iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** XII **Month of publication:** December 2022

DOI: https://doi.org/10.22214/ijraset.2022.48304

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue XII Dec 2022- Available at www.ijraset.com

Influence of Coconut Shell Ash and Glass Powder as Partial Replacement of Cement in Concrete: An Experimental Study

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Abstract: ***The amount of garbage generated by industrial and agricultural activities on the earth's surface has given rise to concerns about the environment's sustainability and the planet's ecosystem. Because waste generation generates CO2 and other hazardous gases during disposal or manufacturing, it contributes to global warming. In this investigation, the cement is replaced by waste materials such as Coconut Shell Ash (CSA) and Glass Powder (GP). Using CSA and GP with cement replacements of 0%, 2.5%, 5%, 7.5%, 10%, and 12.5%, more than 108 specimens have been prepared in laboratory and examined. After being mix designed , the concrete is mixed in a ratio of 1:2.03:3.10 by weight of cement sand and coarse aggregate at water/cement ratio of 0.55. Initial setting, final setting time, compressive strength, split tensile strength, and flexural strength are among the qualities of concrete and cement that have been investigated.***
Keywords: garbage, industrial, Glass Powder, aggregate, concrete.

I. INTRODUCTION

Concrete is a blend of coarse aggregate, fine aggregate (sand), admixtures and water. Today Global Warming (GW) and environmental pollution have become manifest harms in early and recent years, concern about environmental issues. It can happen due to use and production of the mass-waste, mass consumption, mass-production. Normally it can see that glass does not harm to environment due to not produced pollutants matter but it can harm animal as well as human shortly when we do not take care off that time it harmful and it is not non-biodegradable. For that we required new technologies to overcome them from this problem. The glass has many chemical diversities like Soda-lime Silicate Glass, Alkali- Silicate Glass and Boro-Silicate Glass. These all types of glasses generally used in Civil Engineering work as Pozzolana. The Alkali contents increases the properties of cement. It also used in brick manufacturing & ceramic manufacture. The useful and recycled materials, glasses and glass powder are mainly used in various Civil Engineering project because glass powder as supplementary cementitious material and coarse aggregate. All type of glass is near to 100% recyclable. It also increases concrete durability without affects any property in concrete. In recently glass and glass powder has used as a construction material for reducing environmental pollution. In concrete mixed the coarse & fine glass aggregate produced Alkali Silica Reaction (ASR) but this problem can not happen in the case of glass powder because it has Supplementary Cementitious Material (SCM). Therefore, glass powder used as replacement of SCM.(Gautam et al.. (2016)).

II. LITERATURE REVIEW

Vanjare and Mahure (2012) The prospect of utilising waste materials in the creation of novel concrete is the main goal of this study. Glass Powder was recognised as one type of trash (GP). Different percentages of this waste (GP) were suggested to be used in place of cement while producing self-compacting concrete. By focusing on each component's unique function in self-compacting concrete, the study addresses the components of these combinations (glass powder, fly ash, super plasticizer, and cement).

Vasudevan and pillay (2013) This research was done to find out how utilising discarded glass powder in concrete will affect it. To evaluate the effectiveness of the control sample and the concrete containing recycled waste glass powder, laboratory testing was done. The workability test, density test, and compressive strength test were used to evaluate how well these types of concrete performed. The slump test and compacting factor test are used to evaluate the workability of concrete. In the meantime, concrete's strength is assessed using a compressive strength test. Six 150mm x 150mm x 150mm cubes total one for each type of concrete were cast. The cubes were put to the test at 7, 14, and 28 days to observe how compressive strength developed. According to the findings, waste glass powder was able to improve both the compressive strength and workability of concrete. However, compared to a conventional concrete mixture, the density is lower.

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Patil and Sangle (2013) Cement, aggregates (including fine and coarse aggregates), water, and admixtures make up the building material known as concrete. The usage of Portland cement substitutes is currently the subject of numerous studies employing waste materials including crushed granulated blast furnace slag and pulverised fly ash (PFA) (GGBS). In addition to being utilised as a partial replacement for cement during the time of hydration, waste glass powder (GLP), like PFA and GGBS, is employed as a binder. It also serves as a filler. The concrete element, cement, has been replaced in this investigation with waste glass powders, and mechanical qualities including compressive strength are assessed. Additionally, we investigated the size influence of glass powder on concrete strength. Glass powder is used to substitute cement at 10%, 20%, and 30% in order to test the influence on strength. Glass powder is separated into two grades, one with particle sizes less than 90 microns and the other with sizes ranging from 90 microns to 150 microns, for the investigation of the size effect of glass powder. According to the study, the initial strength gain caused by the addition of GLP on the seventh day is quite low, but it increases on the 28th day. It has been discovered that adding 20% more GLP increases strength. Additionally, GLPs smaller than 90 microns are particularly effective at boosting strength.

