

# Experimental Investigation of Concrete Utilizing Rice Husk, Iron Slag and Silica Fumes to Enhance its Properties A Review

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## ABSTRACT

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As per the statistics India has used around 379 million metric tons of concrete in the financial year 2022 proving to be the most widely used construction material due to its versatility and holds the property of being customized as per the environmental requirement. Without the excessive usage of concrete, human development is impossible in today's reality. Concrete's most significant component is cement. Unfortunately, cement production emits a substantial amount of greenhouse gases and poses a significant threat to the environment.

As a result, lowering the reliance on cement for concrete strength is unavoidable for the long-term growth of human life.

This is the primary reason for seeking an appropriate cement substitute in order to get high-strength concrete at a reasonable cost. In addition, modern projects necessitate extremely high concrete strength, which can only be achieved by properly combining admixtures into the concrete. In India, industrial waste materials such as silica fume, rice husk ash, and iron slag are readily available. Their disposal has become pricey as a result of recent implemented norms and restrictions. As a result, it is vital to identify a viable use for these waste products. Because of their high siliceous content and pozzolanic qualities, these materials can be utilised to substitute cement in concrete mixes and as admixtures to achieve high strength. The two most significant parameters that determine the performance of concrete in any field application are flexural and compressive strengths. It's crucial to figure out how these admixtures affect concrete's flexural and compressive strength.

In this research we are presenting review of literature related to concrete technology.

**Keywords :** Replacement of Cement, Admixtures of Concrete, Flexural Strength, Compressive Strength.

## I. INTRODUCTION

Concrete is these days the most broadly utilized man-made construction material on the planet. It is obtained by blending cementitious materials, water, aggregate and infrequently admixtures in required extents. Green concrete is prepared using different biodegradable materials which can be designed in any shape which retains all the properties of traditional concrete and is sometimes capable of performing even better. The solidifying is caused by a chemical reaction between water and cement, which occurs over time, resulting in stronger concrete. Ordinary Portland Cement (OPC) is a key component in the manufacturing of concrete and has no substitute in the civil construction sector.

## II. Literature Review

Anitha J et.al (2016) the investigation was carried on performance of concrete with GGBS and different PCE based water reducing admixture the tests on compressive strength and Workability of the concrete with Ordinary Portland cement and Portland pozzolana cement with GGBS and admixture are carried out at different curing periods for M45 grade of concrete to conclude its behavior.

Results stated that Type B admixture gives good workability even after slump retention of 45min and can be used in places where very less loss of slump is required. Places where concrete with slightly less initial workability but good 1 day strength is required, type J admixture can be used. Loss of slump is slightly higher in PPC concrete than OPC concrete due to high surface area and more fineness. The concrete added with PCE based superplasticizers generally showed higher constancy in terms of performances and efficiency in terms of water reduction to attain the same initial workability in normal concrete without PCEs.

Rahul Chaudhary et.al (2017) In this project work cement was replaced with Mineral admixture by 5%,

10%, 15% and 20 %. Beams and cubes were casted for each replacement of cement. The concrete beams were tested after 7, 14, and 28 days from preparation and the cubes were tested after 7 and 28 days. The cement was replaced in concrete mix by mass while keeping all the other components constant. The beams and cubes were kept in fresh curing water at temperature  $27 \pm 2$  °C after the removal from mould and were tested in wet condition after taking them out from the water. The beams were tested by Third Point Loading Method according to IS: 516-1959.

Results stated that Silica fume gives the highest values of flexural and compressive strength as compared to RHA and iron slag. Iron slag can be suitably used as a replacement of cement as it is an abundantly available waste product and is also very cheap in comparison to silica fume and cement. Steel slag and silica fume gives high early strength to the concrete as compared to RHA and the concrete without any admixture. The compressive strength of concrete containing RHA is always lower than that of concrete without any replacement of cement.

Arossa et.al (2017) in the research paper, Fly ash and mineral powder was used for composite preparation of high strength lightweight aggregate concrete. The performance of concrete with different proportions of admixtures was investigated.

With increase in percentage of the ground fly ash from 30% to 40% with 10% of Silica Fume the strength of concrete is increased. There is a decrease in the strength when 40% of Fly Ash is added with 5 & 15% of Silica Fume. Results concluded that this deficiency could be overcome by using silica fume upto 10% only when added with fly ash.

