IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 11, May 2023

Use of Wheat Straw Ash as a Partial Replacement to Cement - A Review

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Abstract: *The present study investigates the use of wheat straw ash(WSA) as a partial replacement to cement by weight in concrete. India is a major wheat producing nation in the world. Hence a lot of agricultural waste is generated from the milling process of wheat. This waste is mostly burnt in the fields to avoid the cost related with disposal. Investigations by researchers revealed that the ash obtained from the burning process was rich in silica and its elemental composition indicated presence of around 75% silica in the ash. Silica dioxide is responsible for high strength of concrete. In this study the author reviews various studies related to wheat straw ash and its effect on the mechanical and durability properties of concrete.*

Keywords: Wheat Straw Ash, Mechanical Durability, Permeability, Pozzolanic.

I. INTRODUCTION

Cement is one of the most used manmade materials. As the demand for infrastructure increases due to growing population the demand for cement also increases. As cement is not an energy efficient material, due to the use of cement the carbon footprint also increases, thereby causing global warming and climate change. Also, as wheat cultivation generates a lot of waste, disposing off this waste in landfills or burning it in the open also causes air pollution. This polluted air permeates into the concrete due to large pore size of concrete and leads to corrosion of the concrete structures. One more constructive use that this waste can be put to is, as partial replacement to cement by weight of cement. Using WSA as partial replacement to cement will address these problems caused due to open waste burning as well as reduction in the utilization of cement.

The present study reviews the use of wheat straw ash used in different studies as partial replacement to cement by weight to improve the mechanical and durability properties of concrete.

II. LITERATURE REVIEW

John Bensted and Juliet Munn presented a discussion on the paper presented by H.Birick et.al on the use of wheat straw ash which has very high silica content and also good pozzolanic properties. He concluded that though wheat straw ash has very good pozzolanic properties but it's used as partial replacement to cement can be further investigated for finding its feasibility to be used as partial replacement to cement in concrete[1].

D.Verma et.al.(2012) identified different agricultural wastes which can be usedto manufacture fibre reinforced polymer to be used commercially. He further concluded that Natural fabric-based thermoset composites are generally lower in strength performance compared to other hybrid composites, though they are advantageous in design flexibility, cost effectiveness, lack of health-hazard problems and recycling possibilities[2].

Niveta Jain et.al. (2013) presented a study, investigating the effect of the open burning of the agricultural wastes(AW) leading to increasing health problems due to deteriorating air quality index. She stressed that India being an agricultural country burning of these AWs in theopen leads to emission of greenhouse gases (GHG's) and hence increases the concentration of (CO2, N2O, CH4), air pollutants (CO, NH3, NOx, SO2, NMHC, volatile organic compounds), particulates matter and smoke thereby posing threat to human health. The study presented state wise statistics of the presence of these harmful gases in the environment leading to health hazards. They further stressed the need to create awareness amongst the farming communities about the negative impacts of crop biomass burning and importance of crop residues incorporation in soil for maintaining sustainable agricultural productivity[3].

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Shazim Ali Memon(2018) investigated the use of wheat straw ash in different ways. He established that wheat straw ash can be used in different ways like, as a cement composite abetting in the production of environmentally friendly concrete. As the combustion rate of this fully dried wheat straw ash is high it can be used as fuel for electricity production thus adding economic value to wheat straw[4].

Irfan Ali Shar et.al. (2019) presented a study utilizing wheat straw ash as a partial replacement to cement in different percentages varying from 5% to 20%.The results showed that replacement of cement with wheat straw ash at 10 % produced concrete with maximum compressive strength while for 20% replacement the compressive strength was the minimum. They further concluded that the low particle strength of WSA was responsible for filling all the voids in the concrete resulting in a denser and more compact concrete at 10% replacement of cement with WSA[5].They also stressed that the waste generated from the power plant is obtained in the form of ash. This ash can then be used as partial replacement to cement in concrete due to its high silica content and good pozzolanic properties [4].

Naraindas Bheel et.al.(2021) presented the results from the experimental investigation of the use of wheat straw ash (WSA) as a partial replacement to Portland cement in concrete mixtures. The WSA was used to replace Portland cement up to 20% and the corresponding mechanical performance of the concrete mixtures evaluated. The mechanical performance of the concrete mixtures was evaluated in terms of its compressive strength, modulus of elasticity, split tensile strength and flexural strength[5].

Naraindas Bheel et.al.(2021) used wheat straw ash as a partial replacement to sand in concrete in percentages varying from 10% to 50% with jute fibres as reinforcement. They concluded that for 30 % replacement of cement with wheat straw ash along with 0.5% of jute fibre as reinforcement was the optimum content and it fetched best results. The experimental results indicated that the compressive, splitting tensile, and flexural strengths improved by 32.88 MPa, 3.80 MPa,and 5.30 MPa at 28 days consistently. Similarly, the modulus of elasticity increased while the dosages of jute fiber and WSA increased together in concrete but the permeability and workability of concrete reduced while using jute fiber and WSA together in concrete[6].

Osama Zaid et.al. (2022) used a combination of wheat straw ash and grapheme oxide to investigate the durability properties of concrete. He concluded that the optimum content of wheat straw ash and grapheme oxide was 15% and 0.06% respectively which increased the mechanical and durability properties like compressive strength to 57.3 MPa, split tensile and flexural strength by 33% and 49%, and reduced water absorption, sorptivity, and resistance against acid to 14%, 21%, and 5.6%. Incrementing the dose of graphene oxide to more than 0.060% led to a decline in mechanical strength and durability behavior[7].

Ayaz Ahmed Babar et.al.(2022) revealed that the optimum replacement percentage of 10% gave best results for wheat straw ash as a partial replacement to cement in concrete increasing the compressive strength, and decreasing the unit weights. Workability and water absorption of concrete increased because proportion of WSA increased. This study may be used as one of the reference points towards an eco-friendly approach in the construction industry as the WSA showed positive results over cement[8].

III. OBSERVATIONS FROM THE EXISTING LITERATURE

The existing literature indicates that wheat straw ash enhances the rheological properties of concrete due to its high silica content and low particle size. Though the low particle size increases the surface area and hence the water demand of concrete, it is seen to improve the mechanical adurability property of concrete.

IV. CONCLUSION

The use of wheat straw ash as partial replacement to cement improves the rheological properties of concrete. This is an indication that wheat straw ash can be used as a potential construction material, also providing an effective waste disposal method. The use of wheat straw ash as partial replacement to cement reduces the use of cement which is a major source of greenhouse gas emissions.

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