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A REVIEW "PARTIAL REPLACEMENT OF GLASS POWDER AS A CEMENTITIOUS MATERIAL ON STRENGTH PROPERTIES OF DIFFERENT GRADES OF CONCRETE: AN EXPERIMENTAL INVESTIGATION"

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ABSTRACT
Glass scrap from various sources may be gathered Cement, the most valuable component of concrete and the most widely used building material worldwide, has an impact on both the price and the quality of concrete. On the other side, the production of cement is one of the industries that contribute to global warming by producing carbon dioxide. However, using waste products and by-products in place of cement has become a popular alternative because it lowers the price of producing cement and concrete and has numerous additional indirect advantages, including lower energy costs, lower landfill costs, and environmental protection from pollution. One of the waste products that pollutes the environment the most today is broken glass. The glass powder (GP) of waste glass was investigated in this thesis as a partial cement replacement material in concrete with five different proportions (0%, 10%, 20%, 30%, and 40%) for different concrete mixes (M10, M15, M20, M25,). GP can be utilised as a cement substitute and can enhance the physical and mechanical qualities of concrete for every type of concrete mix examined in this present study, according to experimental results. The results shows workability increases up to 60% withmixing GP as 30% replacement. Similarly compressive strength increases up to 18% ,Flexural strength increases up to 22% and split tensile strength increases up to 13% in 28 days by replacing 20 % GP.

Keywords:
Grades of Concrete, Glass Powder, Workability, Compressive strength, Flexural strength, Split tensile strength.

INTRODUCTION
Glass scrap from various sources may be gathered and repurposed in the cement and concrete manufacturing industry. Through the substitution of aggregates, cement, and cementitious admixtures, it is probable that several recovery channels will open up, providing the construction sector with practical answers for taking part in sustainable growth. Glass is mostly made of silica, thus using it as a partial substitute for cement in concrete might be an environmentally friendly technical-economical answer.
This is what motivated us to use recycled glass powder in order to create a more durable and lightweight concrete, with a particular attention carried on the characterising of various samples of recycled glass powder beforehand using FTRI and FRX to see their chemical constitution.
Concrete is the most common building material worldwide. In comparison to other materials likesteel, wood, aluminium, and plastics, it is used twice as much globally. Cement is the most activeand significant component of concrete.
It has been proved that cement serves as the binding agent for other composition elements, and it occupies 7% to 15% as rate in the concrete matrix, meaning that cement is a crucial component.
The study for a waste material with pozzolanic tendency to substitute cement—such as waste glass,

rice husk, blast furnace slag—was aided by numerous researchers.
The world's atmospheric CO2 emissions from the cement industry range from 5% to 8%, whichis substantially to blame for the rise in greenhouse gas effects and a major driver of climate change.

LITERATURE SURVEY

Hakim *et al* (2024) Concrete typically emerges as the superior choice in terms of strength, adaptability, longevity, noise reduction, energy efficiency, and it additionally possesses the advantage of being fully recyclable. The excessive consumption of natural resources such as sand in traditional concrete production poses environmental concerns and makes concrete production as a significant contributor to greenhouse gas emissions. By using waste glass powder as a partial substitute for fine aggregate, the study explores the potential to lower the carbon footprint of concrete, to reduce the reliance on virgin materials, minimize waste generation, and promote sustainable practices in the construction sector and finally contributing to climate change mitigation and environmental stewardship. Also, it can offer cost savings, as waste glass is often readily available at low cost, reducing the dependence on expensive virgin materials. This article assesses the workability, durability, compressive, flexural, and tensile strength of concrete when waste glass powder is used as a partial substitute for fine aggregate. Additionally, it provides a comprehensive summary of the current state of knowledge on this topic, evaluating the outcomes of previous studies, methodologies, and limitations. This review paper aids in understanding the progress made in this field and identifying areas that require further investigation.

Daban A. Muhedin (2023) The use of waste materials in concrete is now a global trend for effective waste management in order to create a sustainable, eco-friendly concrete. This has the added benefits of protecting natural resources by means of producing more sustainable concrete that has better mechanical properties. This study investigates the characteristics of concrete that contains waste glass powder (WGP) as partial replacement of cement and sand. Laboratory tests were performed to determine the compressive strength and split tensile strength of concrete with 0%, 5%, 10%, 15% and 20% partial replacement of cement and sand separately by WGP after 7, 28, 60 and 90 days of moist curing. Microstructural investigations of X-ray diffractometry (XRD) and scanning electron microscopy (SEM) were performed to determine the effect of WGP on the microstructure of concrete. Results has shown that compressive strength of concrete can be improved to a considerable value at 7, 28, 60 and 90 days when WGP is used as partial replacement of cement by 5%, 10% and 15%, which can be considered as a reasonable amount in producing sustainable concrete. Further replacement percentages resulted in a decrease in compressive strength. WGP enhances the microstructure of concrete in the term of pozzolanic activity and decreasing the microcracks.