Shekhawat and Aggrawal (2014) One of the most frequently utilised building materials worldwide is concrete. However, the creation of portland cement, a necessary component of concrete, results in the release of a sizable amount of CO2, a greenhouse gas; it is estimated that the manufacturing of one tonne of portland cement clinker produces about one tonne of CO2 and other greenhouse gases (GHGs). The sustainable growth of the cement and concrete industries is heavily influenced by environmental concerns. To reduce cement consumption and to some extent lessen environmental pollution, some pozzolanic material must be used in place of some cement. Some industrial wastes, including fly ash, silica fume, blast furnace slag, and others, have already proven useful in the production of concrete. Recent studies have demonstrated that waste glass can be used successfully in concrete as a glass pozzolana or as glass aggregate. Due to its high silica content, waste glass exhibits certain pozzolanic qualities when ground to an extremely fine powder. As a result, glass powder can partially replace cement and contribute to the development of strength while also improving durability properties.

Kumar and Raju (2014) The atmosphere is polluted by greenhouse gases like CO2, which contribute to global warming. CO2 makes up roughly 65% of the greenhouse gases that cause global warming. About 7% of the world's total greenhouse gas emissions come from the cement industry. As a result, efforts have been made in the concrete industry to partially substitute cement and coarse or fine aggregates with waste materials. Waste glass is one material that exhibits pozzolanic qualities when ground to an extremely fine powder and can be used in concrete as a partial replacement for cement.

Bhat and Rao (2014) Glass is frequently utilised in the construction and building industries, and a lot of glass is ground up every day. Glass garbage poses a problem for disposal, which has an impact on the environment. The need for low-cost materials to strengthen concrete structures is being felt by the construction sector. Glass powder with a grain size of less than 600 is said to exhibit pozzolanic behaviour. An effort is undertaken to look into the viability of replacing some of the standard Portland cement in concrete with waste glass powder. Concrete with cement replacements of 5%, 10%, 15%, and 20% made from waste glass powder was manufactured, and the attributes of this concrete were compared to those of control mix concrete without replacement. Cube specimens were cast, cured, and tested for 7-day and 28-day strength. There were 24 of them. The outcomes of a compression test were compared.

The results showed that as more glass powder was used in place of cement, the compressive strength increased. There are substitutes for glass powder that can be used to lower the demand for cement. The substitution of glass powder reduces both the unit weight and porosity, as shown by the reduction in water absorption. It lowers the amount of cement needed to make concrete. Additionally, glass powder has shown to be affordable and is regarded as an environmentally benign building material.

Kumar et al. (2014), explained one of the most attractive options of managing such wastes is to look into the possibility of waste minimization and re-use. The cost of cement used in concrete works is on the increase and unaffordable, yet the need for housing and other constructions requiring this material keeps growing with increasing population, thus the need to find alternative binding materials that can be used solely or in partial replacement of cement. Agricultural waste material, in this case, coconut shells, which is an environmental pollutant, are collected and burnt in the open air (uncontrolled combustion) for three hours and that product is incinerated in muffle furnace at 800o C for 6 hrs to produce coconut shell ash (CSA), which in turn was used as pozzolana in partial replacement of cement in concrete production. Concrete mortar cubes were produced using replacement levels of 0 and 5 percent of OPC with CSA. The Coconut Shell ash is used for the partial replacement of cement. Further, use of coconut shell ash as a value-added material as in the case of binary blended cement concrete, reduces the consumption of cement. Reduction of cement usage will reduce the production of cement which in turn cut the CO2 emissions. The time has come for the review of progress made in the field of development of binary blended cement concrete.

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Subramani and Sankar Ram (2015) A source of carbon dioxide emissions alongside deforestation and the use of fossil fuels is the cement making business. The atmosphere is polluted by greenhouse gases like CO2, which contribute to global warming. CO2 makes up roughly 65% of the greenhouse gases that cause global warming. About 7% of the world's total greenhouse gas emissions come from the cement industry.

