TEXTILE FIBRE REINFORCED CONCRETE

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***Abstract*—** The Project work is on the study of textile fibre reinforced concrete. The influence of type of fibres and their content on the characteristics of textile fibre reinforced concrete having different volume fractions are studied. Fibres include steel fibres, glass fibres, synthetic fibres and natural fibres – each of which lend varying properties to the concrete. In addition, the character of fibre-reinforced concrete changes with varying concretes, fibre materials, geometries, distribution, orientation, and densities. The mechanical properties such as compressive strength, split tensile strength and flexural strength are studied. However, whether textiles can cooperate with concrete very well depends on the bond between them. In this paper, the bonding mechanism that the stress was transferred from fine concrete to textile was analysed, and the influences of the initial bond length of textile, the surface treatment of textile, the strength and workability of concrete as well as the level of prestressing force on bond behaviour were investigated on the basis of pull-out tests. The results reveal that with initial bond length increasing, the maximum pull force increases, and increasing concrete strength and improving workability of concrete matrix, epoxy resin impregnating and sand covering of textile as well as prestressing textile can obviously increase the bond strength between the textile and concrete.The textiles with rows made of fibre-threads through basketry which are oriented parallel with the occurring stresses instead of randomly-dispersed short fibres in concrete can increase obviously the efficiency of fibre-reinforcing. Moreover, textiles have no risk of corrosion due to the ingress of chlorides and carbonation of concrete and are lightweight, flexible, high-strength as well as non- magnetic. Therefore, textile reinforced concrete structures are expected to have wide application foregrounds. In order to ensure that the bond between fibre and matrix and avoid pores, both of which influence the strength of the structure, the biggest grain size of matrix must be enough small and matrix must have a very nice workability and consistency so that they fully penetrate the textile.

As prestressed textile reinforced concrete is concerned, the self- can influence the application of prestress. Thus, a new kind of self- compacting concrete (SCC) named as fine concrete is developed. The central task of this paper is development and optimization of the matrix in term of its chemical compatibility with the materials (alkali-resistant glass fibres) as well as a suitable consistency and workability based on test methods used for self-compacting concrete, rapid hardening, and high early strengths, for planned production processes.

***Keywords*—textile, concrete, fibres, bond, strength.**

1. INTRODUCTION

Textile-reinforced concrete is a type of reinforced concrete in which the usual steel reinforcing bars are replaced by textilematerials. Instead of using a metal cage inside the concrete, this technique uses a fabric cage inside the same. The fibres used for making the fabric are of high tenacity like Jute, GlassFibre, Kevlar, Polypropylene, Polyamides (Nylon) etc. The weaving of the fabric is done either in a coil fashion or in a layer fashion. Molten materials, ceramic clays, plastics or cement concrete are deposited on the base fabric in such a way that the inner fabric is completely wrapped with the concrete or plastic.

As a result of this sort of structure the resultant concrete becomes flexible from the inner side along with high strength provided by the outer materials. Various nonwoven structures also get priority to form the base structure. Special types of weaving machines are used to form spiral fabrics and layer fabrics are generally nonwoven.

1) USES:

Uses of textile reinforced materials, concretes are extensively increasing in modern days in combination with materials science and textile technology. Bridges, Pillars and Road Guards are prepared by kevlar or jute reinforced concretes to withstand vibrations, sudden jerks and torsion (mechanics). The use of reinforced concrete construction in the modern world stems from the extensive availability of its ingredients – reinforcing steel as well as concrete. Reinforced concrete fits nearly into every form, is extremely versatile and is therefore widely used in the construction of buildings, bridges, etc. The major disadvantage of RC is that its steel reinforcement is prone to corrosion. Concrete is highly alkaline and forms a passive layer on steel, protecting it against corrosion. Substances penetrating the concrete from outside (carbonisation) lowers the alkalinity over time (depassivation), making the steel reinforcement lose its protection thus resulting in corrosion. This leads to spalling of the concrete, reducing the permanency of the structure as a whole and leading to structural failure in extreme cases.

2) LIMITATIONS:

- Maintenance cost of a steel structure is very high.
- If steel loses its ductile property, chances of brittle fractures increase.
- Corrosion occurs.
- Availability of steel is in demand.

3) ADVANTAGES OF TEXTILE FIBRES:

- Corrosion resistant reinforcement.
- They are light and thin.
- High quality fine grained concrete surfaces with great freedom of design in terms of surface structure and colour.
- Can be freely positioned in alignment with the direction of force and close to the surface of the component.
- Easy processing and high degree of freedom in form.
- Control cracking due to plastic shrinkage and drying shrinkage.

4) METHODOLOGY:

- Calculation of mix design.
- Preparation of fibre mat.
- Casting of cubes and slab.
- Curing of water for required number of days.
- Testing of cubes and beams for compressive strength and flexural strength respectively.

