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A REVIEW STUDY OF POLYMER FIBRE REINFORCED CONCRETE WITH CONVENTIONAL CONCRETE PAVEMENT

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Abstract: Road transportation is undoubtedly the lifeline of the nation and its development is a crucial concern. The traditional bituminous pavements and their needs for continuous maintenance and rehabilitation operations points towards the scope for cement concrete pavements. There are several advantages of cement concrete pavements over bituminous pavements. Shrinkage cracking of concrete is a major problem in plain cement concrete pavements especially in tropical regions. This paper explains on polymer fibre reinforced concrete pavements, which is a recent advancement in the field of reinforced concrete pavement design. PFRC pavements prove to be more efficient than conventional RC pavements, in several aspects, which are explained in this paper. The design procedure and paving operations of PFRC are also discussed in detail. A detailed case study of Polyester fiber waste as fiber reinforcement is included and the results of the study are interpreted. The paper also includes a brief study of various researchers.

Keywords: Fiber Reinforced Concrete, Cement, Polymer Fibers

1.0 INTRODUCTION

Concrete is weak in tension and has a brittle character. The concept of using fibres to improve the characteristics of construction materials is very old. Early applications include addition of straw to mud bricks, horse hair to reinforce plaster and asbestos to reinforce pottery. Use of continuous reinforcement in concrete (reinforced concrete) increases strength and ductility, but requires careful placement and labour skill. Alternatively, introduction of fibres in discrete form in plain or reinforced concrete may provide a better solution. The modern development of fibre reinforced concrete (FRC) started in the early sixties. Addition of fibres to concrete makes it a homogeneous and isotropic material. When concrete cracks, the randomly oriented fibres start functioning, arrest crack formation and propagation, and thus improve strength and ductility. The failure modes of FRC are either bond failure between fibre and matrix or material failure. In this paper, the state-of-the-art of fibre reinforced concrete is discussed and results of intensive tests made by the author on the properties of fibre reinforced concrete using local materials are reported. Construction of rigid pavements is essential for airports as well as for highways where weak sub grade exists or heavy traffic volume is encountered. Concrete is the most common material used in the construction of rigid pavements and overlays but the problem associated with concrete is its sensitiveness to moisture loss and shrinks whenever moisture loss occurs due to hydration of cement, evaporation, etc. If concrete member is restrained, then tensile stresses are developed in the concrete and when these stresses touch the tensile strength, cracks are formed.

Mixing of FRC can be accomplished by many methodsl21. The mix should have a uniform dispersion of the fibres in order to prevent segregation or balling of the fibres during mixing. Most balling occurs during the fibre addition process. Increase of aspect ratio, volume percentage of fibre, and size and quantity of coarse aggregate will intensify the balling tendencies and decrease the workability. To coat the large surface area of the fibres with paste, experience indicated that a water cement ratio between 0.4 and 0.6, and minimum cement content of 400 kg/m are required. Compared to conventional concrete, fibre reinforced concrete mixes are generally characterized by higher cement factor, higher fine aggregate content and smaller size coarse aggregate. Due to increasing traffic volume on existing airports and roadways, major challenges are faced by road agencies because they have to repair deteriorated pavements to maintain smooth traffic flow on these pavements. To reduce reflecting cracking, several techniques including a seal coat application to the existing pavement, saw and seal the hot-mix-asphalt (HMA) overlay, cracking and seating of concrete pavements, use of geo synthetics, etc. are used. The agency observed that none of these sections exhibited reflection cracking during the first year following rehabilitation. However, most of the reflection cracking appeared during the second year after rehabilitation. However, relatively small increase in the length of the reflection cracking over time for all of the rehabilitation techniques was noted. In addition, the amount of reflection cracking does not significantly increase after this period. However, it is expected that these cracks will continue to deteriorate.

