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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. This paper describes the effect of incorporating waste glass as a partial replacement for cement and investigates the impact of ammonium nitrate on concrete properties. Waste glass is used to help solve environmental problems associated with large amounts of cement consumption and also to determine its effects on concrete classes about strength and durability. Ammonium nitrate, researched for use as a concrete additive, would have to be investigated and understood for its effects on the setting time, development of compressive strengths, and other performance characteristics of concrete mixtures. Experimental investigations were conducted using varying percentages of waste glass substitution in concrete mixtures, ranging from 0% to 20%. Compressive strength tests were performed at different curing ages to evaluate the mechanical properties. Additionally, concrete samples were prepared with varying concentrations of ammonium nitrate to assess its influence on the same properties. Results indicate that incorporating waste glass up to a certain percentage enhances early-age strength, although higher substitutions may compromise long-term durability. Ammonium nitrate demonstrates potential benefits in accelerating early strength development but requires careful consideration of its long-term effects on concrete performance. This research contributes to ongoing research on sustainable building materials and provides insights into optimizing concrete mix designs using waste glass and chemical additives like ammonium nitrate. The findings offer valuable information for engineers and researchers aiming to enhance concrete sustainability and performance through innovative material substitutions and additives.

Keywords: Strength of Concrete; Cement Replacement; Ammonium Nitrate in Concrete.

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1. Introduction

Due to its versatility, strength and durability, concrete is one of the most widely used building materials in the world. However, due to the high energy consumption and CO_2 emissions associated with cement manufacturing, this process contributes significantly to carbon dioxide emissions as sustainability becomes more important in the construction industry, there is growing interest in finding new materials that can reduce environmental impact without compromising performance (Qaidi et al., 2022; Ez-Zaki et al., 2018; El Gharbi and Diouri, 2018).

One promising approach is to partially replace cement with waste materials such as waste glass. Waste glass from post-consumer or industrial sources presents an opportunity to reduce environmental concerns by diverting waste from landfills and reducing the demand for cement as well as potential benefits results such as

improved efficiency, reduced heat transfer and the possibility of upgrading certain devices.

The research shall mainly be focused on establishing whether partially degraded cement deposition has any effect on the strength characteristics of concrete. Various proportions of waste glass will be considered to develop its influence on the tensile strength compressive strength and durability of concrete. Its interaction with these properties needs to be understood to come up with optimal mix designs of concrete that can best incorporate this waste material for sustainable construction (Tayeh, 2018; Xiao et al., 2020; Vijayakumar, 2013).

Furthermore, the study will examine the impact of ammonium nitrate on concrete. Ammonium nitrate is known for its ability to accelerate early strength development in concrete mixtures. By systematically evaluating its effects, this research seeks to determine the optimal concentrations of ammonium nitrate that enhance concrete performance without compromising long-term durability.

This paper is intended to provide insight into the feasibility and effectiveness of using waste glass as a partial cement replacement and the implications of ammonium nitrate addition in concrete production through detailed experimental investigations and analysis.

2. Problem Statement

- Within the realm of complex engineering challenges, a significant issue comes to the forefront: the damaging effect of ammonium nitrate on our structures, especially in industrial settings. This issue is exemplified by the challenges faced by Fatima Fertilizer Company Sadiqabad Pakistan, where ammonium nitrate corrosion is a major concern. The chemical reactions between ammonium nitrate and concrete components, like calcium hydroxide.
- The construction industry is having a large environmental impact because we use too much cement. They release large amounts of carbon dioxide. As a way of making construction greener, especially in manufacturing concrete, we have been pursuing a bright idea: replacing few quantities of the cement with waste glass. Even if glass recycling is tricky, using it instead of cement help reduce the growing problem of glass waste piling up in landfills. The approach addresses environmental problems associated not only with cement use and glass disposal but also aims at making the construction process of concrete more sustainable overall (Aliabdo et al., 2016; Zheng, 2016; Shao et al., 2000; Du and Tan, 2014; Khatib et al., 2012).

3. Objectives

Evaluating the strength implications of using waste glass as a cement substitute and assessing how concrete behaves when exposed to ammonium nitrate. Suggest optimal mix designs incorporating waste glass and ammonium nitrate based on experimental findings. Offer guidelines for engineers and practitioners on utilizing waste glass and chemical additives effectively to achieve sustainable and durable concrete.

4. Methods and Material

4.1. Mix Design

We use 1:2:4 f or concrete and we dip concrete specimen in water tank for curing.

Table 1. Details of specimen

Sr. No.	Amount	%Waste of Glass
1	A1	0% waste glass
2	A2	4% waste glass
3	A3	12% waste glass
4	A4	20% waste glass

4.2. Testing

We perform slump cone test. And we conducted split tensile test, flexural test and compressive test.

4.3. Compressive strength

Compressive strength refers to how well concrete can withstand being squeezed or compressed. It's like measuring how much pressure it can handle before it breaks or gets squashed. This property is really important in making sure that concrete structures like buildings and bridges are strong and safe.

4.4. Split Tensile Strength Test

Split tensile Strength test is a measure of how well concrete can resist being pulled apart or stretched. Imagine trying to pull apart a piece of concrete from both ends - it's like testing how strong it is against forces that try to split it in two. This property is crucial for understanding how concrete will perform under tension, such as in bridges and pavements where it may be subjected to pulling forces.

4.5. Flexural strength

Flexural strength is like measuring how well concrete can resist bending or cracking when a force is applied to it. Imagine a beam or a slab of concrete—flexural strength tells you how much weight or load it can carry before it bends or breaks. This property is important for structures like floors, beams, and bridges, where concrete needs to support weight without cracking under pressure.

5. Result

Table 2. Workability of concrete by using waste glass

Sr. No.	Waste Glass%	Slump cone value	% Difference in the Slump cone value of concrete
1	0	83	-
2	4	106	27.09%
3	12	103	24.09%
4	20	93	12.04%

Table 3. Split tensile strength of concrete by using as waste glass

Sr. No	Waste Glass%	split tensile strength in MPa	% Difference splitting tensile strength of concrete
1	0	2.49	-
2	4	2.93	17.67%
3	12	3.15	26.50%
4	20	2.31	-7.23%

Table 4. Compressive strength of concrete by using waste glass

Sr. No	Waste Glass%	Compressive strength in MPa	% Difference in compressive strength of concrete
1	0	22.14	--------
2	4	24.01	8.44%
3	12	27.3	21.99%
4	20	20.01	9.62%

Table 5 Flexural strength of concrete by using as waste glass

Sr. No	Waste Glass%	Flexural Strength in MPa	%Difference in Flexural strength of concrete
1	0	3.29	----------
2	4	3.62	10.37%
3	12	4.01	22.64%
4	20	2.09	-6.29%

6. Conclusions

The study concludes that replacing cement with up to 12% waste glass in concrete is viable, offering environmental benefits without significantly compromising strength. However, higher levels of replacement reduce structural integrity, necessitating further research for optimization. This approach promotes recycling and reduces cement-related emissions, aligning with sustainable construction practices.

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