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Use of Limestone-Calcined Clay (LC3) Cement with Polyethelene Terephthalate Fibre in Concrete

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Abstract

As urban infrastructure demands continue to grow, the evolution of construction materials becomes imperative. This project, titled " An Experimental study on Limestone-calcined clay (LC3) cement with the use of (PET) Polyethylene terephthalate fibres in concrete Road Construction ". Limestone calcined clay cement (LC3) is a new type of low-carbon cement that can reduce energy consumption and carbon dioxide emissions while meeting the performance requirements of ordinary cement. In this study, a specimens were designed for 4 groups of curing ages. The compressive load–displacement data were measured the compressive curve characteristics were analyzed then, a compressive constitutive model of the composites was deduced and obtained.

The results show that, after 28 days, the compressive strength values of LC3 generally decreases with increasing PET fiber content In addition, the specimens showed better properties in terms of toughness, ductility and energy absorption. However, in the microstructures, the addition of PP fibers will cause more internal defects and flaws. This results of this study can provide some theoretical experience and technical support for the engineering application of LC3.

INTRODUCTION

Limestone-calcined clay cement (LC3) is one of the green or low-carbon binder options for replacing Portland cement, leading to sustainable construction. Reducing the thermal conductivity of the building's rendering mortar is helpful in reducing energy consumption for heating and cooling in buildings [2]. Limestone calcined clay cement (LC3) is an emerging cement that uses reduced clinker content in production, leading to a sustainable future by reducing CO_2 emissions. Compared to OPC, LC3 has performed well under normal conditions.[3] The disposal of used plastic bottles is one more serious issue which is faced after its use, as the plastic is non-biodegradable material and cannot be disposed easily. Due to faulty waste management practises, several inventions that were made to make our lives more convenient have contributed to environmental pollution. Water bottles and bottles for carbonated beverages are made of polyethylene terephthalate (PET). This is a problem for the environment because used plastic bottles can't easily biodegrade and need to be recycled or reused. The building industry is looking for low-cost materials to increase the strength of concrete structures in the modern world. The trash PET bottles may substitute some of the fine aggregate in regular Portland cement.Utilizing PET in concrete reduces post-cracks, and this is affected by PET fiber shape. PET fibers can increase the tensile, compressive, and flexural strengths of concrete if the recommended optimum dosage is used.

A zero-slump concrete with before the replacement of Ordinary Portland cement with

Limestone- calcined clay cement (LC3) and use of waste PET bottle fibers in preparing for pavement construction. This will not only reduce the CO2 emission but also will help in minimizing the disposal issue of waste plastic and may be useful in upgrading some properties. The primary reason for the addition of fibers in concrete is to enhance the post-cracking response of the concrete i.e., to enhance its energy absorption capacity and apparent ductility and to provide crack resistance and crack control. Also, it assists in maintaining structural integrity and cohesiveness in the material.

LITERATUREREVIEW

1. Mand Kamal Askar et al, Polymers(2023)

Plastic waste has been growing remarkably. Numerous waste plastic productsare generated by manufacturing processes, service industries, and municipal solid waste (MSW). The increase in plastic waste increases concern about the environment and how to dispose of the generated waste. Thus, recycling plastic waste becomes an alternative technique to the disposal of plastic waste in a limited landfill. One of the solutions is to use plastic waste as recycled material in concrete construction to produce what is called green concrete. This research illustrates a summary of studies that utilized polyethylene terephthalate (PET) in concrete as a volume ratio or concrete aggregate replacement.

2. Ameer Hamza Ahmed ,*et al.* (2024)

It describes about smart cities.Smart cities essentially require the state-of-the-art Smart service technologies span multiple sectors, with robotic systems being one of the primary solutions to address these requirements.Time is a critical issue when dealing with people who experience a sudden cardiac arrest that unfortunately could die due to inaccessibility of the emergency treatment.

3. Salim Barbhuiya *et al.* (2023)

The paper begins with an introduction to LC3 and its importance in reducing carbon emissions in the cement industry. It then discusses the raw materials used in the production of LC3 and the properties of the material, including its hydration process and thermal and X-ray diffraction analysis. The properties of LC3 concrete, including fresh, mechanical and durability properties, are also examined. The compatibility of chemical admixtures with LC3 is explored, followed by a discussion on the environmental benefits of using LC3.

