Paper ID No.:MS-019

Paper Title: Preparation and Characterization of Polymer Concrete from Unsaturated Polyester Resin Reinforced with Building Waste

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Abstract

Physical, optical and mechanical properties are the important material properties for engineering applications like as polymer concrete. Analysis of prepared polymer concrete is an important issue for a composite of unsaturated polyester resin and building waste. Density is low of prepared polymer concrete for low percentage of building waste; on the contrary, density is high of prepared polymer concrete for high percentage of building waste. Percentage of water absorption in prepared polymer concrete is nearly zero. The optical surface view of prepared polymer concrete shows the proper composition of prepared polymer concrete. The flexural strength of prepared polymer concrete decreases with increasing of building waste. The hardness of prepared polymer concrete decreases with increasing of building waste. The compressive strength of prepared polymer concrete decreases with increasing of building waste. Therefore, this prepared polymer concrete as a construction material can be considered for replacing concrete used today.

Keywords – *Density, Water absorption, Optical Microstructure, Flexural Strength, Hardness, Compressive Strength*

1. Introduction

Polymer concrete is a composite material which results from polymerization of a monomer/aggregate mixture. The polymerized monomer acts as binder for the aggregates and the resulting composite is called "Concrete". Polymer concrete in which the binder is an organic polymer; a construction and structural material that is a solidified mixture of a macromolecular substance with a mineral aggregate. [1-2] Polymer and polymer-cement concretes are used for floors in industrial plants, garages, and hospitals. They are used in the production of high-quality road and airfield paving's and for repairing damaged concrete surfaces and patching cracks. The overall goal of this research work has to investigate some physical, optical and mechanical properties of prepared polymer concrete from unsaturated polyester resin reinforced with building waste. In order to study the possibility of superior performance, preventing the composite from water absorption and reducing the costs; polymer concrete has been prepared with different compositions. In view of the above consideration, the following work- plans have been undertaken: collection of raw materials, preparation of polymer concrete with different compositions from unsaturated polyester resin and building waste, determination of the density and water absorption of the prepared polymer concrete, determination of optical and mechanical properties such as flexural strength, compressive strength and hardness of the prepared polymer concrete. The main objectives of this research work are:

i) Preparation of high- performance and water resistant polymer concrete for construction purposes.
ii) Preparation of polymer concrete with standard physical, optical and mechanical properties.

The physical, optical and mechanical behaviors of prepared polymer concrete have been analyzed to correlate the structure- property relation. This research work gives the ideas to find a suitable composite for the application in the field of construction.

2. Materials and Method

2.1 Materials

Polymer concrete formulation has been prepared by mixing building waste and unsaturated polyester resin. Building waste content in polymer concrete has been varied from 20% to 60% in the polymer concrete formulation. Methyl ethyl ketone peroxide (MEKP) is an organic, colorless and oily liquid which has been used as hardener in the polymer formulation. Methyl ethyl ketone peroxide (MEKP) has been used as 1% of unsaturated polyester resin in the polymer concrete formulation.

2.2 Equipments

The equipments have been used here, such as Slide-calipers, Screw gauge, Vacuum dryer, Dryer, Digital balance, Universal testing machine (UTM), Microscope and Leeb Rebound hardness machine.

2.3 Methods

2.3.1 Collection of raw materials

Firstly, for the preparation of polymer concrete, the basic raw materials such as building waste, unsaturated polyester resin and methyl ethyl ketone peroxide have been collected. To prepare polymer concrete from these raw materials following steps are involved:-

- ✓ Washing of building waste & purchasing of unsaturated polyester resin and methyl ethyl ketone peroxide from the market.
- ✓ Weighing
- ✓ Mixing
- ✓ Molding

2.3.2 Method of density measurement

The density, or more precisely, the volumetric mass density, of a substance is its mass per unit volume. The symbol most often used for density is ρ. mathematically; density is defined as mass divided by volume. $\rho = \frac{m}{v}$

Where,

ρ = Density of the sample

m = Mass of the sample V = Volume of the sample

Volume is the quantity of three-dimensional space enclosed by a closed surface, for example, the space that a substance (solid, liquid, gas, or plasma) or shape occupies or contains. [3-4] Volume of prepared polymer concrete is defined as

$$V = \frac{\pi}{4} \times d^2 \times T$$

Where, V = Volume of the sample

d = Diameter of the sample

T = Thickness of the sample

2.3.3 Method of water absorptive measurement

To determine water absorptive of prepared polymer concrete; various composition of prepared polymer concrete has been kept into water at different intervals such as 20 minutes, one hour, two hours, five hours, 12 hours, 23 hours, 47 hours, 96 hours, 144 hours.

