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"A Study On The Effect Of Strength Of Concrete By Partially Replacing Cement With Waste Glass And Check The Effect Of Ammonium Nitrate On Concrete"

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Abstract – In order to determine how waste glass affected the mechanical qualities of the concrete, tests for compressive strength, splitting tensile strength, and flexural strength were carried out. This goal led to the initial usage of waste glass powder (WGP) in place of some cement, with three distinct ratios of WGP being employed in the manufacturing of concrete: 5%, 15%, and 25%.In order to investigate the combined impact of varying WGP ratios on concrete performance, mixed samples (5%, 15%, and 25%) were created by substituting WGP and crushed glass particles for cement, fine and coarse aggregates, and cement. In its fresh form, the workability and slump values of concrete made with various percentages of leftover glass were measured and contrasted with those of plain concrete. The compressive and splitting tensile strengths of the hardened concrete made from waste glass were measured using 6 inch by 6 inch by 6 inch cubic specimens and cylindrical specimens with a 6 inch diameter and a 12 inch height.Based on the acquired data, the ideal dosage can be thought of as 15% WGP replacement for cement. Conversely, the mechanical qualities of concrete made with a combination of crushed glass particles and WGP rose up to a certain point before declining due to poor workability. As a result, 5% is thought to be the ideal replacement level since combined waste glass exhibits much higher strength and improved workability qualities. The discarded glass and cementitious concrete showed good adherence. Finally, useful empirical formulas have been created to calculate the flexure, splitting tensile, and compressive strengths of concrete containing various percentages of waste glass. using the use of suggested expressions, it is simple to estimate these strength values of the concrete made using glass powder during the design stage as opposed to performing an experiment. Ammonium nitrate can have a detrimental effect on concrete when it comes into contact with moisture. The presence of ammonium nitrate can lead to a chemical reaction known as ammonium nitrate attack, which causes the concrete to deteriorate and crack over time. This reaction occurs due to the formation of expansive compounds within the concrete, compromising its structural integrity. In severe cases, this can lead to significant damage and even structural failure of the concrete. Therefore, it's important to prevent the contact of ammonium nitrate with concrete, especially in environments where this chemical is present, such as in fertilizer storage facilities or areas where explosive materials are handled.

Keywords – Eco-Friendly Environment, Waste Glass Replace By Cement, Waste Glass Powder (WGP)Workability, Compressive And Splitting Tensile Strength.

I. INTRODUCTION

For sustainable environmental awareness, it's fascinating to consider using ordinary Portland cement (OPC) in particular proportions and substituting it with recycled cement [1,2]. Both a significant quantity of energy and carbon dioxide (CaO2) are emitted into the atmosphere during the manufacture of cement[3]. Cement additives are therefore interesting in lowering cement output [4]. Remainders from industrial production processes, leftovers from transfers, or product residues after their economic life is up are all considered waste [5]. The need to produce construction materials that will reduce greenhouse gas emissions is urgent due to the growth of contemporary cities, depletion of natural resources, climate change, and growing environmental awareness [4,7]. Researchers are interested in using waste glass powder (WGP), which is growing as a result of industrialization and urbanization, as an additive material for concrete because of its benefits for both economy and mechanical performance [8]. Because waste glass doesn't have a designated place to be stored, its oxidation effect raises the possibility of soil and water pollution. Thus, recycling glass in the process of making concrete will significantly help to lessen environmental issues.

As per ASTM C618-19, scrap glass can be broken into powder to produce pozzolanic material or cement additive due to its amorphous form and high calcium content. Consequently, WGP can be utilized in the manufacturing of concrete by substituting it in specific ratios with cement [9]. According to recent studies, concrete's mechanical qualities are improved when 15–25% glass powder is substituted with cement. Investigated the mechanical impact of WGP in concrete as a cement alternative using a 25% substitution with cement. As per the findings, it was noted that the samples' tensile and compressive strengths had increased while their vacancy ratio and density had decreased [10]. In their investigation to examine the relationship between WGP and other materials, applied cement mortar and discovered that the samples' compressive strength rose as the pace at which glass powder was added increased. When 15% glass powder was added, they achieved the maximum strength. They discovered that machinability rose with increasing WGP content and that adding 15% WGP at day 28 of cure resulted in the highest compressive strength [11]. It is commonly known that when soda-lime glass is finely ground, pozzolanic reactivity rises as particle size falls [12].

