USE OF POLYMERIC WASTE MATERIALS IN CONCRETE FOR ROAD PAVEMENTS

[1]Ankur, [2]Shivam Singh Patel

[1]Student, [2]Assistant Professor
DEPARTMENT OF HIGHWAY ENGINEERING
MAHARISHI UNIVERSITY OF INFORMATION TECHNOLOGY
LUCKNOW - 226013 (U.P), INDIA

***ABSTRACT*: Concrete is strong in compression but weak in tension and brittle also. Cracks also start forming as soon as the concrete is placed. These three drawbacks don't permit the use normal concrete in pavements as they lead to lack of ductility along with fracture and failure. These weaknesses in concrete can be mitigated by using fibers as reinforcement in the concrete mix. Waste materials in the form of polyethylene and tires cause environmental pollution which leads to various health problems. Polyethylene and waste tires can be recycled and used effectively in the concrete as reinforcement in the fiber form. Polyethylene is a synthetic hydrocarbon polymer which can improve the ductility, strength, shrinkage characteristics etc. This paper deals with the effects of addition of polyethylene fiber on the properties of concrete. Polyethylene and tire fibers were cut into the size of 30mm x 6mm and they were used 1.5% each by volume. Grade of concrete used were M30, M35 and M40. IRC 44:2008 was followed for the design of concrete mix. In this study, the results of the strength properties of Polyethylene fiber reinforced concrete have been carried out. Finally it can be concluded that polyethylene and tire can be used effectively in reinforced cement concrete.**

INTRODUCTION

For a developing nation such as India, road networks play a crucial role in providing a durable and comfortable surface for vehicles. Pavements are mostly made using bitumen. However, in certain situations concrete pavements are also preferred. Many additives have been explored for beneficial use of concrete as a paving material. A recent research has shown that fiber reinforced concrete (FRC) can be used for the construction of pavements as it is found to be very good in strength and it also exhibits other desirable properties . The definition of FRC given by ACI Committee 544 is "fiber reinforced concrete is a concrete which is made of cements containing fine and coarsse aggregates along with water for obtaining cementious properties and discontinuous fibers". The fibers used are of various types such as steel fibers, polymer or natural fibers etc. As said earlier, fiber reinforced concrete is that form of concrete where fibers are put into the concrete as reinforcement in order to increase the strength characteristics and other mechanical properties of the concrete. Fiber reinforced concrete is not just provided for local strengthening in tensile region but it is provided for obtaining a gain in compression and tension along with reduced deflections and shrinkage and increased ductile property. Apart from the above mentioned properties, polymeric fibers also help in corrosion reduction. Commonly, Recron 3s, polyester and polypropylene have been used for the purpose of FRC. Recently, other forms of recycled fibers like plastic, disposed tires, carpet waste and wastes from textile industry are also being adopted for the same purpose. Basic function of these fibers is to act as crack arresters.

Fig- Steel Fiber

Fig- Polypropylene Fiber

Fig- Polyethylene Fiber

Fibers help in resisting the minor cracks and would not let them grow into macro cracks. Hence, the material transforms into a material with improved ductility and toughness to failure. Since it has been established that fiber introduced concrete has the property of obtaining extra strength in flexure, compression, fatigue and impact, it can successfully be reinforced in concrete to get more strength as a whole and use it for pavements as concrete in itself is weak in tension and impact. Fibers in combination with concrete also results in a mix with improved early resistance to plastic shrinkage cracking, reduced water absorption, greater impact resistance, enhanced flexural strength and tensile strength of concrete and thereby protects the concrete from drying shrinkage cracks. Standard documents such as IS: 456:2000 Cement Concrete Mix Designs for pavements with fibers, IRC: SP: 76: 2008 Guidelines for Ultra-Thin White Topping with fibers, Vision: 2021 by Ministry of Surface Transport, New Delhi etc. include the use of polymer fibers with concrete. Many national bodies such as Central Public Works Department (CPWD), Airport Authority of India, Military Engineering Services, Defense Airfields, NF/Southern Railway, ISRO (Bangalore) etc. have also approved the use of polymer fiber reinforced concrete.

USE OF WASTE POLYETHYLENE AND TIRES

Plastics are very strong and non-biodegradable in nature. The chemical bonds in plastics make it extremely sturdy and impervious to ordinary common techniques of degradation. The daily use of plastics has increased very rapidly and it has become a common habit of people to just throw out the plastic and causing environmental pollution. Over 1 billion tons of plastic have been produced since 1950s, and the same is likely to remain as such for many years [28]. These wastes get mixed with MSW or they are simply thrown causing nuisance to the society. There is a big need of recycling of the plastics as well waste tires because we don't have any other option of disposing them without securing environment from pollution. For example, there are two processes for the disposal of wastes: land filling and incineration. If the wastes are simply dumped, they cause soil and water pollution and if they are incinerated, they cause air pollution. Hence, there is a need to recycle the wastes into something useful which will not hamper the environment and the process in which it is used.

OBJECTIVE

The present work is aimed at using two polymeric waste materials, such as polyethylene and tire fibers as reinforcement in concrete pavement. The basic objective of this work is to assess the advantages of using such waste materials such as increase in compressive, flexure and shear strength and decrease in deflection characteristics of the resultant concrete and also the determination of the deflection in the laboratory testing then its comparison to the theoretical deflection and check whether the errors are in the permissible limits of 20%. The main goal of the study is to utilize waste materials polyethylene and tier to achieve greater concrete strength properties in order to recycle them into something very useful and helping in reducing the environmental impact that the both of them have.

