International Research Journal of Multidisciplinary Science & Technology
www.irjmrs.com ISSN : 2455-930X

EXPERIMENTAL STUDY ON MECHANICAL PROPERTIES OF MULTI BLENDED CEMENT CONCRETE USING FLY ASH, SILICA FUME, RICE HUSK ASH AND LIME POWDER

Virgin Devi S[1], Thenmozhi.S Ph.D[2], Sastha Arumuga Pandi.S M.E[3]
[1]*P.G Student, Sree Sastha Institute of Engineering and Technology, Chennai.*
[2]*Professor, Dept. of Civil Engineering, Sree Sastha Institute of Engineering and Technology, Chennai.*
[3]*Assistant Professor, Dept. of Civil Engineering, Sree Sastha Institute of Engineering and Technology, Chennai.*

---***---

Abstract - *Concrete is a composite building material made from the combination of aggregate and a binder such as cement. The most common form of concrete is Portland cement concrete, which consists of mineral aggregate (generally gravel and sand), Portland cement and water. In concrete mix, cement and water form a "paste" or "matrix" which fills the voids of the fine aggregate and binds them together. Due to the scarcity of cement all over the world many researches are going on to replace the cement in the concrete mix. Hence it is necessary for us to find the alternative material to replace the cement. This study aims at finding out an appropriate replacement material for cement. In this project, cement has been partially replaced with fly ash, silica fume, and rice husk ash and lime powder. In order to reduce the cement content and thereby increase strength of concrete as blended cement concrete. Compressive Strength, Split tensile strength and flexural strength are investigated by casting cube, cylinder and beam specimens which are cured by ordinary water for 24 hours. The properties are tested at the age of 7 days and 28days.*

Keywords: cement replacement, multi blended cement concrete, mechanical properties.

1. INTRODUCTION

The production of cement is an energy intensive process, resulting in emission of greenhouse gases which adversely impact on the environment. At the same the cost of production of cement is increasing at alarming rate and natural resources giving the raw material for its manufacturing are depleting. The use of waste material having Cementitipus properties as a replacement of cement incement concrete has become the thrust area for construction material experts and researchers. The main focus now a day is on search of waste material or bye product from manufacturing processes, which can be used as partial replacement of cement in concrete, without compromising on its desired strength. The Fly ash (FA), Silica Fume (SF), Rice Husk Ash (RHA) and Lime Powder(LP) was waste product, which may be used as partial replacement of cement in concrete due to its inherent cementitious properties. In the country like India, where the development of the infrastructures projects such as large irrigation, road and building projects are either being constructed or in completion of their planning and design stage, such uses of waste material in cement concrete will not only reduce the emission of greenhouse gases but also will be the sustainable way of management of waste. The Fly ash (FA), Silica Fume, Rice Husk Ash (RHA) and Lime Powder(LP) are some of the pozzolanic materials which can be used in concrete as partial replacement of cement. A number of studies are going on in India as well as abroad to study the impact of use of these pozzolanic materials as cement replacements and the results are encouraging. These materials include fly ash, silica fume, Rice Husk Ash (RHA) and Lime Powder (LP) can be used separately or in combination. The strength , durability and other characteristic of concrete depends on the properties of its ingredients, proportion of mix, method of compaction and Concrete, other controls during placing and curing, For concretes, a combination of mineral and chemical admixtures is always essential to ensure achievement of the required strength.

2 .LITERATURE REVIEW

2.1 GENERAL

The recent development in mechanical properties of blended cement concrete materials added with fly ash, silica fume, rice husk ash, lime powder motivated the present study. In this chapter, the literature pertaining to the present study is reviewed and discussed here.

2.2 REVIEW BASED ON RICE HUSK ASH

M. Jamil *et al* (2013), this study was carried out to find the maximum pozzolanic (chemical) contribution of RHA in cementitious system in terms of replacement percentage. This study determines the chemical contribution of RHA on the basis of replacement percentage of RHA. The replacement percentage is determined as approximately 14.3% for ASTM type-I cement with 55% C3S and 19% C2S. This percentage could vary with the change of RHA composition or type of cement used. All the results found in this study are theoretical and based on the chemical reactions in the hydration process of cement. Results may also vary depending upon the percentage of C3S and C2S present in cement. There is also a good agreement between the theoretically found replacement percentage and the experimental results found in available literature.