Ruidong Wu and Juanhong Liu (2018) In order to study the performance of concrete with compound admixture of iron tailings and slag powder under low cement clinker system, the mixture ratio of different iron tailings powder and slag powder was designed to prepare C30 and C50 concrete. The workability, strength, carbonation depth, chloride diffusion coefficient, scanning electron microscopy (SEM), energy dispersive spectroscopy (EDS), and X-ray

diffraction (XRD) of concrete were measured, respectively.

The test results show that iron tailings powder is beneficial to improve the workability, and the strength of concrete decreases with the increase of iron tailings powder content, while the carbonation depth and chloride diffusion coefficient increase with the increase of iron tailings powder content. Under low cement clinker system, the iron tailings powder should not be used alone (below 70% of mineral admixture). When the ratio of iron tailings to slag powder is 1 :1, the strength, carbonation depth, chloride ion permeation coefficient, and the microstructure of concrete are roughly the same to that of concrete with single slag powder. So, the iron tailings powder can replace S95 grade slag powder in the same quantity. Iron tailings powder does not take part in hydration

reaction, but it can improve particle gradation, reach close accumulation, and increase the quantity of central grains.

Vishal Gadgihalli et.al (2017) research paper presented analysis of properties of concrete using potassium power as admixture and verified the strength of concrete and temperature emitted due to chemical reaction to normal Portland cement.

Results stated that using potassium as concrete admixture takes very less time that is 31 minutes 44 seconds for M20 and 33 minutes 52 seconds for M30 compared to normal concrete taking 34 minutes 13 seconds for M20 and 38 minutes 48 seconds for M30 grade concrete that is approximately 8% and 13% times faster in cooling by M20 and M30 grade of concrete respectively. Hence, the time for reduction of temperature has reduced by using potassium powder as chemical admixture.

Elah Olekwu Benjamin and Omeinijie Peter (2015) The research seeks to find the effect of Gum Arabic on some properties of cement and concrete at both fresh and hardened states. Properties of cement and concrete investigated include: setting times and shrinkage of cement, workability, compressive

strength and durability of concrete in acidic medium. Quantities of Gum Arabic added as admixture to the cement and concrete were 0%, 0.2%, 0.4%, 0.6%, 0.8% and 1.0% of the weight of cement. Cement pastes containing the above quantities of Gum Arabic were prepared and tested for shrinkage and setting times of cement. Similarly, concrete mix of 1:2:4 (cement: fine aggregate : coarse aggregate) was designed incorporating 0%, 0.2%, 0.4%, 0.6%, 0.8% and 1.0% of the weight of cement in the concrete mixes, varying the water/(cement + Gum Arabic) ratios. Trial mixes were design first to determine the optimum water/(cement + Gum Arabic) ratios which were used for the actual mixes for workability, compressive strength and durability of concrete in acidic medium.

The results of the investigation shows that Gum Arabic could be used as an admixture in concrete and that its use increases the shrinkage of cement, both the initial and final setting times of cement, improves the workability of concrete and reduces its water requirement and compressive strength of concrete but slightly improves its durability in acidic medium. Between 0.2% and 0.6% by weight of the cement is recommended for incorporation in concrete.

Legeto Cosmas Kirui et.al (2016) The research was set out to identify whether chemical admixtures are being used in the construction industry in Kenya and their influence on quality of concrete in a bid to solve the problem. The study adopted a mixed design approach which incorporates both qualitative and quantitative elements of research.

The study came to several conclusions key among them; that chemical admixture are used in the construction sector with good effect on the quality of concrete; chemical admixtures enable projects to be managed easily. The study recommended formulation of legislation to guide the use of admixtures which will lead to solving of the current challenges of counterfeit chemical admixtures, lack of proper training by contractors and lack of interest from building statutory bodies on its use.

A. A. Akindahunsi and H. C. Uzoegbo (2015) research paper examined properties of concrete, such as

strength, oxygen permeability and sorptivity using starch [cassava (CA) and maize (MS)] as admixtures. Concrete cubes containing different percentages of the CA and MS by weight of cement (0, 0.5, 1.0, 1.5 and 2.0 %) were cast. Compressive strength tests were carried out after 3, 7, 14, 21, 28, 56, 90, 180, 270 and 365 days of curing. Oxygen permeability and sorptivity tests were carried out on another set of concrete specimens with the same percentages of starch at 7, 28, 90, 180, 270 and 365 days. Oxygen permeability and sorptivity tests data obtained were subjected to Kruskal–Wallis one-way analysis of variance by ranks.