It was discovered that 5%, 15%, and 25% of weight cement could replace WGP's pozzolanic reactivity. However, below 30%, the pozzolanic reaction between the hydration products of WGP cement did not result in a drop in the compressive strength of the concrete. After we replacing 5% waste glass the split tensile strength of concrete is increased by 1.2 MPA of the required strength and compressive strength of concrete is increased by 2.3 MPA of the required strength [13]. Previous research has demonstrated that pozzolanic reactivity of secondary cementitious materials can be enhanced by ground glass powder. As a result, the ground glass powder's granule size has significant consequences. Depending on the rate of replacement, the waste glass's particle size, which needs to be considered during the mix design may have an impact on the active silica reaction [11-14].

For the majority of developing nations, solid waste management is a crucial concern [15]. Reusing or recycling waste materials, such as glass, plastic, and metal, has become a more appealing choice than storing or discarding them. In recent years, waste glass has begun to be commonly used for the formation of concrete in civil engineering applications. Because of its pozzolanic function, waste glass powder (WGP) can be chosen instead cement or natural aggregates in concrete applications where it can help minimize environmental contamination, preserve natural resources, and generate low-cost concrete. Despite the fact that this topic has been the focus of numerous studies, the findings reported in the literature vary [16].

The majority of the time, concrete is accidentally exposed to ammonium nitrate due to its use in neighboring operations like handling or storage. An ammonium nitrate attack is a chemical reaction that can occur when ammonium nitrate and moisture in concrete come into contact. Expandable compounds are created as a result of the ammonium nitrate's reaction with the concrete's constituent parts [17]. Over time, these compounds push against the surrounding concrete matrix, causing it to break and decay. A few examples of these variables are the amount of ammonium nitrate present, how long the exposure lasted, and how porous the concrete was. Precautions must be taken to keep ammonium nitrate away from concrete structures in settings where it is handled or stored, such as regions where explosives are made or fertilizer is stored. To reduce the possibility of causing damage to the concrete, this can involve putting in place barriers, coatings, or keeping the proper spacing between the components [18].

II. PROBLEM STATEMENT:

One major problem that arises in the context of complicated engineering issues is the detrimental impact of ammonium nitrate on concrete structures, particularly in industrial contexts. The problem is best shown by the problems that Fatima Fertilizer Company (FFC) in Goth Machhi, Sadiqabad Rahim Yar Khan, 64200 Pakistan, is facing. One of the main issues is ammonium nitrate corrosion. Ammonium nitrate and concrete constituents, such as calcium hydroxide, react chemically to generate calcium nitrate, ammonia gas, and water. This weakens the cement that has been partially replaced with glass waste concrete. This intricate issue highlights the necessity of conducting thorough investigation to identify workable remedies to lessen ammonium nitrate's corrosive effects.

Because the construction sector utilizes a lot of cement, which emits a lot of carbon dioxide, it has a major environmental impact. To reduce the environmental impact of building, particularly while producing concrete, we're investigating a possible replacement for some of the cement: leftover glass. Using glass instead of cement could help lessen the rising issue of glass waste building up in landfills, even if recycling glass can be difficult. This strategy attempts to make concrete building more environmentally friendly overall in addition to addressing the problems associated with the production of cement and the disposal of glass. In generation of cement, enormous quantity of Carbon dioxide (CO_2) is emancipated to atmosphere which helps global issues, which is global to reduce cost of cement and make environment free from pollution.

