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A Study on the Appropriateness of Waste Glass & Recycled Concrete Aggregates

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Abstract

The possibilities of utilising discarded glass as glass powder, glass aggregates, and recycled aggregates is investigated in this study. Humans have been forced to recycle trash by environmental contamination and rising production and storage expenses in our time. Crushed scrap concrete from laboratory test cubes and pre-cast concrete columns was used to create recycled aggregate. The concrete incorporating discarded glass and recycled aggregates had a higher compressive strength as a consequence of the study. Three different concrete compositions were put to the test. Concrete using natural aggregate as a control, as well as two varieties of natural fine and recycled coarse aggregate concrete. This necessitates the use of high-quality recycled concrete coarse aggregate as well as adherence to strict design and production guidelines. The specimen that contained both waste glass and repurposed concrete performed better than the one that solely included waste glass. The findings suggest that recycled brick aggregates can be utilised in place of regular brick aggregates in new building projects.

Keywords*: - Recycling, waste glass powder, waste glass, coarse aggregate, recycled aggregates*

INTRODUCTION

Because of their advantages in improving some or all of the properties of concrete, the economic incentives of using a waste or by-product material, and the environmental implications, partial cement

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replacement materials obtained from waste or by-product streams of other industries are preferred in concrete production. Glass has a high silica concentration, making it a potentially pozzolanic material. Glass makes up roughly 5% of municipal solid trash, yet only 20% of it is recycled.

The use of waste glass and recycled aggregates is critical for human development because the vast amount of glass waste produced by humans increases the need for land to dispose of it, consuming valuable landfill space and reducing the area available for other waste landfills, necessitating the construction of new expansive landfills. Buildings and transportation infrastructure that are old and dilapidated are demolished and replaced with new ones. The most common causes for replacements include changes in purpose, city reorganisation, traffic direction extension and increased traffic load, natural calamities, and so forth. The usage of aggregates is quickly rising as a result of today's concrete manufacturing and use; thus, these must be recycled. Recycled concrete aggregate (RCA) is made by crushing destroyed concrete in two stages and then screening and removing pollutants such reinforcement, paper, wood plastics, and gypsum.

LITERATURE REVIEW

Glass is a readily recyclable material because it can be reprocessed and returned to the glass-making furnace. In many circumstances, there will be quantities of recovered glass that are not recyclable.

When destroyed concrete is crushed, a little portion of mortar and cement paste from the original concrete stays bonded to stone particles in recycled aggregates, which is one of the most essential qualities of RCA. The poorer quality of RCA as compared to natural aggregate is due to the associated mortar (6).

When compared to NA, RCA has the following characteristics.

1. Higher water absorption
2. Lower bulk density
3. Decreased specific gravity
4. Increased abrasion for 12seconds
5. Crushability has improved
6. Increased quality of dust particles

Before or during mixing, a particular quantity of water must be added to saturate recycled aggregate in order to get the proper workability of RCA. On the basis of recycled aggregates, the extra water quantity is determined.

Coarse and fine aggregates are the two primary types of recycled aggregates (5,

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6); coarse aggregates are defined as bigger than 2mm in diameter, while fine aggregates are defined as less than 2mm. The coarse aggregates, with their substantial fraction of coarse aggregate, lower the quantity of cement required when concrete is created. When using fresh aggregates to create concrete, the aggregates themselves contain moisture, either from condensation on the particles or by being cleaned with water in some way.

NATIONAL STATUS

The application of RCA in structural concrete has been studied for ten years. IIT Kharagpur and IIT Delhi researchers focused on RCA, which consisted mostly of hand broken coarse aggregates rather than machine crushed aggregates (2008).

However, the Indian building sector has failed to recognise RCA's potential. To promote RCA in India, more study is required. The notion that it may be used to replace natural coarse aggregate up to 100 percent is still not acknowledged in India. To employ RCA, the concrete mix design must be changed. Because it has excellent structural potential, the technical and economic benefits of manually recycled RCA over machine recycled RCA must be proved by experimental investigation.

RESEARCH SIGNIFICANCE

Municipalities have significant challenges in recycling, disposal, and decomposition of water glass. This issue may be considerably reduced by repurposing discarded glass as a cement substitute in concrete. The supply of natural aggregate and minerals used in cement production is limited, and it is vital to minimise energy consumption and CO2 emissions from building activities. The use of glass as a partial replacement for sand and aggregates is being considered as a solution to this problem. By substituting the waste glass powder with sand and coarse aggregates, the concrete containing waste glass powder has to be researched. In addition, recyclable aggregates are used.

METHODOLOGY

The trash coarse aggregate and broken glass (mostly clear glass) are gathered for the tests from a single source of old destroyed concrete on the Jain Global campus.