2.3.4 Method of optical properties measurement

The prepared polymer concrete is sectioned and around 10mmx10mm cross-sectional area is prepared. After progressive polishing prepared polymer concretes are brought for fine polishing on a polishing wheel. Prepared

polymer concretes are thoroughly washed in water and dried by acetone. Prepared polymer concretes are observed by an optical microscope and micrographs are recorded with a digital camera.

2.3.5 Method of flexural strength measurement

Flexural strength, also known as modulus of rupture, or bend strength is a material property, defined as the stress in a material just before it yields in a flexural test. The flexural strength represents the highest stress experienced within the material at its moment of failure. Flexural strength of prepared polymer concrete is determined by using universal testing machine. For that thickness of prepared polymer concrete is measured by screw gauge and width of prepared polymer concrete is measured by slide calipers.

2.3.6 Method of Leeb rebound hardness measurement

The Leeb rebound hardness test is one of the four most used methods for testing metal hardness. This portable method is mainly used for testing sufficiently both laboratory work pieces and large work pieces. The traditional methods are based on well-defined physical indentation hardness tests. [63-66] The prepared polymer concrete has been sectioned and around 10mmx10mm cross-sectional area of prepared polymer concrete has been prepared. Cleaning of prepared polymer concrete has been done after sectioning prepared polymer concrete. Prepared polymer concrete has been kept upon solid surface where glycerin also applied before. After then Leeb rebound hardness measurement device has been applied on prepared polymer concrete surface for obtaining data.

2.3.7 Method of compressive strength measurement

Compressive strength is the capacity of a material or structure to withstand loads tending to reduce size, as opposed to tensile strength, which withstands loads tending to elongate. In other words, compressive strength resists compression, whereas tensile strength resists tension. In the study of strength of materials, tensile strength, compressive strength, and shear strength can be analyzed independently. Compressive properties of prepared polymer concretes are determined by using universal testing machine. For that thickness of prepared polymer concrete is measured by screw gauge and width of prepared polymer concrete is measured by slide calipers.

3. Results and Discussion

The results of the research work are as presented in the following

3.1 Density of prepared polymer concrete

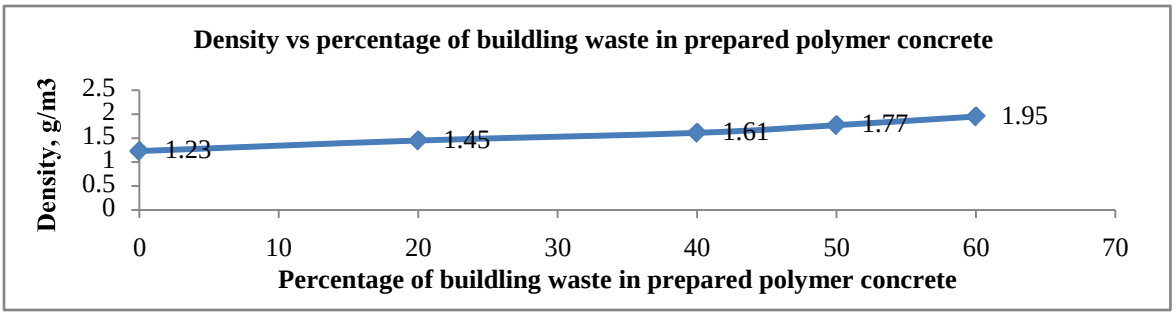


Figure-1: Density versus Percentage of building waste in prepared polymer concrete