Alireza Naji Givi *et al* (2011)**,** The RHA blended concrete can improve the workability of concrete compared to OPC. It can also increase the initial and also final setting time of cement pastes.RHA helps in enhancing the early age mechanical properties as well as long-term strength properties of cement concrete. The sulfate resistance of RHA concrete increases with increasing the RHA replacement level up to 40%. Using 30% RHA as A replacement of part of cement could be considered optimum for all content of W/C ratios in investigated mortars because of its high value of compressive strength

Ramezanianpour *et al* (2008), he showed that concrete incorporating RHA had higher compressive strength, splitting tensile strength and modulus of elasticity at various ages compared with that of the control concrete. In addition, results show that RHA as an artificial pozzolanic material has enhanced the durability of RHA concretes and reduced the chloride diffusion. In general, the RHA concrete had higher compressive strength at various ages and up to 90 days when compared with the control concrete. The results show that it was possible to obtain a compressive strength of as high as 46.9 MPa after 28 days. In addition, strengths up to 63.2 MPa were obtained at 90 days. He also declared that concrete containing RHA has a greater splitting tensile strength than that the control concrete at all ages. It is clear that, as the amount of RHA increases, the tensile strength increases up to 20%. For instance, at 90 days the 15%RHA concrete had a compressive strength of 5.62 MPa compared with 4.58 MPa for the control concrete

2.3REVIEW BASED ON FLY ASH

Thomas *et al* (2015), using fly ash in concrete structures influences heat of hydration and hence the internal temperature of concrete. Whether Fly ash is used as replacement of cement or as a mineral additive, it slows the chemical reaction between cement and water, limits the amount of heat generation and reduces the internal temperature rise, resulting in less thermal cracking and higher strength and more durable concrete structures

Mateusz Radlinski *et al* (2012) ,This research was primarily conducted to verify the presence of synergistic effects in ternary cementitious systems containing Portland cement (OPC), class C fly ash (FA) and silica fume (SF). For a ternary mixture containing 20% FA and 5% SF by mass, the synergistic effect was observed mostly at later ages (7 days onward) and it resulted in an increased compressive strength and resistance to chloride ion penetration as well as a reduced rate of water absorption (sorptivity) compared to predictions based on individual effects of FA and SF in respective binary systems. Instead, it was the result of smaller initial inter-particle spacing caused by lower specific gravities of both FA and SF which, in turn, led to a lower volumetric w/cm. If the mixture design was adjusted to account for these differences, the physical effect would be diminished.

Amit Mittal *et al* (2010), has said that, experimental study on use of fly ash in concrete to study the effect of partial replacement by fly ash, studies have been conducted on concrete mixes with 300 to 500 Kg/m^3 cementitious material at 20%, 30%, 40% and 50% replacement levels. In this paper the effect of fly ash on workability, setting time, density and compressive strength is studied. Use of fly ash improves the workability of concrete. This phenomenon can be used either to reduce the unit water content of mix or reduce the admixture dosage.

2.4 REVIEW BASED ON SILICA FUME

Debabrata Pradhan and D. Dutta *et al* (2015), investigated the effects of silica fume on conventional concrete concluded the optimum compressive strength was obtained at 20% cement replacement by silica fume at 24 hours, 7days and 28 days. Higher compressive strength resembles that the concrete incorporated with silica fume was high strength concrete.

Vishal S. Ghutke *et al* (2014), concluded from their result that silica fume was a better replacement of cement. The strength of concrete gained in silica fume was high as compared to the concrete of only cement. They performed various tests by varying the water -cement ratio from 0.5 to 0.6 and analyzed their results which concluded-As the water -cement ratio increases the strength of concrete decreases. The target value of compressive strength can be achieved at 10% replacement of silica fume. The strength of 15% replacement of cement by silica fume was greater than the normal concrete. Therefore the optimum silica fume replacement percentage varies from 10% to 15%. Compressive strength decrease s when the cement replacement was above 15% silica fume.

Faseyemi Victor Ajileye *et al* (2012), concluded cement replacement up to 10% with silica fume leads to increase in compressive strength for C30 grade of concrete. From 15% there is a decrease in compressive strength for 3, 7, 14 and 28 days curing period. It was observed that the compressive strength of C30 grade of concrete was increased from 16.15% to 29.24% and decrease from 23.98% to 20.22%.The maximum replacement level of silica fume was 10% for C30 grade of concrete.

