A Study on Properties of Structural Concrete Using Polymeric Material

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Abstract- *As concrete is the most commonly used material in construction, improvement of cementations material become more and more essential. Conventional concrete has two major drawbacks: low tensile strength and a destructive and brittle failure. In an attempt to increase concrete ductility and energy absorption, Fiber Reinforced Concrete (FRC) has been introduced. By studying the research paper it is clear that by using synthetic fiber, steel fiber in concrete it gives better result. And we also used this kind of fibre in concrete where required high strength. The purpose of the research was to study production technologies, properties of carbon fibers, methods of construction, using this material, compare carbon fiber and structures, using carbon fiber with traditional materials and structures and find out reasons for application in construction. In addition, my task was to create calculating tool in Excel to estimate effect of carbon fiber strengthening to the structure. Now as we studied that Many Researchers studied and gave good results for carbon fiber reinforced Concrete with Different Proportions but no researchers doing work on carbon fiber grid. So this may be new attempt To compare Cost And Strength Parameters of carbon Fiber Reinforced Concrete Nowadays carbon fiber grid is Used broadly In Construction.*

Keywords- Concrete, Fibre Reinforced Concrete (FRC), Carbon fibre grid, Electric Oven.

I. INTRODUCTION

Concrete is weak in tension and has a brittle character. Cement concrete is characterized by brittle failure, the nearly complete loss of loading capacity, once failure is initiated. The concept of using fibres to improve the characteristics of construction materials is very old Use of continuous reinforcement in concrete (reinforced concrete) increases strength and ductility, but requires careful placement and labor skill. Alternatively, introduction of fibres in discrete form in plain or reinforced concrete may provide a better solution.

This characteristic, which limits the application of the material, can be overcome by the inclusion of a small amount of short randomly distributed fibres (steel, glass, synthetic and natural) and can be practiced among others that remedy weaknesses of concrete, such as low growth resistance, high shrinkage cracking, low durability, etc. The strength and durability of concrete can be changed by making appropriate changes in its ingredients like cementations material, aggregate and water and by adding some special ingredients. Hence concrete is very well suited for a wide range of applications. However concrete has some deficiencies as low tensile strength, low post cracking capacity, brittleness and low ductility, limited fatigue life, not capable of accommodating large deformations, low impact strength

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 presence of micro cracks at the mortar-aggregate interface is responsible for the inherent weakness of plain concrete. The weakness can be removed by inclusion of fibres in the mix. Different types of fibres, such as those used in traditional composite materials have been introduced into the concrete mixture to increase its toughness, or ability to resist crack growth. The fibres help to transfer loads at the internal micro cracks. Such a concrete is called fibre-reinforced concrete (FRC). Thus fibre-reinforced concrete is a composite material essentially consisting of conventional concrete or mortar reinforced by fine fibres.

1. Thermal Cracking- Expansion & Contraction

- Structural concrete like all other materials, will expand as they rise in temperature and contract as they fall in temperature.
- Small amounts of expansion and contraction are typically accommodated without excessive damage; however excess, extreme temperature variations can lead to catastrophic failures.
- Concrete used in various structures can suffer large transverse cracks as a result of excessive contraction in cold weather.
- Most materials expand when they are heated, and contract when they are cooled.

- When free to deform, concrete will expand or contract due to fluctuations in temperature.
- The size of the concrete structure whether it is a bridge, a highway, or a building does not make it immune to the effects of temperature.
- The expansion and contraction with changes in temperature occur regardless of the structure's cross-sectional area.
- Thermal cracking occurs due to excessive temperature differences within a concrete structure or its surroundings.

2. Fibre Reinforced Concrete:

Conventional concrete can be considered as a composite material in which the sand and aggregate are the dispersed particles in a multiphase matrix of cement paste. Concrete differs from most structural composites in that its strength is not greater than that of its components. The reason for this is that the interface between the components is the weak link in the composite and plays a major role in determining a number of properties of concrete. Usually, the aggregates are stiffer and stronger than the paste, and the non-linearity of the concrete stress-strain response is caused by the interaction between the paste and the aggregate [Collins and Mitchell, 1991]. The concept of using fibres to improve the characteristics of matrix is as old and well established as adding straw or horsehair to mud bricks. The fibre reinforced matrix can continue to carry a considerable amount of load after cracking has occurred. The principal role of fibres is to bridge cracks and resist their formation. The advantage of adding fibres into a matrix include enhancement of compressive strength, tensile strength, flexural toughness, shear strength, durability and resistance to impact. The physical properties of composites depend on the type and the dosage of the added fibres.

TYPES OF FIBRE

Fibres have been used in construction materials for many centuries. The last three decades have seen a growing interest in the use of fibres in ready-mixed concrete, precast concrete, and shot Crete. There are numerous fibre types available for commercial and experimental use which fall within the categories of steel, carbon, synthetic, Glass and Natural.

