Volume 8, No. 4, May 2017 (Special Issue)
International Journal of Advanced Research in Computer Science
REVIEW ARTICLE
Available Online at www.ijarcs.info

ISSN No. 0976-5697

Different types of Fibres used in FRC

Parveen Kaur
Lecturer,
Civil Engineering Department
Sant Baba Bhag Singh University,
Khiala Punjab, India
parveenkaur199394yahoo.com

Mohit Talwar
Assistant Professor,
Civil Engineering Department
Sant Baba Bhag Singh University,
Khiala, Punjab, India
civil.talwarnit@gmail.com

***Abstract* - Fibre reinforced concrete is an old technique, but in the modern era, its importance and its lots of applications are developed. Plain concrete with additional different types of fibres is targeting the changes in the properties of the composite material. Basically, durability is connected with dynamic loading. This paper is about to understand the basic knowledge of fibre reinforced concrete and showing the different types of fibre systems and their applications with existing construction examples.**

Keywords – Fibre Reinforced Concrete

I. INTRODUCTION

Concrete is a composite material and widely used in all over the world like a stone with desirable durability and high compressive strength. Concrete is used as a construction material but it has a disadvantage that is brittleness means concrete has the relatively low tensile strength and poor resistance to crack opening and propagation and weak in tension. With some assumptions, deformed steel bars or pre-stressing tendons are provided on concrete to improve its limitations (RCC). It can usually be reinforced with materials that are strong in tension.

Fibre is such a reinforcing material. Fibres are small pieces of reinforcing material possessing certain characteristics and properties. Fibres are considered as a construction material to enhance the flexural and tensile strength and as a binder that could combine Portland cement in bonding with cement matrices.

Fibres increase the structural integrity of the concrete. Fibres are usually used in concrete to control cracking due to plastic shrinkage and drying shrinkage. It produces greater impact and abrasion resistance. Use of micro fibres offers better impact resistance. Fibre reinforced concrete (FRC) is a new structural material which is gaining increasing importance. FRC is relatively a new composite material made of hydraulic cement, aggregates and discrete fibres. FRC system has been used for various purposes.

Fibres find applications in civil engineering on a large scale by virtue of their inherent advantages. High strength fibres, favourable orientation, the volume of fibres, fibre length and diameter of fibre have been found independently to improve the strength of composites.

II. HISTORY

The concept of using fibres as reinforcement is not new. In ancient times horsehair was used in mortar and straw in mud-bricks. In 1900s asbestos fibres were used in concrete. But asbestos was discouraged due to detection of health risk. In 1963 Romualdi and Botson published their classic paper on FRC. After

that new material like steel, glass and synthetic fibres replaced asbestos in concrete. Research is still in progress on this technology. FRC is considered one of the greatest advancement in the construction engineering.

Some examples or famous structures built by FRC system

- Roman colosseum was built in 80 AD, used horse-hair as secondary reinforcement in fig.1.
- Tipu Sultan's palace at Srirangpattnam has been built with Sheep's wool in fig. 2.
- A Pueblo house built in 1540 with straw reinforcement adobe brick is believed to be the oldest house in the USA in fig. 3.
- Use of horsehair in plaster has many historical references.

Fig.1 - Roman colosseum

Fig. 2 - Tipu sultan's palace

CONFERENCE PAPERS
National Conference on Emerging Trends on Engineering & Technology (ETET-2017)
On 21st April 2017
University Inst. of Engg. & Tech. & University Inst. of Computer, SBBS University, Punjab (India)

Fig.3 - Pueblo house

III. PROPERTIES OF FRC

Fibres impart the following properties when introduced with concrete:-

i. Increases the tensile strength of the concrete
ii. Reduces the air voids and water voids.
iii. Increases the durability of the concrete
iv. Reducing bleeding in fresh concrete
v. Giving more flexural strength as compare to strength given by rebar.
vi. Restricting the growth of cracks under loads.
vii. Some fibres produce greater impact, abrasion in concrete.

IV. DIFFERENT TYPES OF FIBRES-

1. SFRC - Steel Fiber Reinforced Concrete
2. GFRC - Glass Fiber Reinforced Concrete
3. SNFRC - Synthetic Fiber Reinforced Concrete
4. NFRC - Natural Fiber Reinforced Concrete

Steel fibres

Steel fibres are most commonly used fibres. Steel fibre reinforced concrete is basically a cheaper and easier to use a form of rebar reinforced concrete. Rebar reinforced concrete uses steel bars that are laid within the liquid cement, which requires a great deal of prep work but make for a much stronger concrete. Fig. 4 shows steel fibre reinforced concrete uses thin steel wires mixed in with the cement. Generally, round fibres are used.