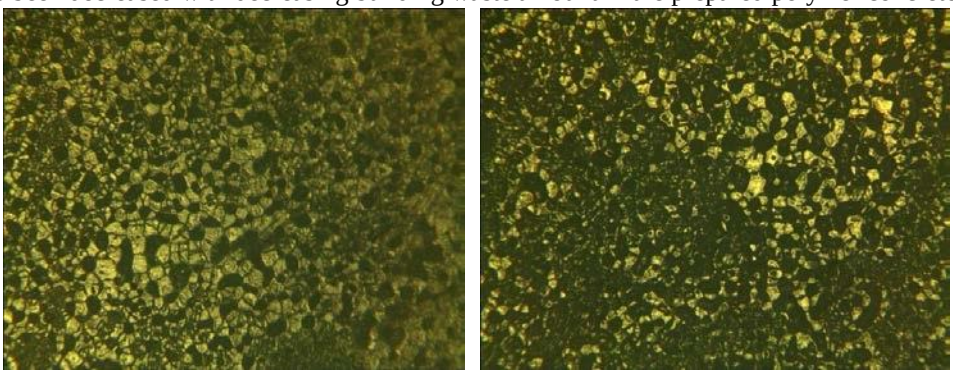
From above figure-1, it shows that density increases with increasing of building waste in prepared polymer concrete. Variation of density is observed with the change of composition of building waste in prepared polymer concrete. High density is notified with the high percentage of building waste in the composites of unsaturated polyester resin and building waste; besides low density is notified with the low percentage of building waste in the composites of unsaturated polyester resin and building waste. The calculated density of prepared polymer concrete has been increased 18%, 30%, 44%, 58% for 20%, 40%, 50%, 60% building waste adding respectively.

3.2 Water absorption of prepared polymer concrete

Water absorption of prepared polymer concrete with various compositions of building waste and unsaturated polyester resin is very nearly zero. Prepared polymer concrete of different compositions has been contacted with water in the various period of time but water absorption of prepared polymer concrete is zero.

3.3 Optical microstructure observation of the prepared polymer concrete

The microstructure of different composition of prepared polymer concrete under magnification of optical microscope is observed from microscopic view. Optical micrographs of prepared polymer concretes from optical microscope show that density phase has been increased with increasing building waste amount in the prepared polymer concrete; besides density phase has been decreased with decreasing building waste amount in the prepared polymer concrete.



(a) 20% building waste & 80% resin (b) 40% building waste & 60% resin

(c) 50% building waste & 50% resin (d) 60% building waste & 40% resin

Figure-2: Optical surface view of prepared polymer concrete (a, b, c and d)

Optical surface view of prepared polymer concrete (a, b, c and d) reveals that density has been increased upto addition of 60% building waste.

3.4 Flexural strength of prepared polymer concrete

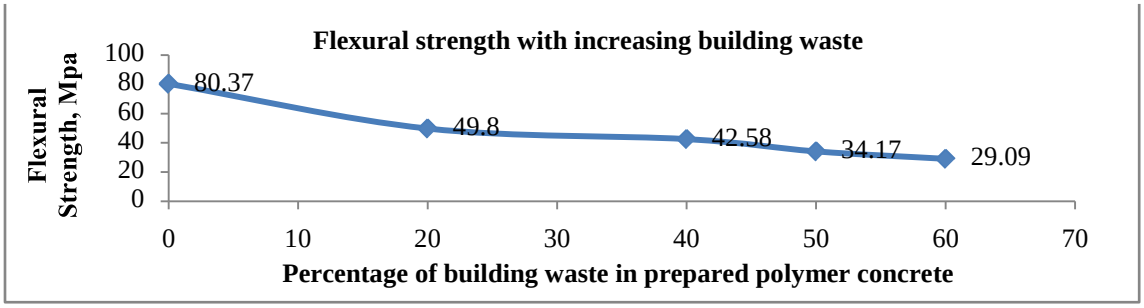


Figure-3: Flexural strength of prepared polymer concrete with building waste

From above figure-3, it shows that flexural strength of prepared polymer concrete decreases with increasing of building waste in concrete. So it can say that concrete containing high percentage of building waste behaves low flexural properties, besides concrete containing low percentage of building waste behaves high flexural properties.
The calculated flexural strength of prepared polymer concrete has been decreased 38%, 47%, 57% and 63% for 20%, 40%, 50% and 60% building waste adding respectively.