LITERATURE REVIEW

Fiber reinforced concrete (FRC) is made by mixing polymer fibers into a conventional concrete mix. The definition of FRC given by ACI Committee 544 is "FRC is a concrete which is made of cements containing fine and coarse aggregates along with water for obtaining cementious properties and discontinuous fibers

Role of polymer in pavement

There is a need of improvement in the quality of the pavements as the steady increase of wheel loads, change in climatic conditions; tire pressure & daily wear and tear adversely affect the performance of vehicles over the pavement. Synthetic polymer fibers can be used to overcome the above mentioned problems which are faced in daily life. Modifying the concrete with the polymers can improve the crack arresting capability, fatigue life and many other mechanical prospects of pavement.

Polymer fibers as an option to conventional reinforcement

Fibers are known to have been used initially by the ancient Egyptians back in 1500 B.C. These people used the hair of animals as reinforcement for not only mud bricks but walls in housing also. Various studies have provided an overview of the developmental stage of Fiber Reinforced Concrete. In the 1960s, polymer fibers were taken seriously for using in reinforcement concrete and it then picked its momentum from then.

Types of fiber

Reinforced concrete ACI has divided fiber reinforced concrete into four categories namely SFRC, GFRC, SNFRC and NFRC. Here SFRC means steel fiber reinforced concrete, GFRC stands for glass fiber reinforced concrete, SNFRC is synthetic fiber reinforced concrete and NFRC is an acronym for natural fiber reinforced concrete. There are also discussed many theoretical and practical insights about different design application and physical and mechanical properties. Another method of classification was adopted by Cement and concrete Institute in which fibers are divided into the following types, glass fibers, steel fibers, synthetic fibers and natural fibers.

(A) Synthetic fibers:- Synthetic fibers include polyethylene, polypropylene, acrylic, carbon, aramid, nylon, polyester etc. Synthetic fibers can be further classified into macro-fibers and micro-fibers. Both of these subtypes have different properties with respect to each other. We have used polyethylene and tire in the form of macro-fibers as the reinforcement.

Fiber properties

The effect of all types of fibers has been studied by many researchers. They have studied the physical properties along with mechanical properties of concrete. But there hasn't been done much research on polyethylene fiber reinforced concrete and waste tire fiber concrete. The knowledge regarding these fibers as reinforcement in concrete is limited.

The way fibers are distributed in the concrete significantly afacts the properties of FRC. It was found out in a study that the fibers which are of higher volume fraction and longer in size showed balling at the time of mixing. This leads to stiffening of the concrete paste. When the volume fractions of fibers are increased, it further leads to a reduction in workability. This will in turn have an impact on the mechanical properties of concrete and its quality. Synthetic fibers are used mainly to control cracking and plastic shrinkage.

(A) Ductility:- Ductility can be defined as "the ability of material to undergo large deformations without rupture before failure". It is considered a good warning indicator before failure. When fibers are induced into the conventional concrete, they increase the ductility of the concrete. High damage tolerant beam-column joints can be achieved by using high performance fiber reinforced cement composites. When this joint is constructed with 1.5% by volume of ultra-high molecular weight polyethylene fibers tend to show very good strength characteristics along with reduction in deformation.

(B) Fracture Toughness:- Under a static, dynamic or impact load, the energy absorption capacity of material is measured through fracture toughness . Post-cracking behaviour of concrete beam is checked at mid span by determining the deflection for fracture toughness. There have been made studies over the effects of toughness on fiber type, dosage, properties, and bonding conditions. Conventional reinforcement such as steel is provided in the concrete because it fails in tension. Similarly due to very good ductile and toughness properties fibers can also be induced into the concrete as reinforcement in order to improve the tensile resisting capacity of the concrete by redistributing the stress concentration.

(C) Other properties:-Fiber reinforcement causes reduction in early age shrinkage as well as the drying shrinkage in concrete. Fiber in a concrete captures the micro cracks and prevent it from turning into a macro crack even at the very early ages. Concrete when reinforced with polyethylene fibers in 2 to 4% by volume shows a linear deflection curve up to the first crack formation but it transfer the load to the fibers until the fibers break. There have been shown increase in the compressive strength up to 20% and flexural strength upto 40% at 28 days when fiber induced are steel or polypropylene. Further when waste tire fibers are used in the concrete, under Impact loading, resistance is shown for cracking. The reinforced concrete thus made, shows increase in the toughness of the concrete. The toughness of waste tire modified concrete is found to be much larger than conventional concrete. Hence its energy absorption capacities are much larger compared to the normal concrete. Further, the failure occurred in ductility rather than in brittleness. Waste tire fibers have been found to have capture the cracks when minor impacts are made on concrete. Waste tires also contribute towards ductility in case of compression failure.

LEARNING OUTCOME

Where petroleum and its by-product levels are shrinking by the day, concrete pavements are a better substitute of bituminous pavements for highway road applications. Locally available normal OPC can be used for pavements replacing bitumen which is a distillation product of crude petroleum.

Use of non-biodegradable substance like waste polyethylene is an economic and environment friendly approch in the field of transportation. Unlike steel fibers it is non-corrosive, light weight and has less cost. Similarly wasted tire fibers (with steel wires

striped out) can be used in concrete effectively. These two material together when incorporated with concrete fulfill two main requirement of pavement material, cost effectiveness and reduced pollution.

It can be seen that the FRC made by using wasted materials like polyethylene and tire fiber significantly increase the strength of concrete. The fiber introduced concrete exhibited good strength against compression, flexure and shear, three most important properties of concrete. It also made the concrete tougher and significantly reduced the deflection that it undergoes when subjected to any external loads.

REFRENCE

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