Gupta et al. (2022) A significant amount of glass (such as beverage, soda-lime, toughened,float, and mirror glass) is manufactured around the world for use in creating and producing adaptable items that can be used for a variety of purposes. A small portion of this enormous amount of glass is recycled, while the remainder is thrown in open spaces. The project aims to create tangible, environmentally friendly products and sheds light on the better use and utilisation of waste glass. Consequently, there is increased interest among researchers in using glass waste in place of cement and aggregate in construction. In order to describe the various cement substitutes made from recycled drinking glasses, this study examined the durability attributes of the concrete that was produced. Different weights ranging from 0 to 40% at 5% intervals have been utilised for the cement replacement. The impact on waste glass concrete's mechanical (compression, flexural, and abrasion), water absorption, density, permeability, and strength loss characteristics is evaluated. The replacement dosages given to the glass's concrete play a direct part in the concrete's features. The experimental examination demonstrates several significant effects for such beverage glass waste replacement powders, including a reduction in the density and water absorption. The main cause of the refining of the voids, which results inthe formation of C-S-H gel, also known as calcium silicate hydrates, is the reaction betweenglass waste powder and calcium hydroxides, or (Ca(OH)2); these processes are known as

pozzolanic reactions. However, after being exposed to sulphates for 90 days, concrete containingwaste glass exhibits greater sulphate resistance in terms of compressive strength.

Ibrahim (2021) Waste glass (WG) causes serious environmental issues, in part because WG Rivers are inconsistent. Concrete manufacturing has used a number of strategies to achieve this goal in response to growing environmental difficulties to reduce solid wastes and reuse them as much as feasible. This study's main objective is to investigate the suitability and impact of using waste glass powder (WGP) as a partial replacement for cement weight in three different types of concrete. Ordinary concrete, concrete having silica fume (SF), and concrete with fly ash arethese three crucial varieties (FA). 0%, 5%, 10%, 15%, and 20% were the WGP replacement percentages based on cement weight. Both both the hardened and fresh stages of concrete, some mechanical and other properties have been studied. The test results demonstrated that using WGP as cement in concrete was appropriate. Ordinary concrete (group 1) has compressive and tensile strengths that are increased by 5% WGP in comparison to the control mix without waste glass powder by around 8% and 13%, respectively. The compressive and tensile strengths of silica fume and fly ash concrete (groups 2, 3) decreased in comparison to control concretes at all ratios of WGP replacement. At a 20% WGP ratio, this reduction was around 13%–14%, respectively. In addition, compared to reference concretes [0%WGP], plain, SF, and FA concrete mixes with the proportions 5%–20% WGP as a partial replacement of cement weight had lower water absorption and density. Ordinary concrete (group 1) lost about 3% of its fresh and dry density compared to control concrete at a 20% WGP ratio. When compared to control concrete [0%WGP], the decreasing ratios of water absorption for groups 1, 2, and 3 specimens built of 20% WGP are 27,78%, 14.75%, and 18.75%, respectively. For all of the concrete types used in this investigation, increasing the WGP concentration improved workability.

Nath et al. (2020) Self-compacting concrete is a high performance concrete that self- consolidates without mechanical vibration and can flow under its own weight to entirely fill the form work. This paper provides an overview of the application of glass powder added to concreteto address difficulties with availability, price, strength, and contamination. In this study, four different weights of glasspowder were added to cast M20 grade SCC specimens in four different proportions (0.3%, 0.6%, 0.9%, and 1.2%) with a water cement ratio of 0.45. Following a 28-daynatural process in water as the control, prisms measuring 100 by 100 by 500 millimetres and
cylinders 150 by 300 millimetres were manufactured for testing. Tests were conducted on both r-sand and m-sand to determine the qualities of fresh concrete, including slump cone, L-Box, U- Box, V-Funnel, and J-Ring tests. Self-compacting concrete undergoes tests on fresh concrete to determine its flow and use. Flexural strength and split tensile strength tests can be used to experiment with the properties of hardened concrete on both river sand and manufacturing sand. After 28 days of cure, the tests are run. The results of the tests demonstrate the qualities and applicability of concrete.