III. AIM AND OBJECTIVES

- Investigate the impact of partially replacing cement with waste glass on the compressive strength of concreteand establish a clear understanding of how different levels of waste glass.
- Check the tensile strength of concrete. Tensile strength is determined by applying a compressive load to a cylindrical or prismatic concrete specimen along its longitudinal axis while transmitting a tensile load diametrically across the specimen.
- Determine the Flexural strength of beam.Flexural testing measures the force required to bend a beam of plastic material and determines the resistance to flexing or stiffness of a material.

IV. MATERIALS AND METHODS

4.1 Mix Proportion

Throughout the study, a fixed proportion of 1:2:4 was immersed in a water tank for the purpose of curing.

Table 1: Details of batches of specimens

Serial No	Batch	WASTE GLASS %
1	B-1	0% waste glass is replaced by Cement
2	B-2	5% waste glass is replaced by Cement
3	B-3	15% waste glass is replaced by Cement
4	B-4	25% waste glass is replaced by Cement

4.2 Testing of the Specimens

Workability of concrete is determined by Slump Cone test. In this study,compressive strength, and split tensile strength tests, Flexural strengthwere conducted.

4.2.1 Compressive strength:

Compressive strength of concrete is a measure of its ability to resist axial loads pushing it togetherConcrete. Specimens that are cylindrical are broken in a compression testing equipment to determine the compressive strength. Compressive strength is expressed in megapascals (MPa) or pounds-per-square-inch (psi) units and is computed by dividing the failure load by the cross-sectional area resisting the load.

1.2.2 Split Tensile strength:

Concrete's split tensile strength indicates how well it can withstand tensile stresses under diametrical compression. A cylindrical concrete specimen is subjected to a compressive load along its length to evaluate its fracture strength. The split tensile strength is then determined by measuring the force necessary to create this splitting.

1.2.3 Flexural strength:

Concrete's flexural strength, commonly referred to as its modulus of rupture, gauges how well it can withstand bending or flexural forces. It is ascertained by placing a load on a concrete prismatic or cylindrical specimen until the failure to bend occurs. The specimen's dimensions and the maximum bending moment applied to it are used to compute the flexural strength. This characteristic is essential for evaluating how concrete behaves in bending structural elements like walls, slabs, and beams.

V. RESULTS

This study's main goal was to investigate how waste glass affects concrete's strength characteristics. Glass waste was used in the concrete mixture as a partial cement substitute. Replaced with 0%, 5%, 15%, and 25% of the cement.

Table 2: Workability of concrete by using WASTE GLASS as partial replacement of cement.

Sr. No.	% of waste glass	Slump value (mm)	Percentage difference in the Slump value of concrete when waste glass is used to replace a fraction of cement, compared to conventional concrete.
1	0%	82	-------
2	5%	108	24.29
3	15%	101	18.18
4	25%	89	7.86

