and MB5 are recommended. Ultrasonic pulse velocity was shown “excellent” and “good” remark in concrete quality grading above 3.5 pulse velocities (km/sec) for all mixes. Shown high intensity for MB5 (5172) and low intensity for MT2 and MT4 (4167). So all mixes were shown good and satisfactory result.

TABLE-3 REBOUND HAMMER TEST

2) Rebound Hammer			
Mix Id	Specimen	Rebound Number	Compressive Strength
M0	1	44	45.77
	2	44	46.67
MB1	1	40	41.56
	2	40	42.67
MB2	1	38	40.00
	2	40	40.44
MB3	1	42	43.78
	2	46	46.67
MB4	1	34	35.56
	2	38	38.22
MB5	1	44	43.56
	2	42	44.44
MT1	1	32	32.67
	2	32	33.11
MT2	1	38	37.56
	2	38	38.22
MT3	1	30	32.67
	2	34	34.89
MT4	1	32	30.89
	2	30	29.33

5.6 REGRESSION ANALYSIS.

Regression Analysis for Mixes was done and Equation is Comp Strength = 17.11 + 0.233C +0.01F + 0.084G -0.62P experimentally evaluated values of compressive strengths are in close agreements with Values predicted by Regression Analysis

Regression Statistics	
Multiple R	0.897575674
R Square	0.80564209
Adjusted R Square	0.541796469
Standard Error	3.183899526
Observations	10

VI.CONCLUSIONS

1. From the experimental statistical and SEM investigations, following are the overall conclusions.
2. It is possible to produce concrete of M40 Compressive strength as that of control mix using GGBS at 50% replacement with cement and addition of polymer.
3. Addition of 2%, 3% polymer further improves the strength characteristics of concrete for 4% strength drops (Decreases).
4. Out of different % of polymer addition tried, 3% addition of polymer results in peak value compressive strength and split tensile strength for binary blend concrete and for ternary blend concrete 2% addition of Polymer in peak value compressive strength, split tensile strength.
5. Binary blend concrete containing polymer proves to be more economical than control mix hence where ever control mix can be used M40 is recommended.
6. Ternary blend concrete containing polymer proves to be more economical than control mix hence where ever control mix can be used M30 is recommended.
7. From Regression analysis it is observed that the equation generated is predicting values which are in close agreement with experimental values.
8. Results of Rebound Hammer and Ultrasonic Pulse Velocity tests are satisfactory.

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