2.5 REVIEW BASED ON LIME POWDER

Mateusz Radlinski *et al* (2011), this study is express the research on ternary blended cement concrete containing OPC, FA and lime powder. This shows that the ternary mixture containing 20% fly ash &5% silica fume achieved a high compressive strength at the later age (7 days and onwards).This ternary mixture not only achieve the later age strength but also resist the chloride ion penetration.

P. Thongsanitgarn *et al* (2011), In this study limestone powders with different particle sizes of 5, 10 and 20 µm were used to replace a part of Portland cement in different replacement levels to produce Portland-limestone cement pastes. The percentages of limestone replacement are 0, 5, 7.5, 10, 12.5, 15 and 20% by weight. The limestone particle size has influence on the observed compressive strength values. It was confirmed that compressive strength increased with the fineness of limestone. The compressive strength of Portland-limestonecement pastes decreased in all ages with an increasing amount of limestone due to the dilution effect.

Ramezanianpour and Malhotra *et al* (2007), High volume fly ash (HVFA) concrete that contain lime powder and fly ash in excess of 50% replacement levels have been produced with the fly ash inter ground with cement or 11added to the mixer as separate batch materials. The former also known as blended HVFA cements exhibit improvements in all properties (like mechanical strength, durability to freeze thaw resistance) except resistance to deicing salts when compared to the concrete in which the fly ash and cement were added separately at the mixer (Bouzoubaâ et al.2001). HVFA is also known to improve the later age performance to strength and chloride ion penetration.

3. MATERIAL AND METHOD

3.1 Cement

The cement used for present study was 53 grade ordinary Portland cement confirming to IS: 8112-1989. The preliminary tests on cement were conducted according to IS: 4031-1988 and results are tabulated in TABLE 1.

TABLE – 1: PROPERTIES OF CEMENT USED

Properties	Observed values
Specific gravity	3.15
Fineness	3%
Initial setting time	45 min
Final setting time	195 min
Soundness(Le chatelier method)	6

3.2 FINE AGGREGATE

River sand passing through IS 4.75 mm sieve confirming to zone III as per IS: 383-1970 was used as fine aggregate. The properties of fine aggregates determined are given in TABLE 2.

TABLE – 2: PROPERTIES OF FINE AGGREGATE

Properties	Observed values
Specific gravity	2.74
Fineness Modulus	2.46
Bulk Density	1587 kg/m^3
Percentage of Bulking	35%
Water Absorption	1.21%

3.3 COARSE AGGREGATE

Crushed granite stone with a maximum size of 20 mm was used as a coarse aggregate. The properties of coarse aggregates determined are given in TABLE 3.

TABLE – 3: PROPERTIES OF COARSE AGGREGATE

Properties	Observed values
Specific gravity	2.75
Fineness Modulus	6.89
Bulk Density	1534 kg/m^3
Aggregate Crushing Value	30.2
Aggregate Impact Value	34.1
Maximum Size of Aggregate	20mm
Water Absorption	0.69%

3.4 Fly ash

Fly ash is finely divided residue resulting from the combustion of powered coal and transported by the flue gases and collected by electrostatic precipitators. Fly ash supplies from ASHWIN CERAMICS, Chennai. Class C fly ash was used in this project. Properties of fly ash are depicted in TABLE 4.

3.5 Rice Husk Ash

Rice husk ash is obtained by burning rice husk in a control manner without causing environmental pollution. When properly burnt in high SiO_2 content and can be used as a concrete admixture. Properties of Rice Husk Ash are depicted in TABLE 4.

3.6 Lime Powder

The lime powder is made by crushing the limestone. The lime is the most important ingredients used in the manufacture of cement. The lime powder is very fine than any other admixtures. Because of its fineness nature it is used as fillers in the concrete in order to fill the pores that are present in the concrete during mixing of concrete.

Properties of Lime Powder are depicted in TABLE 4.

TABLE – 4: CHEMICAL PROPERTIES OF MATERIAL USED.