Results stated that incorporation of CA and MS starches into concrete improves the durability properties of the concrete. The statistical analyses of concrete mixed with different starches when compared with control indicated that generally concrete with starches performed better than control. However, overall the concretes with addition of different concentrations of MS starch performed better than concretes with different concentrations of CA starch.

G. K. Patel and S. V. Deo (2016) the objective of the research paper was to investigate the influence of natural organic materials (i.e. gram-flour, ghee and triphala) as admixture on the durability of concrete. A new method was proposed with 70% loading of average compressive strength to know the durability of concrete under practical conditions. Various experiments performed to identify the influence of natural organic

materials as admixture on durability of concrete. Electrical resistivity, ultrasonic pulse velocity (UPV) and carbonation tests were performed on hardened concrete for 0.4 and 0.45 w/c ratios.

The results stated that that addition of gram flour provided better durability in terms of electrical resistivity, UPV and carbonation for both the w/c ratios over normal concrete. Even under 70% loading, better durability results were noticed for concrete

with gram flour. Although for concrete with ghee and triphala poor results were noticed.

Rubaiyet Hafiza and Ahsan Habib (2015) research paper explored the effects of using fiber and admixture in the mechanical properties of the strength of concrete of different grades with primary concern to establish the divergence in the strength properties of M20, M25 and M30 concrete with addition of admixture and polymer fiber. The experimental program was planned to quantify the compressive strength of M20, M25 and M30 concrete using admixer and polymer fiber. This investigation was conducted to observe the effects of different additives on concrete, contributing in the compressive strength at various ages of curing.

Results stated that Admixture and polymer mixed concrete shows a slight increase in the compressive strength as compared to plain concrete. It was observed that polypropylene fibers have not contributed significantly towards compressive strength of concrete. Maximum compressive strength was achieved for admixture.

Nikhil NadhV. S and Jayasree S (2018) research paper intended to find the amount of black liquor sludge to be added in M30 and M50 concrete mixes for getting a slump of 100 mm with a water cement ratio of 0.35 for medium workability and to study its mechanical and flexural properties. The primary objective of the research was to develop concrete mixes of BLC30 and BLC50 (concrete of grade M30 and M50 with Black liquor sludge as admixture) for a slump of 100 mm with water cement ratio of 0.35 and find the mechanical and flexural properties of BLC30 and BLC50.

Results stated that the addition of Black liquor sludge of 20 and 25% by replacing water provided a slump of 100 mm in M30 C and M50 C mixes respectively. All the mechanical properties of BLC30 and BLC50 mixes were found to be within acceptable limit and satisfies

IS specification. The BLC30 and BLC50 beams showed similar behaviour with respect to control specimens. Hence Black liquor sludge can be

effectively used as admixture in concrete for increasing workability for both normal strength and high strength mixes. It can be also used for structural applications.

Deepshikha Jain and Jay Shah (2019) research paper presented a blend plan method for elite cement blends. Since rheological parameters and compressive quality are major properties of cement in two distinct phases of generation, the connection between rheological parameters and compressive quality has been utilized as opposed to utilizing water-bond proportion versus compressive quality relationship. Water-bond proportion and total volume to glue volume proportion has likewise been resolved from rheological conduct and utilized in the blend structure. In the proposed technique, the architect can evaluate parameters like compressive quality and efficient costing at the structure organize for a given target quality, notwithstanding elements of cement.

Results stated that steel fiber give more strength on the concrete but its cost is higher, so instead of steel fiber the rice straw and pieces of cement bags and get enough strength. Here more strength is achieved than the require strength in M25 grade so one can reduce the grade like M15 and get the target strength.

Salim Idris Malami et.al (2020) The objective of this research was to explore the effect of sawdust as an admixture in concrete as well as that of sodium chloride solution as a curing medium of concrete. Concrete cubes were casted by replacing 0%, 5%, 10% and 15% of sawdust by weight of cement as an admixture and the workability and compressive strength of concrete cubes at 7, 14, 21, and 28days was determined.

