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Review on Fiber Reinforced Pavement Blocks

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Abstract
Concrete paving blocks are ideal materials on the footpaths for easy laying, better look and finish. Concrete reinforced with fibers are composite material consisting of fibrous material which may increase its structural integrity. Fibers can be of natural as well as synthetic. Natural fibers are sustainable materials which are easily available in nature and have high advantages whereas synthetic fibers are fibers made by humans through chemical synthesis. The aim of this paper is to enhance the current knowledge about pavement blocks, fiber reinforced concrete, synthetic and natural fibers.

Keywords: *Concrete paving blocks, Natural fibers, Synthetic fibers, fiber Reinforced concrete.*

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I. INTRODUCTION

Concrete paving blocks (pavers) have been used in pavements for more than 50 years in Europe, and have been used in the United States since the 1970's. Many successful applications exist using pavers for heavy industrial, port, and airfield pavements. Lot of facelift is being given to roads, footpaths along with roadside. Concrete paving blocks are ideal materials on the footpaths for easy laying, better look and finish. Cement concrete paving blocks are precast solid products made out of cement concrete. The product is made in various sizes and shapes viz. rectangular, square, and round blocks of different dimensions with designs for interlocking of adjacent paving blocks. As countries continue to develop and urbanize at an exponential rate, the need for cement paving blocks has become an essential part of town and city development and expansion. This coupled with the development of technique that can improve quantity and performance of cement paving bricks than ever before. After World War II, most of Europe was in ruin and reconstruction began. The roads where rebuilt using paving stones as they have historically proved to be able to withstand certain demands that concrete and asphalt could not meet. German engineer, Fritz Von Langsdorff developed a choice of shapes and introduced the use of colors in concrete pavers. Concrete interlocking pavers where now an efficient and economical choice as mass production started in the 1960s in Germany. In the 1970s production technology spread through Europe and other parts of the world including the United States. Since then America has seen a significant growth of concrete interlocking pavers and has been growing steadily

1.1 LITERATURE REVIEW

The main aim of this section is to present an overview of research work carried out by various researchers in the field of Paving block, Fiber Reinforced Concrete, Natural and Synthetic fibers.

1.1.1 Pavement Blocks

Concrete pavement blocks [CPB] have been extensively used in a number of countries as a specialized problem solving technique for providing pavements in areas where conventional types of constructions are less durable. Pre-cast concrete paving blocks are gaining popularity and acceptance as they are becoming more commonly used for different purposes like the street roads, parking lots, outside on land scope and even in areas of heavy wheel loads such as the airports, warehouse pavements and pedestrian walkways just to mention a few. At a precast concrete plant, the properties, design, and shape of CPB can easily be modified to fulfill the requirements of different applications. Another reason for the rising applications of CPB is its high compressive strength and excellent durability. In the event of reconstruction or rehabilitation, CPB can be re-adjusted and reused without substantial loss in its designed properties [1]. The method of manufacture of CPB has an important bearing on the quality, durability and level of finish – dimensional tolerance etc. Esstentially, the manufacturing process involves compacting concrete in a steel mould clamped to a vibrating table. Vibropressing compaction of dry mixed concrete has increased the production rate of paving blocks, as it eradicated the need of formwork to hold the fresh concrete mixture in shape after molding. This technique also optimized the cost-benefit ratio as it

helps in achieving high strength blocks with the minimum utilization of water and cement [2]. Researchers dealing with pavements and experts on materials have been increasingly focused on the structural strength of the pavement materials without paying sufficient attention to the environment and cultural norms. In the 21st century, the concept of pavement design and rehabilitation needs to be modified owing to new requirements such as the additional structural loads derived from the climate change, environmental challenges, social requirements, and aging population. Therefore, the concept of post-modern pavement (PMP) was proposed to address the structural, sustainability, and sociopsychological requirements [3]. The durability of CPB is mainly dependent on the quality and strength of the paving block. However, the block–block interface conditions are also critical to the overall performance of the pavement [4]. The paving blocks can be produced in different grades of concrete, shapes and size. Several standards and specifications, such as the Indian Standards (Bureau of Indian Standards, 2006), the British Standards (BS EN 1338:2003) (British Standards Institution, 2003), the ASTM C936/C936M (ASTM, 2015), are available for the detailed definition and basic requirements of the paving blocks. Interlocked paving blocks offer many advantages like the need for maintenance and repair is less, the material is economical as only domestic materials are consumed during production, the speed of production and the material capacities are higher, they are readily accessible for traffic immediately after being laid on the road [5].