Constituents	Cement %	Fly Ash %	Silica Fume %	RHA %	Lime Powder %
Lime (CaO)	60-67	8.7	65.19	0.55	52.38
Silica (SiO_2)	17-25.	54.9	22.03	79.84	1.81
Alumina(Al_2O_3)	3-8	25.8	4.03	0.14	0.23
Iron Oxide (Fe_2O_3)	0.5-6	6.9	3.67	1.16	0.26
Magnesium Oxide(MgO)	0.1-4	1.8	0.88	0.19	0.26
Sulphur Trioxide(SO_3)	1.3-3	0.5	2.86	---	1.68

4 EXPERIMENTAL PROGRAM:

The concrete mix M30 grade is prepared as per the procedure given in the IS: 10262: 2009, and proportion of mix were 1:1.5:3.The replacements of OPC with waste product are made on an equal weight basis. The w/c ratio is taken 0.4% for all the mixes. The percentage for cementitious material in concrete is depicted in TABLE 5.

TABLE – 5: PERCENTAGE OF REPLACING CEMENT

	Cement %	Fly Ash %	Silica Fume %	Rice Hush Ash %	Lime Powder %
Mix 1	50	25	10	10	5
Mix 2	50	20	20	5	5
Mix 3	50	20	15	7.5	7.5
Mix 4	50	15	15	5	15
Mix 5	50	15	25	5	5

In this investigation 20 cubes, 20 cylinders and 20 beams specimen are tested. The Cubes with the dimension of 150x150x150mm,cylinder with dimension of 150mm diameter and 200mm height and beams with dimension of 1000 x 150 x150 mm are prepared for each batch of mixes to measure compressive strength, split tensile strength and flexural strength of concrete respectively at the age of 7 days and 28 days of curing.

All the specimens are kept in water tank for curing and thereafter tested as per IS norms and standard. All the cube specimens are tested for compressive strength in compression testing machine (CTM), all cylinder specimens are tested for split tensile strength in compression testing machine (CTM) and all beam specimens are tested for flexural strength in universal testing machine (UTM).

5. RESULTS

The compressive strength, split tensile strength and flexural strength of concrete containing various percentage of multi blended cement at the age of 7and 28 days are given in Table 6 ,7 & 8 respectively.

TABLE – 6: COMPRESSIVE STRENGTH (N/mm^2)

	7 days	28 days
Mix 1	18.15	39.24
Mix 2	18.98	38.75
Mix 3	19.58	38.21
Mix 4	19.44	37.11
Mix 5	18.36	38.28
Nominal	18.26	36.25

TABLE – 7: SPLIT TENSILE STRENGTH (N/mm^2)

	7 days	28 days
Mix 1	3.01	4.20
Mix 2	3.12	4.03
Mix 3	3.11	4.57
Mix 4	2.91	4.00
Mix 5	2.71	4.23
Nominal	2.71	4.20

TABLE – 8: FLEXURAL STRENGTH (N/mm^2)

	7 days	28 days
Mix 1	2.89	4.90
Mix 2	2.80	4.62
Mix 3	2.98	4.98
Mix 4	2.90	4.56
Mix 5	2.85	4.65
Nominal	2.92	4.70

6 CONCLUSIONS

The main aim of the study is to obtain the suitability material as replacement of OPC in concrete. The results of compression test and flexural test are shown in graphical form in Chart – 1, 2 and 3.

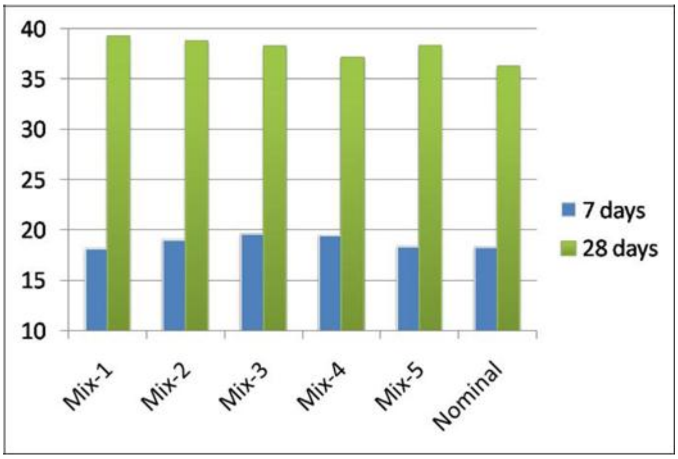

Chart -1: Compressive strength(N/mm^2)