Khoso et al. (2019) Due to concrete's inherent weakness in tension, efforts have been made to address this weakness by smearing various types of fibres into the concrete mix, such as carbon fibre reinforced polymer (CFRP), glass fibre reinforced polymer (GFRP), polypropylene fibre (PPF), and stainless steel fibre (SSF). In this work, GFRP, CFRP, and SSF fibres are used either individually or in combination to improve the mechanical properties of concrete. Additionally, 10% fly ash was substituted for cement in all specimens when casting concrete cylinders, which were then evaluated for compression and tension. To examine the mechanical properties of concrete, fibre reinforcement ratios of 1% and 1.5% were evaluated in addition to several typesof fibre material. The fibre reinforcing ratio of 1% significantly increased the tensile strength as opposed to compressive strength in all concrete cylinder tests. In comparison to the control specimen, the tensile and compressive strengths increased by 26% and 11%, respectively. The mechanical characteristics of concrete were reduced when the fibre reinforcing ratio was raised from 1% to 1.5 %. However, the tensile strength showed less loss than the compressive strength of the concrete. In addition, it was shown that, when compared to the control specimen, the increase in fibre content reduced crack propagation.

Belouadah et al. (2018) The performance of concrete with and without glass powder (GP) when

exposed to high temperatures is experimentally investigated in this research. At both low and high temperatures, the mechanical and physicochemical characteristics of concretes were investigated. Recycling or disposing of waste is one of the main environmental issues. However, a sizable portion of industrial output has produced waste products that have a range of negative effects on the environment. Additionally, using glass or byproducts to produce concrete provides benefits for enhancing some or all of the concrete's qualities. Using wastes in concrete has both financial benefits and advantages for the environment in terms of a smaller carbon impact. Comprehensive investigations were conducted into the occurrence of spalling, compressive strength, mass loss, chemical composition, crystalline phase, and thermal analysis of CPG beforeand after exposure to different temperatures (20, 200, 400, and 600oC). According to the findings, CPG's critical temperature range was between 400°C and 600°C.

Mothefer et al. (2017) Sand has been substituted in various amounts, including 15%, 30%, 45%, 60%, 75%, 90%, and 100%, with Ultra-Fine Glass Powder (UFGP) smaller than 0.075 mm(No. 200), which is made by grinding and polishing edges on flat glass of varying sizes and thickness. When the percentage of replacement fell, it was discovered that there was a minor decline in workability. Analysis is done on how the UFGP affects the qualities of hardened concrete, such as its density, water absorption, compressive strength, and thermal conductivity. According to the study's findings, UFGP significantly increases a material's compressive strengthat 15%, 30%, and 45% while also decreasing dry density up to 45%. This inquiry is environmentally friendly since it takes into account the possibility of using UFGP to create lightweight aggregate concrete without incurring significant costs or energy losses.

Harish et al. (2016) In the twenty-first century, non-biodegradable wastes have become asignificant problem since an increasing amount of them are being dumped in landfills without being recycled. It takes a very long time for these wastes to degrade. Research has been done to fully utilise these wastes as the finished goods for construction materials like concrete as a result of this issue. Concrete now contains a variety of cement substitutes due to the growing emphasis on using environmentally friendly materials in construction. Given the significant volume of glass present in the solid waste stream of any major metropolis, glass powder is one such substance with untapped potential. The mechanical and durability characteristics of cementitious systems incorporating a fine glass powder are reviewed in this research. This research demonstrates how concrete mixtures can be metered to produce compressive strengths that are comparable to or greater. Increased use of a non-standard cement replacement material, like glass powder, may result from a greater understanding of that material's performance, which would ultimately promote sustainability.

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 pulverisedwaste 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.

Bhat and Rao (2014) Glass is frequently utilised in the construction and building industries, anda 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 asmore 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 ofglass 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.

CONCLUSIONS

1. This study presented experimental findings on the replacement waste glass powder to concrete as a cementitious material. Based on the results the following points can be drawn.
2. The sustainability of concrete is increased significantly by replacing up to 15% of cement and sand separately without having any negative effect on the compressive strength of concrete.
3. Regarding the strength activity index and based on 28 days of compressive strength, glass powder can be used as cement replacement until 15%, which can be considered as a reasonable amount in producing sustainable concrete.
4. The performance of concrete in splitting tensile strength when WGP is used either by cement or sand replacement is almost similar to that of compressive strength.
5. SEM images confirms that the microstructure of concrete improves; more C-S-H and less cracks form as a result of secondary hydration.
6. The amount of CH calcium hydroxide content decreases as glass content increases due to its consumption by glass powder in pozzolanic reaction as XRD investigations emphasize.

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