1.1.2 Fiber Reinforced Concrete

Concrete are mostly applied in the construction of barriers and protective structures in places where there is an application of impact loads. Concrete is strong in compression but week in tension. The formation of crack is one of the main reasons for the failure of concrete. To arrest the the cracking the fibres are added to concrete mix. Reduced service life is also a resultant outcome when a standard concrete mix is used for various applications. Effective way to improve these properties of concrete is also the incorporation of fibers [6]. Due to the rapid development in Fibre Reinforced Concrete (FRC) and its extensive applications, FRC is becoming increasingly popular in civil engineering construction [7]. An addition of fibres to concrete has a beneficial effect on its several mechanical properties, such as flexural strength, resistance to dynamic effects, tensile strength, ductility and crack resistance. The main function of the fibres is to bridge cracks appearing in the internal structure of the concrete and to enable the concrete elements to deform plastically [8]. Moreover, the presence of fibres contributes to the reduction of stress concentration at the crack's end, which, if the fibres were absent, would accelerate the propagation of the crack.

1.1.3 Natural and Synthetic Fibers

All fabrics can be characterized as either natural or synthetic fibers (or a blend of the two). Both types have pros and cons; natural fibers come from plants and animals, while synthetic fibers are made from chemical compounds, and each is valued in the textile industry for different reasons. Natural fiber reinforced concrete is a cement based concrete matrix, in which small diameter discontinuous, discrete natural fibers dispersed randomly throughout the concrete matrix [9]. Based on the origins of natural fibers, they are usually classified in three groups, namely- plant, animal, and mineral. Among these, plant fibers are the preferable one. Because, whereas animal fibers are mostly consisting of proteins and mineral fibers are associated with a health issue but cellulose is the significant elements of plant fibers, which makes plant fiber the most preferable one [10]. Synthetic fibers are most commonly added to concrete for slab-on-grade construction to reduce early plastic shrinkage cracking and increase impact- and abrasion-resistance and toughness. The fibers also can be added to precast concrete to improve resistance to handling stresses, to pumped concrete to improve cohesiveness, and to shotcrete to reduce rebound and material waste. Macro synthetic fiber reinforced concrete has a considerable structural bearing capacity. Compared to steel fiber reinforced concrete, it has the advantage of corrosion resistance and durability [11]Polypropylene fibers are new generation chemical fibers. They are manufactured in large scale and have fourth largest volume in production after polyesters, polyamides and acrylics. About 4 million tonnes of polypropylene fibers are produced in the world in a year. Polypropylene fibers can be divided into microfibers and macrofibers depending on their length and the function that they perform in the concrete [12]. Primarily, they differ in the length but more importantly in the function that they perform in the concrete. Macrofibers are also called structural fibers because they are able to replace the traditional reinforcement in the form of steel bars and transfer loads acting on the structure. Therefore, the time needed to make steel reinforcement, and thus the investment costs, are saved. With the development of modern civil engineering, increasingly more attention has been paid to the durability of concrete; in other words, no matter what the design strength is, the durability of the structure should first be satisfied. The addition of GF or PPF can affect the durability of the concrete [13].Hemp fibers are considered as one of the strong member of bast natural fibers family, which are derived from the hemp plant under the species of *Cannabis.* The use of hemp-reinforced concrete has two main advantages. The first is the potential of reducing the coarse aggregates quantities while producing similar or even better mixes, resulting in a sustainable concrete. The second advantage is that the demand for hemp fibers for concrete production would be a major incentive for farmers to grow this plant and benefit from the social impact on the habitat level of living

[14]. The addition of hemp fibres slightly changes the mortars' density, water absorption, compressive and flexural strength, however significantly increased its energy absorption capacity [15].

II. CONCLUSION

Fiber Reinforced Concrete can prevent the failure of concrete due to the formation of crack to some extent. Moreover mechanical properties, such as flexural strength, resistance to dynamic effects, tensile strength, ductility can also be improved. Fibers can be natural or synthetic. Both of then can improve the strength of the concrete depending upon the characterstics of fiber used. Addition of fibers to the pavement blocks was found to improve their mechanical property. It was also observed that since the slump required for pavement are zero, vibration plays an vital role in its strength achievement. The quality of pavement blocks depends upon various parameters such as capacity of compaction, vibration of machine, grade of cement used etc.

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