4. J. Ston , K. Scrivener (2019)

This article presents a study on the creep properties of limestone calcined clay cement. A series of paste samples using limestone and calcined clays as replacement materials were tested under basic compressive creep. The ternary mixes showed a lower creep compliance than the plain cement references, even when using low reactivity clays or lower replacement fraction.

PROPOSED SYSTEM

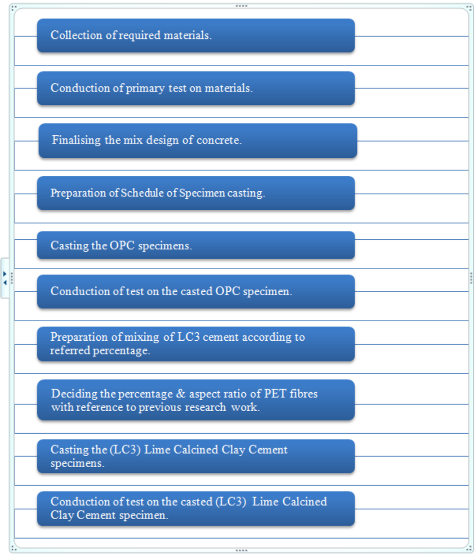

Fig 1: Flow chart of Research work

METHODOLOGY

The concrete of specified mix design will be prepared and casting of concrete mould has been takes place.

A. Mix Design of Concrete

1. Determine the Requirements. Start by understanding the specific requirements of your project.
2. Select the Water-Cement Ratio.
3. Choose the Cement Content.
4. Select and Proportion Aggregates.
5. Determine the Admixture Dosage.
6. Calculate the Mix Proportions.
7. Conduct Trial Mixes.
8. Perform Quality Control Tests.

B. Material Collection

1. Cement

The cementitious material used in RCC mixtures will include 53 grade Ordinary Portland cement (OPC)

2. Fine and Coarse aggregate

The natural river sand and coarse aggregate used will be uncrushed clean, dry, well graded, natural 20 mm nominal size (IS:383-1970, IRC:SP:20-2002). The sand should comply with the requirement of IS:2386 (1963).

3. Limestone Calcined Clay Cement (LC3)

LC3 is a new blend of two materials which have a synergetic effect can reduce half of the clinker content and therby cut up to 40% of the CO2-emissions.The LC3-blend consists of the following materials:

- Clinker that needs to be burnt at very high temperatures between 1400 and 1500°C.
- Calcined clays are burnt at approximately 800°C.
- Limestone is added without processing
- Gypsum for workability.

4. Polyethylene terephthalate fibers (PET)

The PET fibres used in the concrete will be procured from recycled PET material extruded into 12mm fibres.

C. Casting the OPC specimens:

- Take a sample of freshly mixed concrete – We take a sample of the concrete we want to test from our mobile batching unit, where it has been freshly mixed.Concrete cubes are typically made in moulds with dimensions of 150mm x 150mm x 150mm.
- Pour the concrete into cube moulds – The sample concrete is poured into cube moulds. The concrete in each mould is then filled, levelled, compacted and tampered torequirements. Each cube is taken to our temperature-controlled lab, where it is kept for 24 hours, before being cracked and put into our water tanks to cure.Fill the concrete in each mould in three layers.
- After each layer do proper compaction by applying 35 strokes using a tamping rod. After 3 rd layer compaction, Finish the top surface using a flat trowel.
- Let the concrete cubes cure – The cubes are kept in our temperature-controlled water tanks for 28 Days, 56 Days, 90 Days.

CONCLUSION

The results show that, after 28 days, the compressive strength values of LC3 generally decreases with increasing PP fiber content and the combined effect of PP fibers and hydration products causes the compressive strength of LC3 with 0.5% PP fibers to drop sharply .In addition, the specimens showed better properties in terms of toughness, ductility and energy absorption. However, in the microstructures, the addition of PP fibers will cause more internal defects and flaws. This results of this study can provide some theoretical experience and technical support for the engineering application of LC3.

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LC3 containing fiber s and AAC blocks with calcined clay." (2018)

Shiju Joseph, Shashank Bishnoi and Soumen Maity "Analysis that the production of LC3 will be commerically viable with respect to PPC "(2014)