iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 **Issue:** V **Month of publication:** May 2017

DOI:

www.ijraset.com

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Volume 5 Issue VI, May 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

A Research on the Recycling of Glass Fibre Strengthened Concrete Wastes

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Abstract*: *Glass fibre strengthened concrete wastes have been considered difficult to recycle due to its quick hardening nature which cannot be reshaped in a short time following spraying process. Most of the wastes are landfilled and this process causes unfavorable environmental effects, including water pollution. In this study, waste grc particles were granulated and used as filling material in original grc mix design. With the addition of nano calcium carbonate particles at the rate of 2.5%, 5% and 7.5%, recycling would convert this waste material into a beneficial and sustainable material. Moreover, water pollution is prevented due to lack of landfilling and waste preserving processes. Bending test results were realized according to the EN 1170-5 standard and results show that there is a strong potential of using recycled glass fibre strengthened concrete recycled particles as filling with nano calcium carbonate particles.
Keyword: Glass fibre strengthened concrete, mix design, and nano calcium carbonate

I. INTRODUCTION

Recycling process of glass fibre is an environmental problem due to the fact that its insolubility property in the nature and high cost of recycling processes [1]. In addition glass fibre wastes are rarely preferred for concrete producers for requiring additional chemicals and polymers. This fact limits the usage of them. In concrete technology, there are several methods to use them as cement replacement and filler materials [2-8].

The usage of recycled glass fibre as an ingredient in concrete mixes causes various environmental benefits. This usage which depends on many techniques limits the production of raw materials and the harmful emulsions as CO2.

In many researches, nano glass particles were used as cement and aggregate replacement materials. Applying finer particles enhances the mechanical behaviour of the matrix materials [9-14].

Within the scope of this research, grinded glass fibres with the addition of nano calcium carbonates were used as filler material in the mix design of glass fibre reinforced concrete.

II. METHODOLOGY AND APPLICATION

CEM I 52.5 R (White Portland Cement) which complies with the TS EN 197-1 and ASTM C150 standards was preferred for the cement applications. The chemical and physical properties of CEM I 52.5 R cement are shown in Table I.

TABLE I THE CHEMICAL AND PHYSICAL PROPERTIES OF CEM I 52.5 R CEMENT.

Chemical Properties (%)		Physical and Mechanical Properties	
SiO2	21.6	Specific Weight	3.06
Al2O3	4.05	Specific Surface (cm2/gr)	4600
Fe2O3	0.26	Whiteness (%)	85.5
CaO	65.7	Initial Setting (min.)	100
MgO	1.30	Final Setting (min.)	130
Na2O	0.30	Water Used for Consistency (%)	30
K2O	0.35	Volume Constancy (mm)	1.0
SO3	3.30	Remnants Obtained Using 0.045 Sieve (%)	1.0
Free CaO	1.60	Remnants Obtained Using 0.090 Sieve (%)	0.1
Chloride (Cl)	0.01	Compressive Strength for 2 days (MPa)	37.0
Insoluble	0.18	Compressive Strength for 7 days (MPa)	50.0
Loss on Ignition	3.20	Compressive Strength for 28 days (MPa)	60.0

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Volume 5 Issue VI, May 2017
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Polycarboxylate based third generation water reducer was used as the chemical agent. Silica sand was chosen as the original aggregate to be used in the mixtures. Properties of the silica sand are given in Table II.

TABLE III
PHYSICAL PROPERTIES OF THE AGGREGATE USED IN THE MIXTURES

Sieve Aperture Size	1 mm	710 µm	500 µm	355 µm	250 µm	180 µm	125 µm	90 µm	63 µm
Production Range (%)	0	0	0	0.2	0.3	20.1	60.4	16.1	1.8

Mean Grain Size (µm)	140-170	Specific Weight	2.68
Clay Content (%)	0.6-0.8	AFS Value (%)	84.6

Waste glass fibres were grinded with the aid of a grinder (up to 10 mm size) and added the original concrete mixes at the rates of 2.5 %, 5 % and 7.5 %. Apart from this process, nano calcium carbonate was also added to the mixes as a cement replacement materials at the rates of 2.5 % and 5 % in parallel with the literature researches. 28 day bending test results were compared to the original mix parameters. Mix designs are presented in Table III.

TABLE IIIII DESIGN MIXES CONTENT

Design Description	Mix Content
Org-Mix	Original Mix Content
Mix A	Recycled Fiber 7.5 % + Calcium Carbonate 2.5 %
Mix B	Recycled Fiber 5 % + Calcium Carbonate 2.5 %
Mix C	Recycled Fiber 2.5 % + Calcium Carbonate 2.5 %
Mix D	Recycled Fiber 7.5 % + Calcium Carbonate 5 %
Mix E	Recycled Fiber 5 % + Calcium Carbonate 5 %
Mix F	Recycled Fiber 2.5 % + Calcium Carbonate 5 %

Bending test were conducted as per the TS EN 1170-5 standard and with the aid of bending machines. Test results are seen in Figure 1.