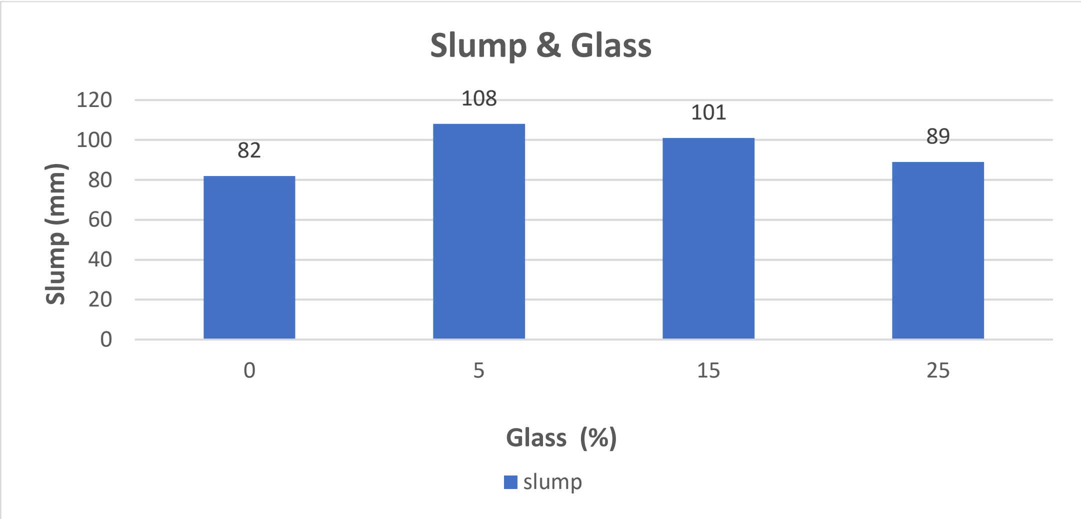

Figure 1: Graph showing workability of concrete with respect to % of waste glass

The Compressive strength of all mixes is determined concrete with different proportions of waste glass was determined at 28 days. For each set of waste glass content, the development of compressive strength with respect to different waste glass percentages are shown in table 3 and figure 2 shows graphical representation of table.

Table 3: Compressive strength of concrete achieved through the incorporation of waste glass as a partial substitute for cement.

Sr. No.	% of waste glass	Avg. compressive strength MPa	Percentage difference in compressive strength of concrete with waste glass as fractional replacement of cement as compared to normal concrete
1	0%	21.76	-------
2	5%	23.56	7.64
3	15%	25.13	13.41
4	25%	-18.51	-17.56

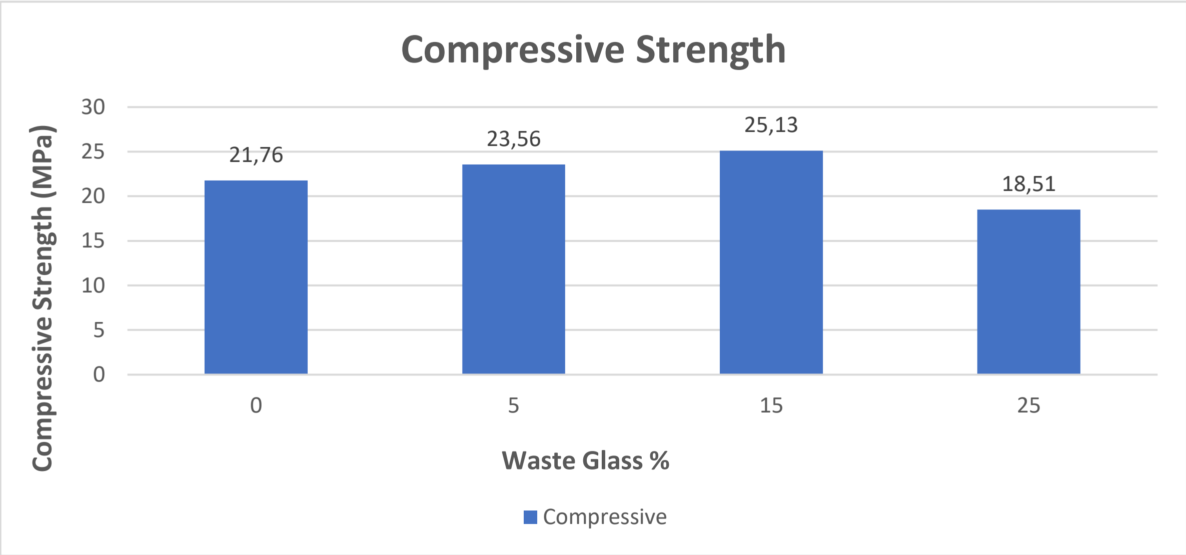

Figure 2: Graph showing compressive strength of concrete with respect to % waste glass

The results of splitting tensile strength of concrete with respect to different waste glass percentages are shown in table 4and figure 3 shows the graphical representation of table 4.3. The splitting tensile strength with 0%, 5%,15%, 25% as partial replacement of cement.