SYNTHETIC FIBRES:

A variety of synthetic fiber materials have been developed since 1960's for use in Fiber Reinforced concrete (FRC)'s. These include fibres such as polypropylene, nylon, carbon, aramid, polyethylene, acrylic and polyester. In current commercial and industrial concrete applications synthetic fibres are typically added to concrete at very low dosage rates, typically in the range of 0.06 to 0.2% by volume. Synthetic fibre reinforced concrete (SNFRC) has found its largest commercial use to date in slabs on grade, floor slabs and stay-in-place forms in multi-storey building [Concrete Institute of Australia 2003].

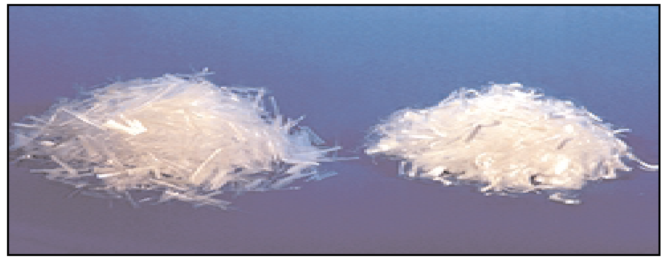

Figure 1. Different types of Synthesis Fibres (Source: Image Capture)

NATURAL FIBREl:

Natural fibres were used as a form of reinforcement long before the advent of conventional reinforced concrete. Mud bricks reinforced with straw and mortars reinforced with horsehair are just a few examples of how natural fibres were used long ago as a form of reinforcement. Many natural reinforcing materials can be obtained at low levels of cost and energy using locally available manpower. Such fibres are used in the manufacture of low-fibre-content concrete and occasionally have been used in thin-sheet concrete with high-fibre content.

Figure 2. Types of Natural fiber (Source: Image Capture)

STEEL FIBRE:

Steel fibres intended for reinforcing concrete are defined as short, discrete lengths of steel having an aspect ratio in the range of 20-100, with any cross section and that are sufficiently small to be randomly dispersed in an unhardened concrete mixture using usual mixing procedures. The most significant properties of steel fiber reinforced concrete (SFRC) are the improved flexural toughness, impact resistance and flexural fatigue performance. For this reason SFRC has found applications in flat slabs on grade where it is subject to high wheel loads and impact. SFRC has also been extensively used in concrete applications for ground support, rock slope stabilization, tunneling and repairs. The ease of placing SFRC into awkward formwork shapes has also seen its application in the manufacture of precast concrete products.

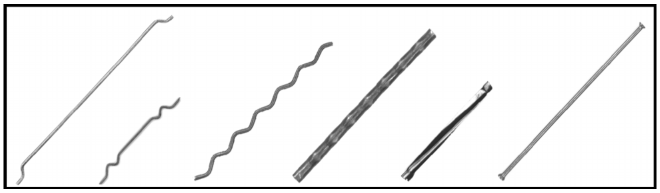

Figure 3. Different Types of Steel Fibre

GLASS FIBRE:

The first research on glass fibres in the early 1960s used conventional borosilicate glass (E-glass) and soda-lime-silica glass fibres (A-glass). The test results showed that alkali reactivity between the E-glass fibres and the cement-paste reduced the strength of the concrete. Continued research resulted in alkali-resistant glass fibres (AR-glass), that improved long-term durability, but sources of other strength-loss trends were observed. Alkali reactivity and cement hydration are the basis for the following two widely held theories explaining strength and ductility loss, particularly in exterior glass fibre concrete. (1) Alkali attack on glass-fibre surfaces reduces fibre tensile strength and, subsequently, lowers compressive strength, (2) Ongoing cement hydration causes calcium hydroxide particle penetration of fibre bundles, thereby increasing fibre-to-matrix bond strength and embrittlement, the latter lowers tensile strength by inhibiting fibre pull out.

Figure 5. Types of Glass fibres

CARBON FIBRE:

Carbon Fibre, is made of carbon crystals aligned in a long axis. These honeycomb shaped crystals organize themselves in long flattened ribbons. This crystal alignment makes the ribbon strong in the long axis. In turn these ribbons align themselves within fibres. The fibre shape is the original shape of the material (its precursor) used to produce the Carbon Fibre. I don't know of any process where fibres are shaped AFTER carbonizing. These fibers (containing flat ribbons of carbon crystals) in turn are bundled by the manufacturer in thicker fibres and are woven into carbon cloth, made into felt, twisted or bundled without twisting. This is referred to as Roving. Carbon fiber is also offered as chopped strands and powder.