Fig. 4 - Steel Fibres

The diameter may vary from 0.25mm to 0.75mm. Use of steel fibre makes significant improvements in flexural, impact and fatigue strength of concrete. The steel fibre is likely to get rusted and lose some of its strength. But investigations have shown that the rusting of the fibres take place only at the surface. It has the very high tensile strength of 1700N/m2.

Steel fibres are incorporated in the shotcrete to improve its crack resistance, ductility and energy absorption and impact resistance characteristics. This imparts the concrete with greater structural strength, reduces cracking and helps protect against extreme cold. Steel fibre is often used in conjunction with rebar or one of the other fibre types. These are used for overlays of roads, airfield pavements, bridge decks, thin shells and plates.

As with any other type of concrete, the mix proportions for SFRC depend upon the requirements for a particular job, in terms of strength, workability, and so on. Several procedures for proportioning SFRC mixes are available, which emphasise the workability of the resulting mix. However, there are some considerations that are particular to SFRC. In general, SFRC mixes contain higher cement contents and higher ratios of fine to coarse aggregate than do ordinary concretes, and so the mix design procedures the apply to conventional concrete may not be entirely applicable to SFRC. Commonly, to reduce the quantity of cement, up to 35% of the cement may be replaced with fly ash. In addition, to improve the workability of higher fibre volume mixes, water reducing admixtures and, in particular, super plasticisers are often used, in conjunction with air entrainment.

Glass Fibre-

Glass fibre is a recent introduction in making fibre concrete. Fig.5 shows glass fibre reinforced concrete (GFRC) much like you would find in fibreglass insulation, to reinforce the concrete. The glass fibre helps insulate the concrete in addition to making it stronger. Glass fibre also helps prevent the concrete from cracking over time due to mechanical or thermal stress. In addition, the glass fibre does not interfere with radio signals like the steel fibre reinforcement does. Glass fibre concretes are mainly used in exterior building façade panels and as architectural precast concrete. GFRC uses fine sand, cement, polymer, water, other admixtures and alkali-resistant glass fibres. Glass fibre reinforced cementious composites have been developed mainly for the production of thin sheet components, with a paste or mortar matrix, and fibre content.

Fig. 5 – Glass Fibres

CONFERENCE PAPERS
National Conference on Emerging Trends on Engineering & Technology (ETET-2017)
On 21st April 2017
University Inst. of Engg. & Tech. & University Inst. of Computer, SBBS University, Punjab (India)

Synthetic Fibre –

Synthetic fibres are the result of extensive research by scientists to improve on naturally occurring animal and plant fibres. Synthetic fibres are being used to improve the performance of concrete. These fibres are more durable. These can be used to improve the strength of hardened concrete and are used for crack control in semi-hardened concrete. Synthetic fibres help to improve pumpability and keep concrete from spalling during impacts. Synthetic fibres helps to prevent cracking as these do not expand in heat and contract in cold.

Fig. 6 – Synthetic Fibres

Some of the synthetic fibres are used in concrete are carbon, nylon, polyester, polypropylene and polyethylene.

Naturally occurring fibres

The oldest forms of fibre reinforced composites were made with naturally occurring fibre such as straw and horse hair. Modern technology has made it possible to extract fibres economically from various plants, such as jute and bamboo to use in cement composites.

The unique aspects of this fibre in the low amount of the energy required to extract these fibres. The primary problem with used of this fibres in concrete is their tendency to disintegrate in an alkaline environment. The effects of being made to improve the durability of this fibre in concrete by using admixture to make the concrete less alkaline and the subjecting the fibres to special treatment. Natural fibres used in Portland cement composite include akwara bamboo, coconut, flax, jute, sisal, sugarcane bagasse, wood, and others mechanical properties of some of these fibres are presented in the succeeding.

Fig. 7 – Natural Fibres

Current development in FRC

The latest developments and research presented the new fibre matrix like:

i. High fibre volume micro-fibre system.
ii. Compact reinforced composites.
iii. Polymer concrete

i) High fibre volume micro-fibre system

It can replace asbestos fibre. It improves toughness and impact strength. These properties make it attractive for thin precast products such as roofing sheets, cladding panels. Cement composites are useful for repair & rehabilitation works.

ii) Compact reinforced composites (CRC)

It consists of an extremely strong, dense cement matrix and extremely expensive. It exhibits flexural strength up to 260Mpa and compressive strength of about 200Mpa. It is as strong as structural steel and can be moulded and fabricated at the site.

iii) Polymer concrete

Polymer concrete is porous due to air voids, water voids. Impregnation of monomer & subsequent polymerization is the latest technique adapted to reduce porosity and improves strength.

Types of polymer concrete are:

- Polymer-impregnated concrete (PIC).
- Polymer cement concrete (PCC).
- Polymer concrete (PC).
- Polymer impregnated & surface coated polymer concrete.