Ultimate load=P= 193.471 KN

Length of Specimen = 12 inch

Diameter of Concrete cylinder = 6 inch

1 KN =101.971 kg

1 kg = 2.2046 lbs.

Split tensile strength = T = 2P/3.14LD

$$T= \frac{2(193.471)(101.971)(2.2046)}{3.14(12)(6)} = 384.56 \text{ psi} = \frac{384.56}{145.04} = 2.65 \text{ MPa} > 1.9 \text{ MPa (Required)}$$

Table 4: Splitting tensile strength of concrete by using as waste glass fractional replacement of cement.

Sr. No.	% of waste glass	Avg. split tensile strength MPa	Percentage variation in splitting tensile strength of concrete with waste glass as partial replacement of cement as compared to normal concrete
1	0%	2.46	-------
2	5%	2.89	14.88
3	15%	3.11	20.9
4	25%	-2.08	-18.27

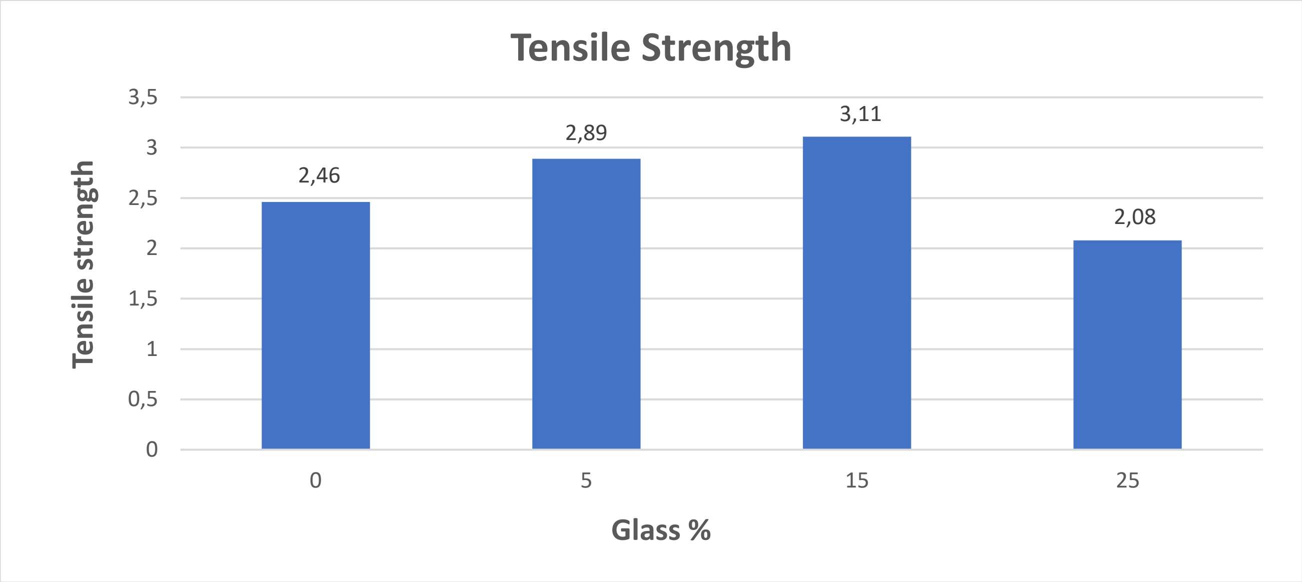

Figure 3: Graph showing splitting tensile strength of concrete with respect to different % of waste glass.

The results of Flexural strength of concrete with respect to different waste glass percentages are shown in table 5 and figure 4 shows the graphical representation of table 4.4. The Flexural strength with 0%, 5%,15%, 25% as partial replacement of cement.

Table 5: Flexural strength of concrete by using as waste glass fractional replacement of cement.

