Analysis of Strength of Concrete using flax fiber as partial replacement of cement

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Abstract **- The aim of the paper was to study the feasibility of using flax fiber by checking the compressive strength, splitting tensile strength by varying its percentages by 0%, 1, 2 %, and 3 % by weight with cement in concrete mix. All the tests were conducted by following the guidelines set by Indian Standard. It was found that all the mechanical properties of concrete were increasing by adding flax fiber up to 2 % and it was the optimum percentage up to which the compressive, split tensile strengths were increasing by 11.37 %, 18% and 30 % after this percentage there was reduction in strength was noticed.**

1.INTRODUCTION

Concrete is considered as the backbone of a modern day structures. Without this it is not possible to build a structure which is strong, durable and capable enough to resist earthquake shocks and other loads like dead load, imposed loads, snow load etc. Mixing of Water, fine and course aggregates along with cement after amalgamating them collectively into a solid stone is described as concrete (Neville, 1995; Mehta, 1986). Once these elements are assorted jointly they outline a liquefied mass, being fresh and impressionable, it can be sorted into any yearned form. Properties like strength, density, chemical and thermal resistance in unsullied and solid state are managed by consequent materials through which concrete is formed (Lea, 1970). Being strong in compression and weak in tension, concrete is required to be reinforced by materials having higher tensile strength (Neville, 1995; Mehta, 1986; Hensher, 2016). To overcome the weakness various researches by using different materials in concrete have been carried out all over the world; one of them has been Fiber reinforced concrete (FRC) which has been very common in the researches carried out in last two decades (Zollo, 1997, Hensher, 2016; L'hermite, 1977; Varastehpour and Hamelin 1997; Qi et.al 2003; Lee and Barr, 2004; Michels, et.al, 2016; Su et al, 2016; Fiorelli et al 2015). Researchers are also trying to develop high performance concretes by making use of fibers and admixtures in concrete with different proportions (Afroughsabet et al, 2016; Preti and Meda, 2015; Carvazen et al, 2015: Yew et.al 2016). Incorporation of fiber in concrete have found to improve various properties such as cracking resistance, impact, wear resistance, ductility and fatigue resistance besides several other strength properties (Carpinteri et.al 2015; Zhao, 2015; Tanyildizi and Şahin 2016; Daviau-Desnoyers et. al, 2016; Shajil et al 2016). Besides building structures, concrete pavement is a key part of highway pavement due to increase in ride superiority, minimum maintenance, and extended design life (Shahin, 2005). With the use of recycled materials the cost and energy consumption associated with concrete pavements can be lowered down with more effective construction methods (Wu, 1996; Correia et.al 2006).

In civil engineering applications most commonly used fibers and waste material includes glass, carbon, cellulose, aramid, steel etc (Parisco et al, 2009; Zollo, 1997). In many developing countries like India there is a need to look over resource conservation, reducing material cost and using waste products paying much attention towards process of recycling of waste materials. This process of recycling of materials from industrial wastes helps to protect natural resources or environmental profits and results in economy (Hossain et al, 2016). By using various recycled wastes in concrete it has been found that compressive, flexural, tensile strength and other mechanical properties as well as energy absorption have increased (Wang et al 1994; de Brito and Saika, 2013; Medina et al, 2014; Pedro et al 2015). Concrete reinforced with cellulose have shown that width of crack is less as compared to plain concrete beside having less width of crack, cellulose reinforced concrete was found to 40 percent tougher then the unreinforced concrete (Soroushian

and Ravanbakhsh, 1998). Fiber like aramid has been found to improve strength of concrete in an analogous way as that of steel (Nanni, 1993). As far as waste of steel fiber is concerned research done by (Aghee et al, 2014) found that addition of more than 0.5% of the waste wires and steel fibers resulted in considerably higher split tensile strength by about 28 than plain concrete. Beside steel fibers carbon fiber is also being off late as a fiber material in concrete. Carbon fiber reinforced concrete has been found to have piezoelectric activities and can sense large range of loading with soaring compassion beside this it is also scrutinize dynamic loading (Sun et al,2000). By adding 3% of carbon and steel fibers by volume in concrete an increase of 12.1% of original tensile strength have been found (Mello et.al 2014). A galvanized iron wire when used in concrete enhances the splitting tensile strength and flexural strength up to 72.65% and 41% (Aravindan and Arunkumar, 2013). Steel and Polypropylene fiber reinforced concrete of M30 grade results in improvement by 18 % in compressive strength for 28 days (Selvi et al, 2013). (Shende et.al. 2011) made comparative studies on steel fiber reinforced cum control concrete under flexural and deflection and observed that flexural strength increases from 13% to 48 % by utilization of steel fibers .by using 1% steel fibers flexural strength increase from 13.35% to 23.35%. With 2% steel fibers strength increases from 18% to 32%.and by using 3% steel fiber flexural strength increase from 20.80% to 48.35 %.