- Polymer-impregnated concrete (PIC)
- Polymer-impregnated concrete (PIC).
- Polymer-impregnated concrete (PIC).

PIC is precast conventional concrete, cured & dried in an oven.Polymerization carried out By using radiation, application of heat or by chemical initiation. Monomers used are methyl methacrylate, styrene, acrylonitrile, T-butyl styrene. The amount of monomer loading depends on the quantity of water and air that has occupied the total void space. A monomer loading time can be reduced by application of pressure.

- Polymer cement concrete (PCC)

PCC is made by mixing cement, aggregates, water & monomer. Monomers used in PCC are polyester-styrene, epoxy-styrene, furans, vinylidene chloride. A superior PCC made by furfuryl alcohol aniline hydrochloride in the wet mix is claimed to be especially dense, non-shrinking, high corrosion resistance, low permeability & high resistance to vibrations and axial extension.

- Polymer concrete (PC)

The aggregate bound with a polymer binder. It minimises void volume in the aggregate mass. Strength obtained is 140 MPa with a short curing period. The graded aggregates are prepacked & vibrated in the mould. It tends to be brittle & it is reported that dispersion of fibre reinforcement would improve the toughness & tensile strength of material.

- Partially impregnated and surface coated concrete

It significantly increases the strength of original concrete. Polymerization can be done by the thermal catalytic method. The depth of the monomer penetration depends upon pore structure of hardened & dry concrete, duration of soaking & viscosity of monomer. Excellent penetration can be achieved by pounding the monomer on a concrete surface.

Applications of FRC

It is used on account of the advantage of increased static and dynamic tensile strength and better fatigue strength. FRC is used for:

- Runway, Aircraft parking and Pavements
- Industrial flooring
- Tunnel and canal lining
- Slope stabilization
- Thin shells
- Curtain Walls
- Pipes
- Manholes
- Dams and Hydraulic structures
- Roof tiles
- Composite decks
- Impact resisting structures

Objective and scope of present research work

The objective of the present work is to investigate experimentally various properties of mixed fibre reinforced concrete for structural applications. It is helpful to overcome the drawbacks like brittleness, multiple cracking under loads and flexural behaviour when used with random orientation. Traditionally FRC has been effectively used in construction. The use of different type of fibres has been reported.

CONCLUSION

The efficient utilisation of fibrous concrete involves improved static and dynamic properties like tensile strength, energy absorbing characteristics, Impact strength and fatigue strength. Also, provides isotropic strength properties not common in the conventional concrete. Fibrous concrete will provide a universal solution to the problems associated with plain concrete. Hence it is not likely to replace the conventional structural concrete in total.

The enormous increase in impact resistance and fatigue resistance allow the new material to be used in some specified applications where conventional concrete is at a disadvantage. A new approach in design and in the utilisation of this material, to account for both increase in performance and economics is, therefore, needed. FRC is costly. FRC is normally applied on bridge construction.

It has the ability to sustain a load without excessive deformation. It can be used as external reinforcement in the rehabilitation of reinforced structures. The architect used it as sliding roofing, flooring and partition.

REFERENCES

[1] Majumdar AJ, Ryder JR. Glass fibre reinforcement of cement products. Glass Technol 1968;9(3):78–84.

[2] Brandt AM. Cement-based composites: materials, mechanical properties and performance. London: E&FN Spon; 1995.Coutts RSP.

[3] A review of Australian research into natural fibre cement composites. Cement Concrete Res 2005;27:518–26.

[4] Thirty years of fibre reinforced concrete research at the University of British Columbia, S. Mindess *Department of Civil Engineering, University of British Columbia, Vancouver, B.C., Canada*

[5] Bentur, A. & Mindess, S. 2007. *Fibre Reinforced Cementitious Composites.* London & New York:Taylor & Francis.

[6] Applications and Properties of Fibre Reinforced Concrete Amit Rai1, Dr Y.P Joshi Scholar M.E (Transportation Engineering) Department of Civil Engineering SATI Govt. Engineering College, Vidisha (M.P) 464001. Professor Department of Civil Engineering SATI Govt. Engineering College, Vidisha (M.P.) 464001.

[7] Priti A. Patel1, Dr Atul K. Desai2Ashour S.A., Mahmood K. and Wafa F.F., “Influence of Steel Fibres and Compression Reinforcement on Deflection of High-Strength Concrete Beams”, ACI Structural Journal, V. 94, No. 6, Nov.-Dec. 1997, pp. 611-624.

[8] Brown J. & Atkinson T.(2012), “Propex Concrete Systems (International)”, United Kingdom”, proceedings of FIBCON2012, ICI,Nagpur, India, February 13-14.

[9] Fibre-reinforced concrete in precast concrete applications: Research leads to innovative products, Nemkumar Banthia, Vivek Bindiganavile, John Jones, and Jeff Novak.