In this experiment, the strength behaviour of concrete created by substituting the cement with waste glass, glass aggregate, and recycled concrete aggregate was investigated. In these tests, ordinary Portland Cement (OPC) 43 grade, locally available sand, and coarse aggregates were

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employed. A Zone-III sand with a specific gravity of 2.62 was employed. The coarse aggregate had a specific gravity of 2.93. The coarse aggregate used was reduced to 20mm. Crushing leftover glass fragments yielded the glass powder. The experiment was conducted using a 475-micron passing fraction and 20-mm glass aggregates. To make recycled coarse aggregate, old concrete debris was crushed and sieved in a Jaw crusher.

Various compositions used for the experiments are as follows:

A1- Cement + Sand + Recycled Coarse aggregate + Glass powder (15% replacement of sand by weight)

A2- Cement + Sand + Coarse aggregate + Glass (15% replacement of coarse aggregate by weight)

A3- Cement + Sand + Coarse aggregate + Glass aggregate (15% replacement of sand by weight) + Glass powder (15% replacement of sand by weight) B1- Cement + Sand + Coarse aggregate + Recycled concrete aggregate (15% replacement of cement by weight) + Glass powder (15% replacement of sand by weight)

B2- Cement + Sand + Coarse aggregate + Recycled concrete aggregate + Glass aggregate (15% replacement of coarse aggregate by weight)

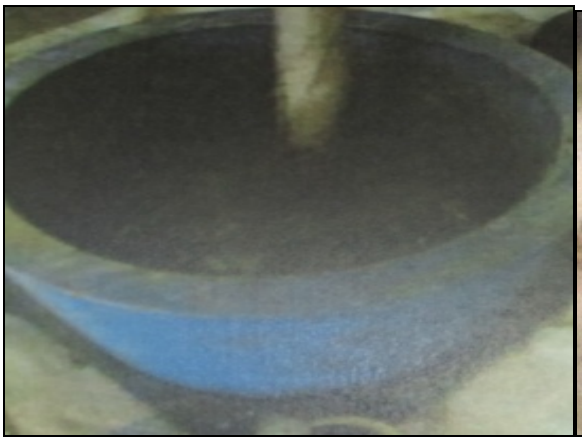


Fig 1: Glass aggregate being prepared



Fig 2: Addition of glass powder

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Fig 3: Prepared moulds



Fig 4: Specimens after compression testing.

RESULTS

Table-1 Observed compressive strength of the specimens

Mix design (M20)	Compressive strength at 14-day (MPa)	Compressive strength at 28-day (MPa)
Conventional concrete	16.8	24.15
A1	21	23.1
A2	18.58	20.37
A3	16.27	16.8
Conventional concrete	16.8	24.15
B1	20.26	25.20
B2	21	27.93

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Table 2: Mixing Proportions

Mix	Description	Cement (Kg)	Sand (Kg)	Coarse Aggregates(Kg)
A1	With 15% glass powder	2.60	4.05	8.50
A2	With 15% glass aggregate	2.60	4.76	7.2303
A3	With 15% glass powder+ 15% glass aggregate	2.60	4.05	7.2303
B1	RCA 15% + 15% glass aggregates	2.213	4.76	7.2303
B2	With 15% RCA + 15% Glass powder + 15% glass aggregate	2.213	4.05	7.2303

Table 3

Mix	Description	Glass Powder (Kg)	Coarse glass Aggregate (Kg)	RCA(Kg)
A1	With 15% glass powder	0.714	-	-
A2	With 15% glass aggregate	-	1.274	-
A3	With 15% glass powder+ 15% glass aggregate	0.714	1.274	-
B1	RCA 15% + 15% glass aggregates	-	1.274	0.390
B2	With 15% RCA + 15% Glass powder + 15% glass aggregate	0.714	1.274	0.390

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CONCLUSIONS

The following are some of the key findings from this study, which may be summarised as follows:

1. The information gathered in this experiment indicates that waste glass, in the form of coarse aggregate and glass powder, as well as recycled concrete aggregate, has a lot of potential in concrete. Because it might be used to substitute expensive materials, the latter form is thought to offer far more chances for value-adding and cost recovery.

2. In the presence of recycled concrete aggregate, the use of glass powder in concrete would avoid the expanding Alkali-Silica Reaction (ASR).

3. This research is a first attempt to introduce the notion of using waste glass in conjunction with recycled concrete aggregate in concrete.

4. In compared to specimens containing both waste glass and reclaimed concrete aggregate, concrete specimens containing waste glass demonstrated lower strength. Concrete containing glass as coarse aggregate and glass powder can achieve comparable strengths (even better for Compositions A1 & B2) to that of natural sand and coarse aggregates.

5. When recycled concrete aggregate was added to the specimen containing discarded glass, the concrete's strength increased.

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