Sr. No.	% of waste glass	Avg. Flexural strength MPa	Percentage variation in Flexural strength of concrete with waste glass as partial replacement of cement as compared to normal concrete.
1	0%	3.18	-------
2	5%	3.57	10.92
3	15%	3.94	25.57
4	25%	2.98	6.71

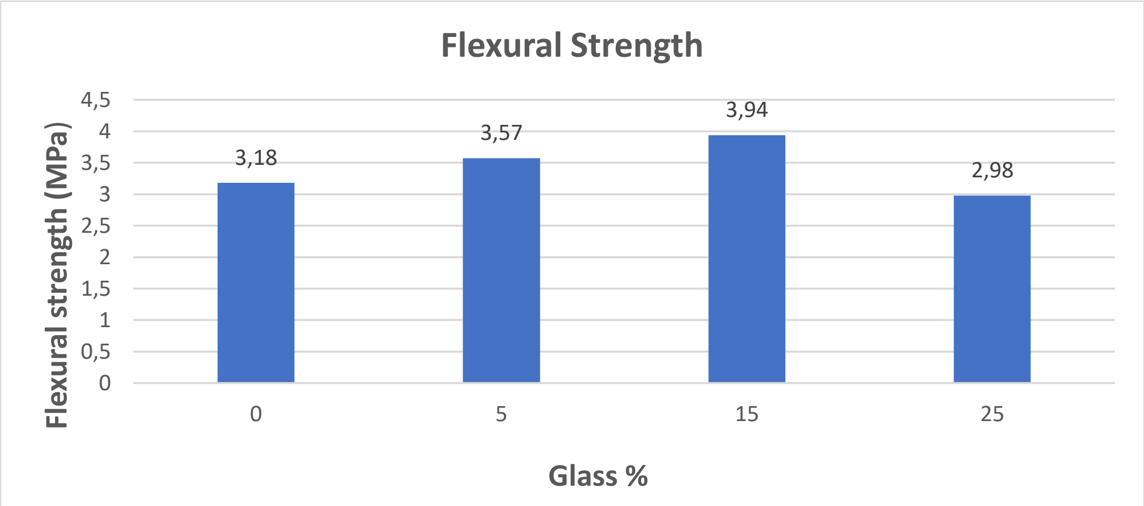

Fig 4:

VI. CONCLUSION:

In order to establish the engineering properties of concrete samples generated with varying percentages of waste glass, a number of experiments were carried out on the samples in both the fresh and hardened instances. The properties of workability and slump were investigated in the new concrete example. Compression strength, splitting tensile strength, and flexural strength of the test specimens produced in the case of hardened concrete were examined. Based on our study following results can be drawn.

- Slump test results show that when waste glass volume rises, the slump value falls. In a similar vein, workability declines as glass powder production rises.
- The compressive test results indicated that the usage of WGP as a replacement of cement as positive effect on concrete upto certain limit and negative effect when percentage of WGP increase.Campared to the reference sample,5% and 15% replacement of waste glass increase upto 8% and 13% respectively and when 25% replacement of WGP by cement, the comressive strength decrease upto 18%.
- The flexural and splitting tensile strength values increased when waste glass was substituted for cement, but only to the extent that the quantity of waste glass was increased. The strength values, however, decreased as the waste glass addition was increased further. 5% and 15% replacement of the used glass produced a 15% and 21% increase in splitting tensile strength, respectively, however a 18% loss in splitting tensile strength was obtained when the waste glass was replaced by 25%. Conversely, flexural strength increased by 10% and 25% for waste glass substitutes of 5% and 15%, respectively, and decreased by 6% for waste glass substitutes of 25%.
- It is evident that substantial strength gains are seen when waste glass is substituted for cement.
- These generalized recommended formulas for splitting tensile strength, flexural strength, and compressive strength can be directly incorporated into the design requirements of waste glass-based concretes.

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