In this paper an experimental investigation was carried out to study the feasibility of using flax fiber by checking the compressive strength and splitting tensile strength of concrete

2.MATERIALS AND METHOD

The materials used in the study were cement, fine aggregates (sand), course aggregate, Water and flax fiber. Tests on these materials were conducted as per Indian Standard (IS) guidelines to determine different properties which are explained as follows

The properties of Unreinforced and flax fiber reinforced concrete which includes Compressive Strength and Tensile Strength were determined by following the Indian Standard guidelines. The Mix design of Concrete was also done by following the Indian Standard guidelines.

2.1.Compressive strength

A total of 12 specimens' cubes of concrete were casted having size of 150x150x150mm for different proportions (0 %, 1% and 2 % and 3 %) by weight of flax fiber as partial replacement of concrete and 3 cubes were used for taking average value (IS 516 :1959)

2.2 Tensile Strength

12 cylinders specimens were casted for different percentages of cotton fiber fiber of size 150mm dia. and 300mm in height confirming to Indian Standard code (IS 5816-1970)

3.RESULTS AND DISCUSSION

The results which were obtained after carrying out tests on different properties of both unreinforced and reinforced cotton fiber concrete are presented and discussed in this section.

The compressive, split tensile and flexural strength were all determined by using M20 mix of 1:1.88:2.86 (Cement: Fine aggregates: Course Aggregates), W/C ratio 0.52. the percentage of cotton fiber was kept for each parameter was kept at 0 %, 2.5% and 5 % and 7.5 % by weight of concrete. Compressive strength is the ability of a material to bear up loads having tendency to decrease size of material (Carreira and Chu, 1985). A total of 12 cube moulds of concrete were to determine the load at which failure will occur. The compressive strength of both plain and cotton fiber reinforced concrete were determined corresponding to average of failure loads of three specimens at different percentages of cotton fiber. It was observed that addition of cotton fiber in concrete increases the compressive strength of concrete. For 0%, 1% and 2% flax fiber content as partial replacement of cement in concrete the compressive strength obtained was 25.5N/mm2, 26.8N/mm2 and 28.4N/mm2 respectively, however at 3% fiber content was found to be 23.33N/mm2. The addition of flax fiber in concrete the Compressive strength of concrete increases by about 11.37% for 2 % fiber as compare to conventional concrete. Thus the optimum percentage for flax fiber as partial replacement in M25 concrete up to which Compressive strength can be increased is 2 % by weight and corresponding compressive strength is.28.4 N/mm2.

Tensile strength is the ability of a material to bear up loads in tension (McHenry and Karni, 1958). A total of 12 cylinders specimens of size 15mm diameter and 300mm height were casted for different percentages of flax fiber. The compression load was applied diametrically and along the length of cylinder until the failure of the cylinder along vertical diameter occurs. The split strength of both plain and cotton fiber concrete were determined corresponding to average of failure loads of three specimens at different percentages of LMS. It was observed that addition of flax fiber in concrete increases the tensile strength of concrete cylinder. For 0%, 1 % and 2% fiber content by in cement as partial replacement the tensile strength obtained was 2.85N/mm2, 3.04N/mm2 and 3.37N/mm2respectively, however at 2 % fiber content by weight the tensile strength decreases and was found to be 2.94N/mm2. The addition of flax fiber in concrete increases the tensile strength of concrete cylinder by about 18% for 1.5 % fiber as compare to conventional concrete cylinder. Thus the optimum percentage for cotton fiber in M25 concrete up to which tensile strength can be increased was found to be 2 % by weight in concrete cylinder and corresponding compressive strength was 3.37 N/mm2.

4.CONCLUSIONS

The compressive, split tensile and flexure strengths of M25 concrete grade were obtained at varying percentages of carbon fiber by weight in concrete. It was observed that mechanical properties of concrete are increased by adding flax fiber up to 2 % as partial replacement of cement by weight after this percentage there was reduction in strength of concrete. All in all it was concluded that flax fiber is an economical and environmental friendly material which can improve structural strength of concrete, reduce steel reinforcements besides reducing width of cracks. It can also be used in future also in various concrete works, which includes determining shear strength parameters and other durability properties.

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