Biofibre Reinforced Concrete

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Abstract This paper presents the outcomes of the experimental program conducted to study the mechanical properties of concrete homogeneously reinforced with biofibres like *Sida cordifolia* plant fibre (SICOF), Pineapple leaf fibre (PALF), Banana fibre (MUSAF) and Bagasse (BAGAF). The optimum content of fibre to be used is determined by conducting an experimental study on MUSAF and it is found to be 0.25 % by weight of concrete. The performance of this biofibre reinforced concrete (BFRC) is evaluated by conducting strength tests like compressive, split tensile and flexural strength tests in accordance to Indian standards. The results when biofibres are used in concrete individually shows that MUSAF and SICOF are good in improving compressive strength and split tensile strength, respectively. Scanning Electron Microscopy (SEM) images indicate that there is good bonding between these biofibres and concrete matrix. In this study, also an attempt has been made to check the performance of biofibres when used in combination. The combinations tried are SICOF-PALF (SP), SICOF-MUSAF (SM), SICOF-BAGAF (SB) and PALF-MUSAF (PM). Out of these, the combination SM gave excellent results both in improving compressive and split-tensile strengths of concrete.

Keywords Biofibres · *Sida cordifolia* · Pineapple leaf fibre · Optimum fibre content · BFRC

1 Introduction

Concrete is the most widely used construction material for permanent structures throughout the world since the last few decades and it is the second largest consumable material after water. However, this extremely versatile material suffers

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V. Matsagar (ed.), *Advances in Structural Engineering*,
DOI 10.1007/978-81-322-2187-6_126

from certain intrinsic deficiencies like low tensile specific modulus, limited ductility and little resistance to cracking. To compensate, steel is added to concrete which distributes the tensile strain forces that causes concrete to crack and ultimately fail. Although this method has been used successfully for many years, there are few associated drawbacks. Steel is expensive to purchase, transport and store. The placement of steel consumes time and labour costs and often requiring placement in difficult and dangerous locations. Most serious of all, steel is highly corrosive in nature leading to failure of structure which is expensive to repair and even requiring demolition of the structure. Hence, researchers are aiming at sustainable and eco-friendly structures and to develop a material which could replace steel.

Since 1960, efforts have been made by scientists and engineers to develop concrete composites, devoid of the basic drawbacks of concrete, culminating in the development of fibre reinforced concrete (FRC). This FRC is a new material in which fibres are randomly oriented and homogeneously distributed. These fibres can be natural or manmade. The proven properties of Natural/Biofibres like renewability, lightweight, non-corrosive nature, high toughness etc. makes them stand in lieu of synthetic fibres. Inclusion of biofibres as reinforcement in concrete have proved to improve resistance to fatigue, impact, thermal shock and spalling and also supports the concept of sustainability and green building. Although several researchers have done investigation on biofibres, very limited or no work has been done on biofibres like SICOF (*Sida cordifolia* fibre), PALF (Pineapple leaf fibre), MUSAF (Banana fibre) and BAGAF (Bagasse). In this study, SICOF is the fibre which is used entirely new exclusively in this work and SICOF and PALF are used as reinforcement in concrete for first time thus finding their new application. This paper presents a summary of findings of the study conducted to investigate the properties of this biofibre reinforced concrete (BFRC). In this study, the biofibres SICOF, PALF, MUSAF and BAGAF are used as reinforcement both individually and also in combinations like SICOF-PALF, SICOF-MUSAF, SICOF-BAGAF and PALF-MUSAF. The present study aims to develop a new class of concrete by analyzing the mechanical properties of BFRC experimentally including compressive, split-tensile and flexural strength. This study is useful for further research on BFRC which helps in developing a sustainable and ecofriendly structures.

2 Background

2.1 History of FRC

The concept of using fibres as reinforcement dates back to biblical times when straws were used in mud brick manufacture [1]. The first modern alternative was the use of asbestos in concrete in the early 19th century, to protect it from crack formation. The need to replace asbestos fibres due to associated health risks in the early 1950s gave rise to the development of composite materials and by 1970s steel