In daily life, glass is used in a variety of ways. It has a short lifespan and is either stored after use or dumped in landfills. Glass cannot decompose in landfills, thus that is why they are not an environmentally beneficial alternative. Therefore, it is imperative to use leftover glasses. There have been numerous attempts to replace cement, fine aggregate, and coarse aggregate in the concrete industry with recycled glass.

Its effectiveness as a replacement for coarse aggregate has been found to be unsatisfactory due to strength regression and expansion brought on by the alkali-silica reaction. The study demonstrates that fine aggregate replacement also results in a loss of strength. Waste glass has been attempted to partially replace cement and coarse or fine aggregates in the concrete industry. In this study, the performance of normal concrete and concrete made from finely pulverised waste glasses is examined. In this study, the potential use of glass powder to partially substitute cement in fresh concrete is investigated. From the results obtained, it is found that glass powder can be used as cement replacement material up to particle size less than 75 m to prevent alkali silica reaction. Glass powder was partially replaced as 10%, 20%, 30%, and 40% and tested for its compressive, tensile, and flexural strength up to 28 days of age.

Sharma and Sangamnerkar (2015) The goal of the research is to assess the effects of using fine glass powder in place of cement, evaluate the pozzolanic character of the resulting concrete, and compare the results to other pozzolanic materials used in concrete, such as fly ash and silica fume.

The current study demonstrates that waste glass exhibits pozzolanic behaviour when ground to a fineness of less than 600 m. Early in the hydration process, it combines with lime to produce more CSH gel and a denser cement matrix. As a result, early alkali consumption by glass particles aids in reducing the alkali-silica interaction, increasing the durability of concrete. Numerous tests were carried out to determine the impact of replacing 5%, 10%, and 15% of the cement with glass powder on compressive strength and durability.

Glass powder with a size range of 600 m to 100 m was used to test the impact of particle size. The findings indicated that 10% replacement of concrete with glass powder produced the greatest increase in concrete strength.

III.MATERIAL USED

A. Cement

Cement formed by crushing, burning and then grinding of the clinker. These clinkers formed by Siliceous, Argillaceous and Calcareous stones. Cement play binding role in concrete mixture while water is added in concrete mixed. Ordinary Portland cement, rapid hardening cement, high alumina cement, super sulphated cement etc. are different types of cement available in the markets and it used different site condition and different desirable purposes

B. Cement Compounds

In Civil Engineering Construction Portland cement is primary material spread in the world. It has 4 principal compounds which known as clinker factors (C3S, C2S, C3S and C4AF) respectively. These compound present in the range of 45-60 %, 15-30%, 6-12% & 6-8 % respectively. The C3S and C2S compound are provide strength in the cement paste for that reason it is more important to another compound. These all compound responsible for strengthing of cement at different ages of water curing .



Figure 1 OPC Cement (43 Grade)

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C. Coarse Aggregate

Aggregate is in natural or crushed state and also has collective term for sand gravel and crushed stone. Concrete is a mixture cementing material .Natural sand and gravel deposits, crushed rock, slag and mine refuse etc. is main source of aggregate. Aggregate is present in natural condition as well as man manufactured. It is generally extracted from larger rock formation or blasted to reduce size after that crushed stone screening to find different size of aggregate. Manufactured rock typically consists of industrial byproducts such as slag (byproducts of the metallurgical processing- typically produced from processing steel, tin copper) or specialty rock that is produced to have a particular physical characteristic not found in natural rock (such as the low density of lightweight aggregate). Aggregates typically constitute 75% of volume in concrete. In my whole thesis work I used maximum size of aggregate of 20mm and which is manufactured by man construction. To provide a rigid skeletal structure and reduce the space occupied by the cement paste is required proper size of aggregate. In this present study three most common type of light, normal & heavy weight aggregate. Natural & artificial aggregate considered as normal weight aggregate.

In my thesis work I used 20 mm and 10 mm size aggregate with 50:50 proportion and also calculate SG (Specific Gravity) and FM (Fineness Modulus) after removing of dust and dirt.



Figure 2 Aggregates of nominal size (20 mm and 10 mm)

IV. CONCLUSION

Based on the above study following conclusions can be made:

1) CSA and GP waste material improves the compressive strength, split tensile strength and flexural strength of concrete.

2) The addition of waste CSA and GP does not affect very much the density of concrete mix.

3) The addition of waste CSA and GP increases the strength of concrete for all curing ages up to a certain point. After that there is an abrupt reduction in the strength of the CSA & GP mixed concrete. Because at higher dosage, concrete loses its ability to make a proper bond.

