Research Inventy: International Journal Of Engineering And Science
Vol.5, Issue 2 (February 2015), PP 56-59
Issn (e): 2278-4721, Issn (p):2319-6483, www.researchinventy.com

Enhancement the Strength of Conventional Concrete by using Nylon Fibre

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Abstract : *Fibre can be defined as a small piece of reinforcing material possessing certain dimensional characteristics. The most important parameter describing a fibre is its Aspect ratio. "Aspect Ratio" is the length of fibre divided by an equivalent diameter of the fibre. The properties of fibre reinforced concrete are very much affected by the type of fibre. The properties of fibre reinforced concrete are very much affected by the type of fibre. Fibres are secondary reinforced material and acts as crack arrester. Prevention of propagation of cracks originating from internal flaws can result in improvements in static and dynamic properties of matrix. Fibre reinforced cement and concrete materials (FRC) have been developed progressively since the early work by Romualdi and Batson in the 1960s. By the 1990s, a wide range of fibre composites and FRC products were commercially available and novel manufacturing techniques were developed for use with high fibre content. In parallel with the commercial development of FRC materials and products, an extensive research programme was undertaken to quantify the enhanced properties of FRC materials and more specifically to allow comparisons to be made between various types of fibres.*

Keywords: *Fibre Reinforced Concrete, Nylon Fibre, Conventional concrete.*

I. INTRODUCTION

Fibre reinforced concrete (FRC) is a composite material consisting of cement, sand, coarse aggregate, water and fibres. In this composite material, short discrete fibres are randomly distributed throughout the concrete mass. The behavioral efficiency of this composite material is far superior to that of plain concrete and many other construction materials of equal cost. Due to this benefit, the use of FRC has steadily increased during the last two decades and its current field of application includes: airport and highway pavements, earthquake-resistant and explosive-resistant structures, mine and tunnel linings, bridge deck overlays, hydraulic structures, rock-slope stabilization, etc. Extensive research work on FRC has established that addition of various types of fibres such as metallic and non-metallic fibre like (steel), glass, synthetic, and carbon, in plain concrete improves strength, toughness, ductility, post-cracking resistance, etc. These dramix hooked end steel fibres and polypropylene fibres can effectively be used for making high-strength HFRC after exploring their suitability. In this investigation, therefore, an attempt has been made to study the feasibility of using two kinds of fibres for making HFRC. Cementitious materials are generally quite brittle, with relatively low strength and strain capacity under tension. Hence a hand-laid steel bar reinforcement is usually necessary to increase tensile strength. For low reinforcement levels, the partial or even complete replacement of this conventional reinforcement by fibers is an advantageous alternative. For special applications, highly ductile fiber reinforced cementitious materials like ultra-high performance concrete or engineered cementitious compo- sites have been developed. Fibres may also be applied to control the detrimental effects of shrinkage. A significant reduction in crack width and crack spacing is possible, especially at early ages. They possess a high tensile strength and a high elastic modulus these are available at relatively low costs. The high modulus, which is much higher than the one of concrete or cement paste prevents the fibre from stretching or cross contraction upon load, which hence leads to a good fibre–matrix bond and smaller crack widths. A variety of tests have been performed to determine the actual characteristics and advantages of tuberous materials. The addition of steel fibres helps in converting the brittle characteristics to ductile ones. To faster the compressive strength without sacrificing the ductility, a strategy adopted is to add discrete steel fibres as reinforcement in concrete. It is obvious that the behaviour of HFRC depends on the orientations, distributions, aspect ratios, geometrical shapes and mechanical properties of fibres in concrete mixtures. The orientations and distributions of fibre affect the properties of FRC such as toughness, strength, ductility and crack width.

II. SPECIFICATION OF MATERIAL USED

A) Nylon Fiber - Nylon is smooth, light weight and high strength.

- **a) Strength:** Nylon has good tenacity and the strength is not lost with age. Nylon has a high strength to weight ratio. It is one of the lightest textile fibres is at the same time also one of the strongest. Nylon has excellent abrasion resistance.
- **b) Elasticity:** Nylon has good elasticity which makes it much suitable for the apparel purposes. The excellent elasticity would mean that the nylon materials return to their original length and shreds the wrinkles or creases. Nylon like other fibres has its own limit of elasticity.

2.1 Nylon Fiber

Nylon is a generic name that identifies a family of polymers. Nylon fiber's properties are imparted by the base polymer type, addition of different levels of additive, manufacturing conditions and fiber dimensions. Currently only two types of nylon fiber are marketed for concrete. Nylon is heat stable, hydrophilic, relatively inert and resistant to a wide variety of materials. Nylon is particularly effective in imparting impact resistance and flexural toughness and sustaining and increasing the load carrying capacity of concrete following first crack.