2.0 LITERATURE REVIEW

Amit Rai, Dr. Y.P.Joshi (2014) conducted the experimental studies and application of fibers reinforced concrete. They study different types of fibers and their application. The improvement in concrete properties by polypropylene fibers, they analysed that compressive strength which is increased about 16%. The flexural strength of polypropylene fibers is improved about 30%.They studies the different types of fibres and the concrete properties. Fiber addition improves

ductility of concrete Slump test were examined to find out the workability and consistency of fresh concrete. The efficiency of all fiber reinforcement is dependent upon achievement of a uniform distribution of the fibers in the concrete, their interaction with the cement matrix, and the ability of the concrete to be successfully cast or sprayed.
Komal Bedi (2014) Experimental studied on flexure strength on polypropylene fiber Reinforced concrete and considered the impacts of polypropylene fiber on the flexure strength of cement. The trial customized was under taken to test standard concrete beam (150 X 150) mm with a span 700 mm for examining strength in flexure. The specimens were contrasted with no fiber and polypropylenes fiber of force 0.89 kg for each cum of cement. To give a premise to flexure, reference examples were thrown without polypropylene fiber. The test outcomes demonstrated that the mechanical properties of flexural strength coming about because of included of polypropylene fiber was generally high.

Kolli, Ramujee (2013) conducted the experimental studies on the strength properties of polypropylene fibre reinforced concrete. A combination of high strength, stiffness and thermal resistance polypropylene fibers are preferred for the fibre reinforced concrete. In this study, the results of the Strength properties of Polypropylene fiber reinforced concrete have been studied. The compressive strength, splitting tensile strength of concrete samples made with different fibers amounts of percentage varies from 0%, 0.5%, 1% 1.5% and 2.0% were studied. The samples with added Polypropylene fibers of 1.5 % showed better results in comparison with the other fibre percentage.

Peng Zhang et al (2013) studied on the Fracture Properties of Polypropylene Fiber Reinforced Concrete. The goal of this paper is to Used 0.04%, 0.06%, 0.08%, 0.1% and 0.12% of polypropylene fibers in concrete containing 15% fly ash and 6% silica fume. They reported by testing beam specimens under three point loading, that addition of fibers greatly improved the fracture parameters of concrete composite such as fracture toughness, fracture energy, effective crack length, maximum mid-span deflection, critical crack opening displacement etc. With increase in fiber volume fraction from 0 to 0.12%, there is increase in fracture parameters. The fibers embedded in concrete affect the stress and strain, enhancing the stress redistribution and reducing strain localization. The addition of polypropylene fibers to plain concrete reduces the crack width to an extent of 21% to 74%.

MR. Mehul J. Patel et al (2013) studied the effect of polypropylene fibre on the high strength concrete. The paper deals with the effects of addition of various proportions of polypropylene fibers on the properties of high strength concrete. An experimental program was carried out to explore its effects on compressive, tensile, flexural, shear strength and plastic shrinkage cracking. A notable increase in flexural, tensile and shear strength was found. The main aim of the investigation program is first to prepare the strength of concrete of grade M40 with locally available ingredient and then to study the effect of different proportion of Polypropylene fiber in the mix and to find optimum range of Polypropylene fiber content is 0.5%,1.0%,1.5% in the mix. The concrete specimens were tested at different age level for mechanical properties of concrete, namely, cube compressive strength, split tensile strength, flexural strength and other test were conducted for cement, chemical admixture, coarse aggregate & fine aggregate.

P. Sathe et al (2013) experimentally investigated on Polypropylene Fiber Reinforced Concrete with Artificial and exploration work of trial examination on polypropylene fiber strengthened cement by supplanting river sand to manufactured sand with and without admixture. Utilization of fiber strengthen polymer in structural designing increment quickly. Different kind of fiber is utilized, for example, glass, and carbon, steel, asbestos, polyester and polypropylene. The different trial examinations for determination of properties of polypropylene fiber are talked about in paper work. This paper introduces the impact of polypropylene (PP) fibers on different properties of cement, for example, compressive strength, elasticity, workability, and fracture properties with different substance of fiber (0%, 0.5%, 1.0%, and 1.5%). The consequence of this present examination demonstrates that by including of 0.5% of polypropylene fiber indicates greatest compressive and rigidity strength.