In order to modify the characteristics of the lay up, other materials are sometimes added such as glass fibres, Kevlar or Aluminum. Carbon fibre is rarely used as it. Rather it is embedded in a matrix. In mast-making and boat building we usually think of epoxy or polyester resins, but carbon fibre is also used as reinforcement for thermoplastics, concrete or ceramics

Figure 5. Carbon Fiber grid (Source: Image Capture)

II. LITERATURE REVIEW

S.M. Kinayekar,V.D Gundakalle,Kishor Kulkarni (2014)1They had addition of carbon fibre as fibre reinforcing material in HSC with 10 percent fly ash show improved mechanical strength properties.

High strength concrete with the addition of 80 mm width of CFRP strip exhibited higher increase in flexural strength and deflection than the addition of volume fraction carbon fibre.

Regression analysis of mechanical properties indicated that the relationship between predicted strength of concrete is higher than experimental strength of concrete and these proposed equations may be preferred for its simplicity and suitability to analysis.

F.Bentayeb,K.AitTahar,A.Chateauneuf(2007)2They had experimental research reported that FRP reinforced columns and beams can be design to satisfy strength and deformability requirements of earthquake resistant structures.FRP re-bars are capable of resisting significant compression and tension-compression cycles without any distress, approximately equal to 20% of the values in tension. The failure in tension and compression was both observed to occur at about 1.2% strain. The response of FRP reinforced concrete beams may limited to elastic behaviour. the class of the concrete and the grid parameters have a large influence on the confinement level.

I. P. KUMAR, P. M. MOHITE, S. KAMLE(2013)3 They had the present study an attempt has been made to measure the axial compressive strength of single carbon fibres by the method of tensile recoil test. Five different sets of experiments were carried out. The compressive strength was evaluated from the experimental data by four different models. The two of the models are statistics-based models and the other two methods – Weibull and logistic are probability-based models. Following are the conclusions that can be drawn from this study.1. The compressive strength evaluated by all the models are in good agreement with each other.2. Any of Weibull or logistic models can be used to fit the recoil stress distribution, as both models show very less variation.3. The Weibull and logistic models predicted the probability of failure either at one end or both ends very well with the experimental data.4. The probability of the upper and lower end failure increases with increase in applied recoil stress.5. The compressive strength of carbon fibres measured by tensile recoil method is 869 MPa (average of all models studied) and agrees well with the results reported in literature obtained using the same method.6. The compressive strength of the fibres tested is much less than its axial tensile strength.

Bing Chen, Juanyu Liu(2003)4 They had check Residual strengths of HSC and hybrid-fiber-reinforced high-strength concrete (HFRHSC) after exposure to height temperatures were investigated in the paper. Based on the scope of this study, the following conclusions are made:1. There is explosive spalling for normal HSC when exposure to high temperatures. The higher the temperature, the severer the explosion. Adding carbon and steel fibers in HSC can delay the time when spalling occurs ,while adding PP fibers can eliminate the spalling under high temperatures.2. That higher residual compressive strengths and splitting tensile strengths of fiber-reinforced HSC than those of normal HSC indicates that adding fibers in HSC canalleviate the deterioration of mechanical properties of HSC exposure to high temperatures.

Manuel Hambach, Hendrik Moller, Thomas Neuman, Dirk Volkmer(2016)5 they had screening matrix properties, we could empirically show that carbon fibre reinforced cement-based screed exhibits the best Conductivity (and thus the best performance as floor heating material)if carbon fibres having an aspect ratio of about 400 (7 mm in Diameter and 3 mm in length) are being used. Based on percolation Theory, the fibre volume content suitable for electrical resistance heating is found to be 1 to 2 vol. % of carbon fibres. A permanent Heating of carbon fibre reinforced composite at 60 _C for 4 weeks Causes no measurable loss of strength, although additional long-term Experiments should be performed to verify the long-term Stability. All performed tests prove that a cement-based screed, Suitable and applicable for in-situ electrical heating, can be fabricated By admixing 2 vol. % of carbon fibres into the composite andusing graphite or silver electrodes for contacting purposes. Further more, it is shown that embedding a grid of electrodes into Fibre reinforced cement plate opens up the possibility to heat Selected areas of the plate up to 100 _C by applying an AC voltage of 12 V.

III. CONCLUSION

As per above literature review, Temperature variation has lead to cracking in concrete on many occasions. It is also observed that polymeric materials in various forms have been used to improve the strength of concrete. In one of the research paper suggested using carbon fiber in different form that is chopped powder form which was studied to show increase in strength of concrete.Also from past research, crack generation in concrete was studied by increasing temperature only. Actual atmospheric conditions requires study on the effect of cooling and heating on concrete.However, there is no research found where thermal cracking is studied along with the use of carbon grids as a reinforcing element.Hence, effect of carbon grid in concrete needs to be investigated for mitigation of thermal cracking.

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