The **NYLON FIBERS** are made with 100% purity provided as a filament fiber for secondary reinforcement of concrete. The three-dimensional reinforcement provided by the nylon fibers intercepts the fissures that occur during plastic retraction of the concrete in the stage when micro-fissures occur without fibers. The nylon fibers also reinforce the impact resistance.

The principal application of **NYLON FIBERS** is for reduction of fissuring, due to plastic contraction of concrete, including: slabs, elevated decks, pavements, sports arenas, roads, parking lots, façades, etc. Other applications include repair of pre-cast walls, pools and mortars for walls.

III. LIMITATIONS OF APPLICATION

The **NYLON FIBERS** should not be used with structural elements of concrete but just with secondary reinforcement .The engineer should confirm that if the steel screen is being used for structural capacity; if so, then the **NYLON FIBERS** can be added, but not as a substitute for the steel screens. When used in elevated slabs the nylon fibers, if used by themselves, cannot guarantee the absence of fissures. The steel screen should be incorporated together with the fibers.

IV. BENEFIT OF NYLON FIBERS :-

Improve mix cohesion over long distances

- Improve freeze-thaw resistance
- Improve resistance to explosive spalling in case of a severe fire
- Improve impact resistance
- Increase resistance to plastic shrinkage during curing

V DISCOVERY OF NYLON:–

An organic chemist, Wallace Carathers produced nylon, a very commonly found polymer, in the year 1935. However, until 1937, the discovery remained unpatented and in the year 1938, the discovery of nylon was announced. The chemical name of nylon is poly hexa-methylene adipamide. It took seven years for the chemist to accomplish success on this project. He also discovered the fact that the liquid form of the polymer solidified quickly when it was blown through the nozzles that were ultra-thin.

VI. MATERIALS USED

The main objective of test program is to study strength characteristics of concrete with adding different percentage of Steel and polypropylene fiber. The main parameters that were studied include compressive strength, Split tensile test and flexural test. The materials used for casting concrete samples, along with the tested results are described as under.

A) Cement:-

Cement is a fine, grey powder. It is mixed with water and materials such as sand, gravel, crushed stone to make concrete. The cement and water form a paste that and binds the other materials together as the concrete hardens. The ordinary cement contains two basic ingredients namely argillaceous and calcareous. In argillaceous materials clay predominates and in calcareous materials calcium carbonate predominates. In the present work Ultra-Tech 43 grade (OPC) Cement was used for casting cubes for all concrete mixes.

The cement was Uniform colour i.e. grey with a light greenish shade and was free from any hard lumps. Ordinary Portland cement Ultra**-Tech 43 grade (OPC**) was used. Tests were carried out on various physical properties of cement and the results are shown in Table.

B) Coarse Aggregate:-

Crushed granite stones obtained from local queries were used as coarse aggregate. The maximum size of coarse aggregate used was 20 mm. The properties of coarse aggregate were determined by conducting tests. The broken stone is generally used as coarse aggregate. The aggregates were washed to remove dust and dirt and were dried to surface dry condition. The aggregates are tested as per IS 383: 1970.

C) Properties of Fine Aggregates:-

Natural river sand was used as fine aggregate. The properties of sand were determined. The results are shown in Table.3.The results obtained from sieve analysis. The results indicate that the sand conforms to Zone II.

D) Water:-

Portable water available in the college campus free from salts was used for casting and curing of concrete as per **IS: 456 – 2000** recommendations.

E) Fly Ash:-Fly ash used in conventional concrete by **<u>10%, 20% & 30% replaced by cement</u>** sample.

Fly ash is a rich cementations industrial waste which has the great potential to substitute Portland cement, a major producer of CO2 and thereby decreasing greenhouse gas emissions. The production of fly ash in India is likely to be more than 175 million tons by the year 2012.Though due to lot of efforts by State and Central Government the utilization of fly ash has gone beyond 50%, still a lot has to be done for full utilization of this precious wealth from the waste. The eastern state of Orissa in India has a large coal deposit thus facilitating thermal power plants and producing more and more fly ash day by day.