3.5 Leeb rebound hardness of prepared polymer concrete

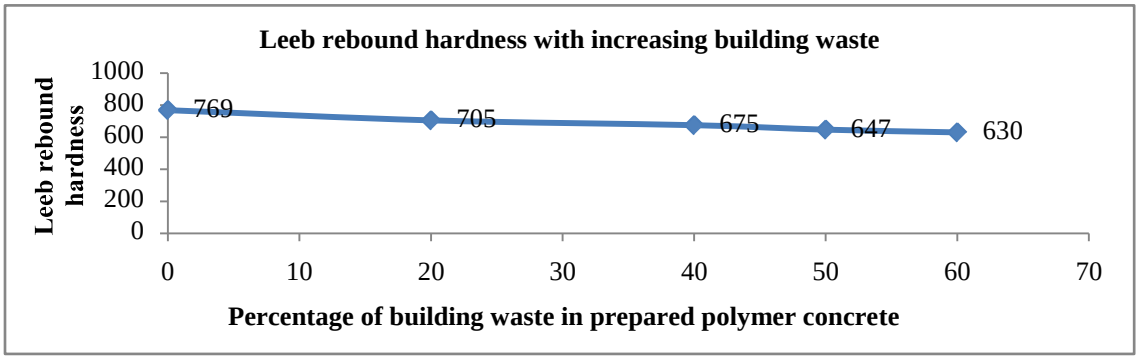


Figure-4: Leeb rebound hardness of prepared polymer concrete with building waste

From above figure-4, it shows that Leeb rebound hardness of prepared polymer concrete has been decreased with increasing building waste in concrete. So it can say that concrete containing high percentage of building waste behaves low hardness properties, besides concrete containing low percentage of building waste behaves high hardness properties. The calculated Leeb rebound hardness of prepared polymer concrete has been decreased 8%, 12%, 16% and 18% for 20%, 40%, 50% and 60% building waste adding respectively.

3.6 Compressive strength of prepared polymer concrete

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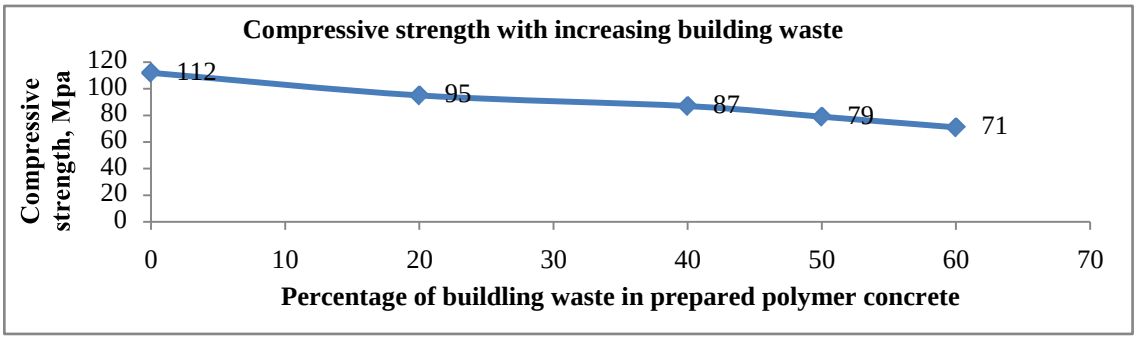

Figure-5: Compressive strength of prepared polymer concrete with building waste

From figure-5, it shows that compressive strength of prepared polymer concrete decreases with increasing of building waste in concrete. So it can say that concrete containing high percentage of building waste behaves low compressive properties, besides concrete containing low percentage of building waste behaves high compressive properties. The calculated compressive strength of prepared polymer concrete has been decreased 15%, 22%, 30% and 37% for 20%, 40%, 50% and 60% building waste adding respectively.

4.Conclusions

In this research work, the effect of prepared polymer concrete from unsaturated polyester resin and reinforced with building waste has been analyzed. The density, water absorption, Optical microstructure observation, compressive strength, flexural strength and hardness behavior have been calculated and quantified. Water absorption is zero. Density phase of prepared polymer concrete is also nearly uniform over various compositions. Compressive strength, flexural strength and hardness behavior of polymer concrete is also within expectation level. So, at the end of research, it can say that polymer concrete from unsaturated polyester resin and building waste will be found application in very specialized domains in the advance world.

5. Acknowledgement

First and foremost, all praise is upon to the omnipotent and omniscient Allah. I am extremely thankful to my Research supervisor Dr. Abdul Gafur, Principal Scientific Officer, Pilot Plant and Process Development Centre (PP and PDC), Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhanmondi, Dhaka, Bangladesh and Dr. Muhammed Yusuf Miah, Professor, Department of Applied Chemistry and Chemical Engineering, Noakhali Science and Technology University, Sonapur, Noakhali, Bangladesh. I would also like to express my heart warming thanks to the head of the following institutions for helping me a lot in doing my entire research work.

1. Pilot Plant and Process Development Centre (PP and PDC), Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhanmondi, Dhaka, Bangladesh.
2. Applied Chemistry and Chemical Engineering Department, Noakhali Science and Technology University, Sonapur, Noakhali, Bangladesh.

I am heartedly grateful to Ministry Science and Technology for financial support by enlisting me of the National Science and Technology (NST) Fellowship.

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