N Pannirselvam et al (2009) conducted the experimental strength behaviour of fibre reinforced polymer strengthened beam. They found that strengthening of structures using fibre reinforced polymer. The objective of their work is to determine the strength of structural behaviour of reinforced concrete beams. They observed that in the beam the deflection duclity values for beams showed increases over the corresponding the reference beams

K. Vamshi Krishna et al studied on behaviour of fiber reinforced concrete for rigid pavements" This paper deals with experimental investigation on mechanical properties of M20 grade concrete by incorporating polyester fibers in the mix. Polyester fibers of 0.1%, 0.2%, 0.3%, and 0.4% by weight of cement are added to the mix. A comparative analysis has been carried out for conventional concrete to that of the fiber reinforced in relation to compressive, split tensile, flexural strengths. As the fiber content increases compressive, split tensile and flexural strengths are proportionally increasing. It is observed that 0.3% fibers by weight of cement is the optimum dosage. It is found that with 0.3% fiber content results in 20% reduction of pavement thickness.

S.A Kanalli et al studied on polymer fibre reinforced Concrete with conventional concrete pavement. Road transportation is undoubtedly the lifeline of the nation and its development is a crucial concern. The traditional bituminous pavements and their needs for continuous maintenance and rehabilitation operations points towards the

scope for cement concrete pavements. There are several advantages of cement concrete pavements over bituminous pavements. This paper emphasizes on POLYMER FIBRE REINFORCED CONCRETE PAVEMENTS, which is a recent advancement in the field of reinforced concrete pavement design. A comparative study of these pavements with the conventional concrete pavements has been made using Polypropylene fiber waste as fiber reinforcement.

Chintan Patel et al studied the performance Evaluation of Polymer Fiber "RECRON-3S" in Pavement Quality Concrete" Road transportation is undoubtedly the lifeline of the nation and its development is a crucial concern. The traditional bituminous pavements and their needs for continuous maintenance and rehabilitation operations points towards the scope for cement concrete pavements. There are several advantages of cement concrete pavements over bituminous pavements. But, there are also some problems outcomes with concrete pavement like micro-shrinkage, cracking, and low water permeability. To overcome this kind of problems, the secondary construction material "Recron-3S" is preferable to add in concrete for making stronger and batter road pavement. Present paper focuses how the compressive and flexural strength of the Pavement Quality Concrete (PQC) increases using Recron-3S fiber with compression test of the concrete. The testing results of the prepared sample cube with Recron-3S has compared with other samples which is without the mixture of the Recron-3S

CONCLUSION

After reviewing the various studies, following points are concluded:

1. The compressive strength, split tensile strength, flexural strength and modulus of elasticity increase with the addition of fiber content as compared with conventional concrete. By replacing cement with polypropylene dosage it help to saving the cement content in concrete.
2. The slump value decreases with increasing the percentage of polypropylene fiber.
3. The growth of the amount of research and applications of steel fiber reinforced concrete (SFRC) and high performance concrete has been phenomenal in the past seven or eight years. High performance concrete has become widely accepted practically on all continents.
4. Polypropylene fibers enhance the strength of concrete, without causing the well known problems, normally associated with steel fibers.
5. Polypropylene fibre can be used with admixtures, plasticizers, and super plasticizers, for increasing the strength of concrete with partial replacement of cement.
6. Polypropylene fibre is Reduce number of joints and Reduce repair due to subsequent damage.
7. The workability of Polypropylene fibre concrete has been found to decrease with increase in Polypropylene fibre content replacement.
8. Polypropylene fibers reduce the water permeability, plastic, shrinkage and settlement and carbonation depth.

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