Coal-based thermal power installations in India contribute about 65% of the total installed capacity for electricity generation. In terms of energy supply the contribution is even higher, as these plants meet base load requirements. In order to meet the growing energy demand of the country, coal-based thermal power generation is expected to play a dominant role in the future as well, since coal reserves in India are expected to last for more than 100 years. Indian coals have very high ash content. The ash content of coal used by thermal power plants in India varies between 25 and 45%. However, coal with an ash content of around 40% is predominantly used in India for thermal power generation. As a consequence, a huge amount of fly ash is generated in thermal power plants, causing several disposal-related problems. In spite of initiatives taken by the government, several non-governmental organizations and research and development organizations for fly ash utilization, the level of fly ash utilization in the country was estimated to be less than 10% prior to 1996-97. Globally, less than 25% of the total annual fly ash produced in the world is utilized.

(a) Definition of FLY ASH:-

Fly-ash is defined in Cement and Concrete Terminology (ACI Committee 116) as "the finely divided residue resulting from the combustion of ground or powdered coal, which is transported from the firebox through the boiler by flue gases." Fly-ash is a by-product of coal-fired electric generating plants.

" Fine particulate ash sent up by the combustion of a solid fuel, such as coal, and discharged as an airborne emission or recovered as a by-product for various commercial uses."

(b) Concept of Fly Ash introduced in Construction:-

Fly ash is a group of materials that can vary significantly in composition. It is residue left from burning coal, which is collected on an electrostatic precipitator or in a bag-house. It mixes with flue gases that result when powdered coal is used to produce electric power. Since the oil crisis of the 1970s, the use of coal has increased. In 1992, 460 million metric tons of coal ash were produced worldwide. About 10 percent of this was produced as fly ash in the United States. In 1996, more than 7 million metric tons were used in concrete in the U.S. Economically, it makes sense to use as much of this low-cost ash as possible, especially if it can be used in concrete as a substitute for cement. Coal is the product of millions of years of decomposing vegetable matter under pressure, and its chemical composition is erratic. In addition, electric companies optimize power production from coal using additives such as flue-gas conditioners, sodium sulfate, oil, and other additives to control corrosion, emissions, and fouling. The resulting fly ash can have a variable composition and contain several additives as well as products from in-complete combustion.

(g) Properties Of Fly Ash:-

1) **Fineness:** The fineness of fly ash is important because it affects the rate of pozzolanic activity and the workability of the concrete. Specifications require a minimum of 66 percent passing the 0.044 mm (No. 325) sieve.
2) **Specific gravity:** Although specific gravity does not directly affect concrete quality, it has value in identifying changes in other fly ash characteristics. It should be checked regularly as a quality control measure, and correlated to other characteristics of fly ash that may be fluctuating.

3) **Chemical composition:**The reactive aluminosilicate and calcium aluminosilicate components of fly ash are routinely represented in their oxide nomenclatures such as silicon dioxide, aluminium oxide and calcium oxide. The variability of the chemical composition is checked regularly as a quality control measure. The aluminosilicate components react with calcium hydroxide to produce additional cementitious materials. Fly ashes tend to contribute to concrete strength at a faster rate when these components are present in finer fractions of the fly ash.

   Sulphur trioxide content is limited to five percent, as greater amounts have been shown to increase mortar bar expansion. Available alkalis in most ashes are less than the specification limit of 1.5 percent. Contents greater than this may contribute to alkali-aggregate expansion problems.

3.7.5 (d) Fly Ash Concrete

Fly ash is one of the naturally-occurring products of the coal combustion process and is a residue that is nearly identical to volcanic ash. It is considered a pozzolanic material, which means that when mixed with calcium hydroxide, it has many of the same properties as cement. There are a number of well documented benefits from replacing a portion of the cement with fly ash to create a cementitious material that is then used along with aggregates, water and various other components, to produce concrete for roads and bridges. Some of the benefits of using fly ash concrete include:

• **Fly ash concrete is stronger.** Over the long run, fly ash concrete has increased strength, which means there is less wear and tear on the roadway from heavy trucks and vehicle traffic.

VII. CONCLUSIONS

The test carried out at 7 days, 14 days and 28 days, the comparison is made between the conventional concrete with different proportion and with different proportion nylon fiber.

- **a.** The compressive strength of nylon fibre mixed with conventional concrete is increased.
- **b.** When we used the nylon fibre in conventional concrete in various proportions 0.2%, 0.25% and 0.3% of volume of concrete the result obtained by the compressive strength is increased.
- **c.** In conventional concrete, cement replaced by 10%, 20% and 30% with fly ash. The comparative study of all mixed the result obtained. In conventional concrete 10% fly ash, 90% cement, and 0.2%, 0.25% and 0.3% nylon fibre getting the good strength of concrete.