The results show that the slump value of the concrete mix reduces as the amount of the sawdust (admixture) increases. also there is progressive loss of compressive strength of cubes cured in 5% sodium chloride having concentration of 50,000PPT with increase in sawdust content of 0%, 5%, 10% and 15% ranged 17.56 N/mm<sup>2</sup> to 16.22 N/mm<sup>2</sup> at 7days, 22.27N/mm<sup>2</sup> to 16.92 N/mm<sup>2</sup> at 14days, 22.77 N/mm<sup>2</sup> to 20.09 N/mm<sup>2</sup> at 21days and 24.34 N/mm<sup>2</sup> to 21.45 N/mm<sup>2</sup>

at 28days respectively. The results further stated that Sodium Chloride has the properties of impurity reducing the strength of concrete and sawdust is not suitable to be used as admixture because it shows a progressive decrease in the compressive strength of concrete with a corresponding increase in its content.

Jacek Góra et.al (2019) The aim of the research paper was to evaluate the physical properties of lightweight concrete with perlite containing different polymer admixtures. Testing physical and strength properties of concrete with the addition of lightweight perlite in the amount of 10 and 20%. The additive was introduced by volume substituting a part of the sand. In addition, the effect of using siloxane admixtures and a vinyl acetate copolymer with different degree of dosing, as well as applied simultaneously, were analysed. The tests were carried out in the field of bulk density and proper density, determination of tightness and porosity, compressive strength and tensile strength after 28 days of maturation. In terms of durability of concrete, absorption and resistance of concretes to the freeze-up effects after 100 freezing and thawing cycles were tested. The results of the study were subjected to statistical analysis using the analysis of variance. The analysed factors of influence were the amount of perlite addition, as well as the type and amount of the added admixture.

In the case of “compressive strength of samples curing in water” at 28 days the strongest effect was the factor K, with 112 days effect size of all three factors was similar; The weakest interfacial transition zone (ITZ) observed through SEM analysis between the perlite aggregates and the cement paste contributed significantly to the worst physical and strength properties of this concrete.

J. Jaya Chandran and Ku. Mani Kandhan (2019) In the experimental investigation Calcium silicate hydrate(C-S-H) and Glass fiber are used to modify the mechanical behavior of the concrete. The percentage varies from 1%, 2% and 3% of chemical with constant of 0.1 % and 0.2% of glass fiber. The experimental work consist of casting RC Beam, Cube, Prism and Cylinder each specimen are curing for 7 days, 14 days, 28 days and testing this test specimen to evaluate the

behavior of concrete. The flexural strength of 1.2m beam also carried out by using ABAQUS software.

Results stated that the addition of calcium silicate and the glass fiber give the good mechanical properties such as compressive strength, flexural strength and split tensile strength are compared then convention concrete. It is established that makes M3 and

M6 mixes give the maximum strength limit. It show the admixture of calcium silicate and glass fiber increase the strength of concrete and reduce the cost effectively.

B. Karthikeyan et.al (2022) research paper discussed the permeation characteristics of concrete made by increasing the fineness of the conventional mineral admixtures and using them as a partial substitute for cement. Silica fume and metakaolin ground to ultrafine state and ceramic powder obtained from grinding waste ceramic tiles were used as mineral admixtures. The mixes were designed for a compressive strength of 50 MPa and were prepared for both binary and ternary blended cases. Binary blended specimens were cast, partially replacing cement with unground silica fume, ground silica fume, unground metakaolin, and ground metakaolin separately in different replacement proportions. Ternary blended mixes were prepared using ceramic powder in 4%, 9%, and 14% and with silica fume in a constant level of 1% percentage. All the cast specimens were compared against the control concrete. A deeper comparative analysis was also made by comparing the performance of specimens made with unground mineral admixtures with that of ground mineral admixtures. Various parameters such as resistance against water absorption, percentage of voids, and sorptivity characteristics were investigated. It was observed that increasing the fineness helps fill up the pores, thereby improving the resistance to permeation action.

### III. CONCLUSION

Here authors state that concrete properties can be enhance or can be deplete utilizing various admixtures. Even waste materials of industries can be initiate to use in concrete technology

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