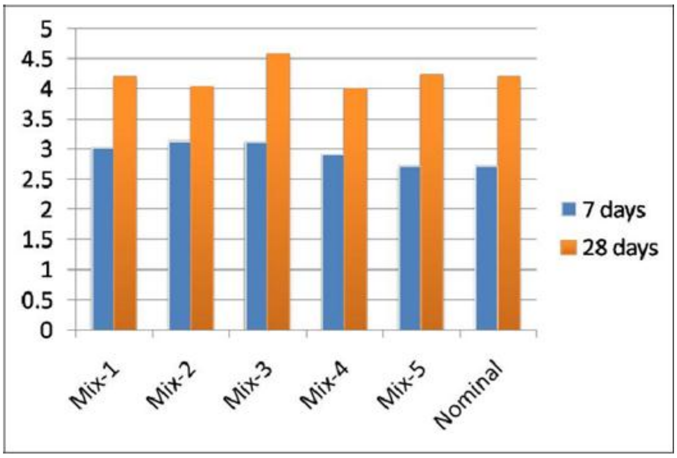

Chart -2: Spilt Tensile strength(N/mm^2)

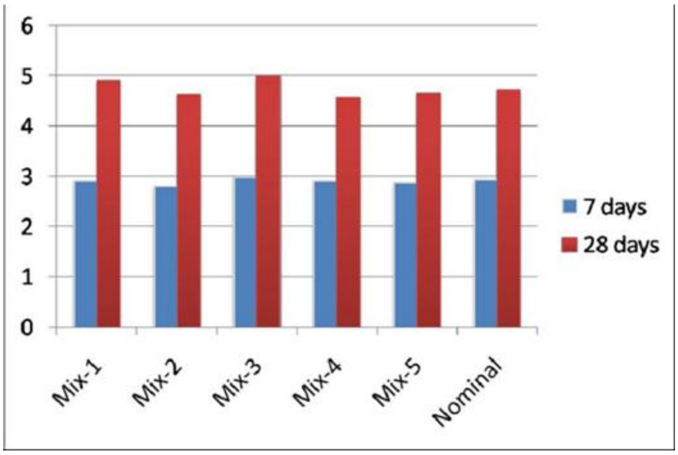

Chart -3: Flexural strength(N/mm^2)

The following conclusions are drawn from the study

- The result shows the blending of material have not compromised the strength in concrete.
- Strength of concrete slightly depends upon the percentage of materials being added.
- The partial replacement of opc in concrete by waste material facilitates environmental friendly disposal of the waste which is generated in huge quantity in industries.

REFERENCES

[1]. **R.Hariharan** "Effect of Ternary Cementitipus system on **A** compressive strength and resistance to Chloride ion penetration" (2011).
[2]. **]Mateusz Radlinski**"Investigation into the synergistic effects in ternary cementitious systems containing portland cement, fly ash and silica fume" (2012).
[3]. **Amit Mittal** "experimental study on use of fly ash in concrete" (2010).
[4]. **M. Mazloom** "Effect of silica fume on mechanical properties of high-strength concrete" (2004).
[5]. **TarunR.nai**k "Use of high volume class F fly ash for structural grade concrete".
[6]. **M. Jamil "**Pozzolanic contribution of rice husk ash in cementitious system"(2013).
[7]. **V. Saraswathy**"Corrosion performance of rice husk ash blended concrete" (2007).
[8]. **AlirezaNajiGivi** "Contribution of Rice Husk Ash to the Properties of Mortar and Concret"(2011).
[9]. **A.M. Fadzil "**Engineering Properties of Ternary Blended Cement Containing Rice Husk Ash and Fly Ash as Partial Cement Replacement Materials"(2008).
[10]. **A. A. Ramezanianpour "**The Effect of Rice Husk Ash on Mechanical Properties and Durability of Sustainable Concretes" (2008).
[11]. **P. Thongsanitgarn** "Effect of Limestone Powders on Compressive Strength and Setting Time of Portland-Limestone Cement Pastes"(2011).
[12]. **Nguyen Van Tuan "**The study of using rice husk ash to produce ultra high performance concrete"(2011).
[13]. **S. Bhanja "**Influence of silica fume on the tensile strength of concrete"(2004).
[14]. **A.M.Fadzil"** study on ternary blended concrete containing rice huk ash and fly ash"(2008).
[15]. **S. Turkel** "The effect of limestone powder, fly ash and silica fume on the properties of self-compacting repair mortars"(2009)