4) The gradual increase seen in the compressive strength of Coconut Shell Ash and Glass Powder mixed concrete at 7 days and 28 days curing with 10% addition of CSA and GP in the amount of 2.844 N/mm2 and 2.902 N/mm2 respectively but after that it starts reducing the compressive strength with increase of CSA and GP addition.

V. ACKNOWLEDGMENT

This work was completed with the grants and facilities of Lakshmi Narain College of Technology, Bhopal (M.P.). Authors are thankful to this institute and faculties for extending this cooperation.

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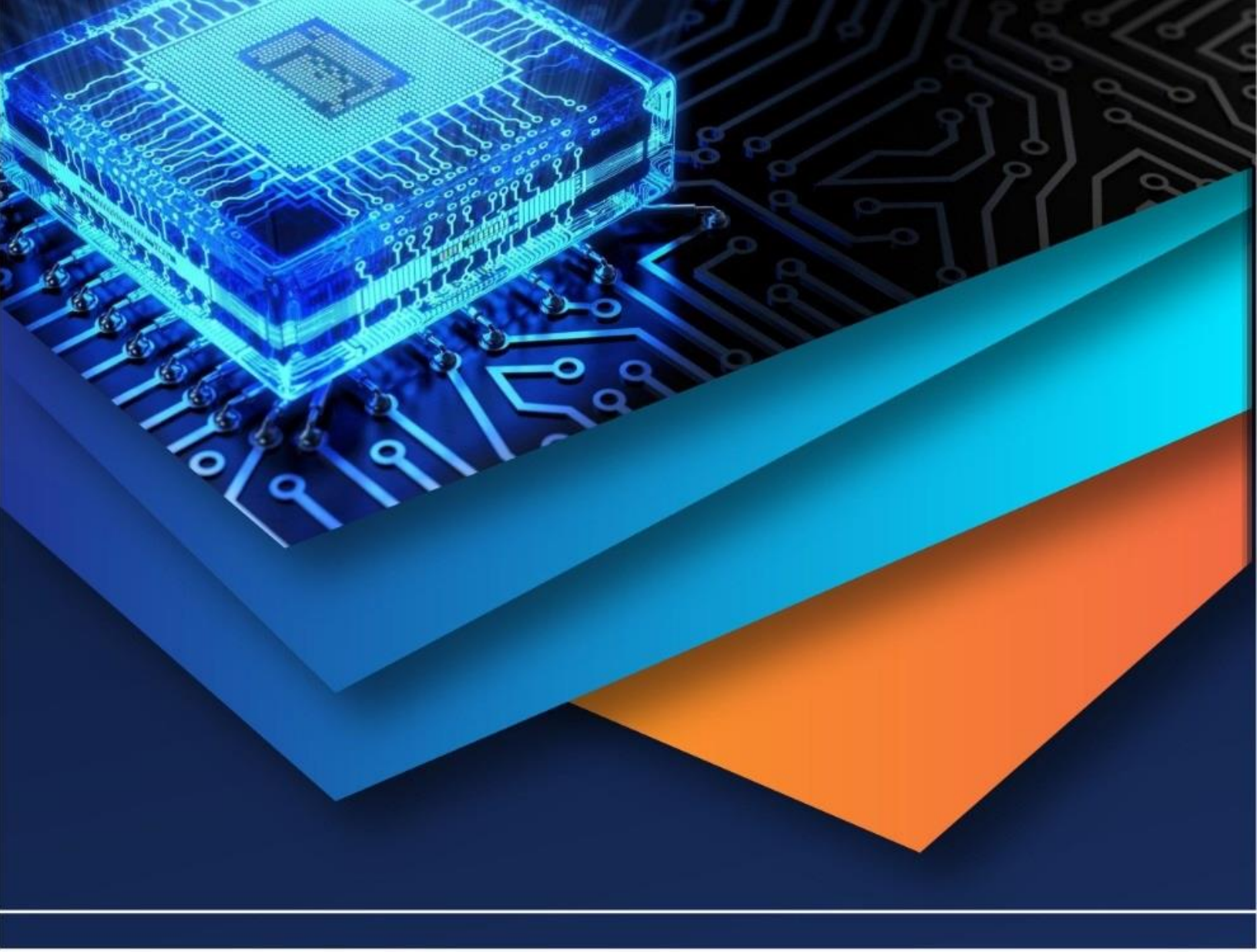
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