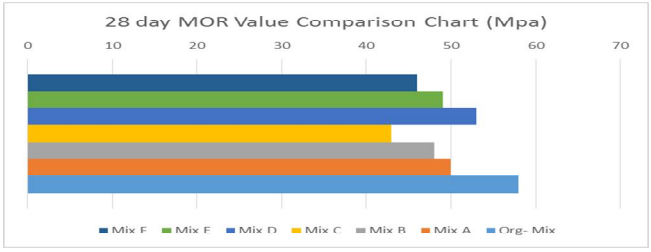


Fig. 1 MOR value comparison Chart (Mpa)

III.CONCLUSIONS

Test results showed that the mix with the addition of 7.5 % recycled fibre and 5 % of nano calcium carbonate bring about nearly the same performance as the original mix design. In addition, wasted fibers were evaluated as structural element of the matrix material and this limits their amount in landfills. However, apart from this benefits it was observed that there was a slight decrease in the compressive strength values of the concrete.

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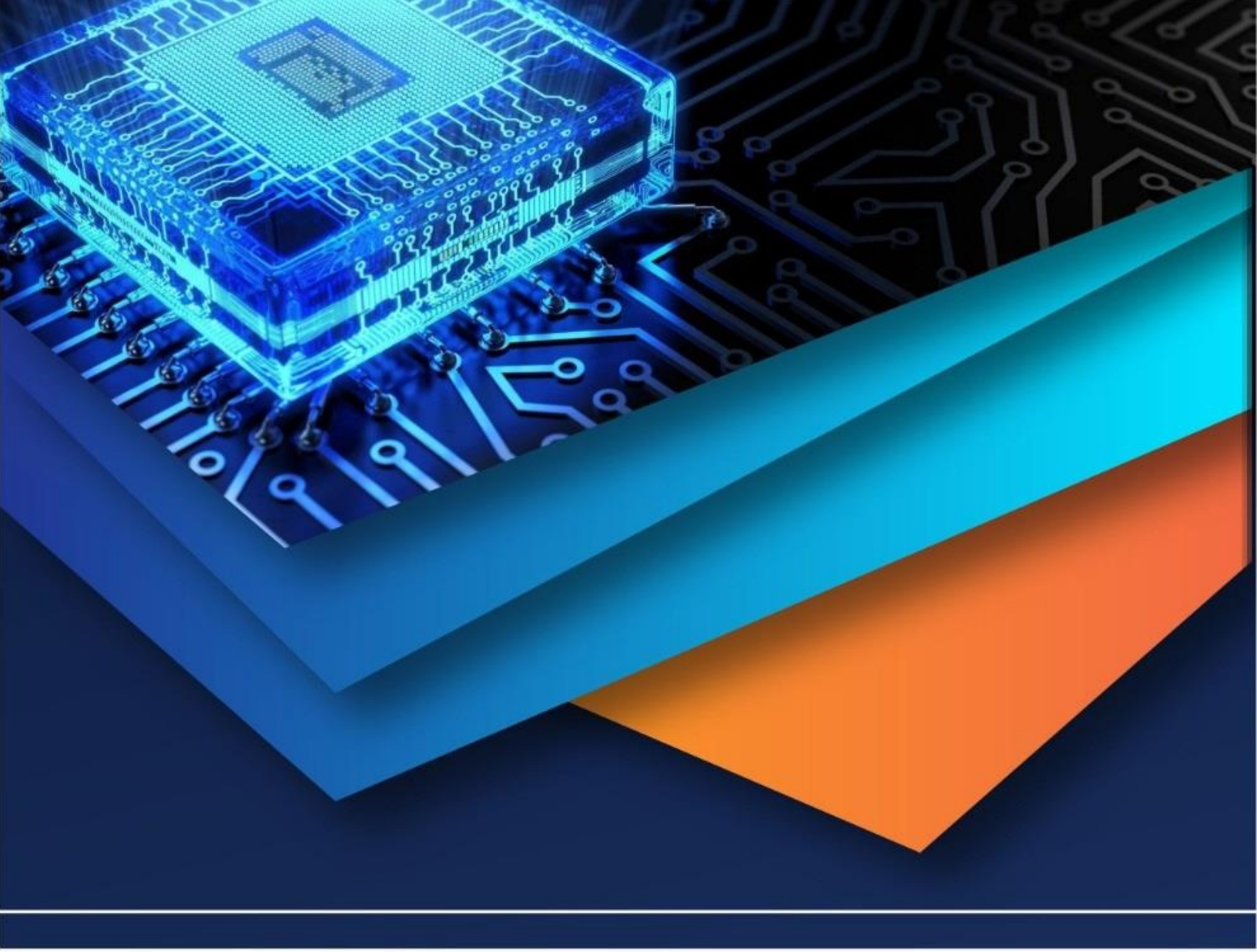
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