2. PROCEDURE

5) PREPARATION OF FIBRE MAT:

1. Combination of glass fibres and polypropylene are made in the structure of grid of 6 to 10 layerswith 10mm spacing both horizontally and vertically.
2. The grid structured composite fibre mat is placed in a mould made of sheet metal of dimensions specified for the bench.
3. Polyvinyl alcohol is applied over the mould, to prevent the fibre from sticking to the mould when placed in the vacuum for 8 hours.
4. After placing the composite fibre mat on the mould, coat the fibres with epoxy resin used specifically for glass fibres.
5. After demoulding the fibre mat from the vacuum, it is placed inside the oven for about 1 hour.
6. The fibre mat completely enclosed by the resin forms a hard plate like structure.
7. Holes of 14 mm diameter are drilled all over the surface of the mat.

8. The preparation of composite fibre mat involves the above mentioned steps.

Fig.1.Formation of textile fibre grid

Fig.2.The completed grid over the frame

Fig.3.The fibre mat on the metal mould for resin application

6) FUNCTIONS OF REINFORCEMENT:

Reinforcing constituents in composites, as the word indicates, provide the strength that makes the composite what it us. But they also serve certain additional purposes of heat resistance or conduction, resistance to corrosion and provide rigidity. Reinforcement can be made to perform all or one of these functions as per the requirements. A reinforcement that embellishes the matrix strength must be stronger and stiffer than the matrix and capable of changing failure mechanism to the advantage of the composite. This means that the ductility should be minimum or even nil the composite must behave as brittle as possible.

3. MATRIX:

The material in which the fibers are embedded is called as matrix. The choice of matrix or resin system for use in any component depends on the number of its characteristics. such as adhesive properties, mechanical properties, micro cracking resistance, fatigue resistance and degradation from water ingress. Most commonly used resin systems are vinyl esters, epoxy and polyester resins.

7) FUNCTIONS OF MATRIX:

- Matrix holds the reinforcement in orderly pattern ie., holding them aligned in the important stress directions.
- By its load bearing principle, the composite is enabled to withstand compression, flexural, shear and tensile forces.
- The matrix must protect the reinforcingfilament from mechanical damage and environmental attack.
- To make each fiber as separate entity, the matrix must isolate from each other.
- To increase the toughness of the composite, the matrix depends on the quality of the interfacial bond strength.

- The matrix binds the fibers together, holding them aligned in the important stressed directions. Loads applied to the composite are then transferred into the fibers, the principal load-bearing component, through the matrix, enabling the composite to withstand compression, flexural and shear forces as well as tensile loads. The ability of composites reinforced with short fibers to support loads of any kind is dependent on the presence of the matrix as the load-transfer medium, and the efficiency of this load transfer is directly related to the quality of the fiber/matrix bond.

- The matrix must also isolate the fibers from each other so that they can act as separate entities. Many reinforcing fibers are brittle solids with highly variable strengths. When such materials are used in the form of fine fibers, not only are the fibers stronger than the monolithic form of the same solid, but there is the additional benefit that the fiber aggregate does not fail catastrophically. Moreover, the fiber bundle strength is less variable than that of a monolithic rod of equivalent load-bearing ability. But these advantages of the fiber aggregate can only be realized if the matrix separates the fibers from each other so that cracks are unable to pass unimpeded through sequences of fibers in contact, which would result in completely brittle composites.

- The matrix should protect the reinforcing filaments from mechanical damage (eg. abrasion) and from environmental attack. Since many of the resins which are used as matrices for glass fibers permit diffusion of water, this function is often not fulfilled in many GRP materials and the environmental damage that results is aggravated by stress. In cement the alkaline nature of the matrix itself is damaging to ordinary glass fibers and alkali-resistant glasses containing zirconium have been developed (Proctor & Yale, 1980) in an effort to counter this. For composites like MMCs or CMCs operating at elevated temperature, the matrix would need to protect the fibers from oxidative attack. A ductile matrix will provide a means of slowing down or stopping cracks that might have originated at broken fibers: conversely, a brittle matrix may depend upon the fibers to act as matrix crack stoppers.

- Through the quality of its 'grip' on the fibers (the interfacial bond strength), the matrix can also be an important means of increasing the toughness of the composite. By comparison with the common reinforcing filaments most matrix materials are weak and flexible and their strengths and moduli are often neglected in calculating composite properties. But metals are structural materials in their own right and in MMCs their inherent shear stiffness and compressional rigidity are important in determining the behaviour of the composite in shear and compression.

8) ADVANTAGES OF COMPOSITES:

- Superior weight specific strength and stiffness.
- Broad flexibility in strength and stiffness tailoring.
- High resistance to fatigue and damage.
- Chemical and corrosion resistance.
- Very low thermal expansion.
- Very high directional thermal conductivity.
- Easy to make very complex geometries.

4. CIVIL/STRUCTURAL ENGINEERING:

Again the bulk of composites used in this field are glass-reinforced plastics. The low inherent elastic modulus of GRP is easily overcome in buildings by the use of double curvature and folded-plate structures: thin GRP panels also offer the advantage of translucency. Glassreinforced cement (GRC) products made with Cem-FIL (alkali-resistant glass fibers) are gradually being introduced as structural cement-based composites, but these GRC are still regarded with some suspicion by architects who prefer to consider only non-load- bearing applications for glass-reinforced cement. Development of suitable highly-drawn polymer fibers and net-like polymeric reinforcement has made it possible to produce stable polymer- reinforced cement for a variety of purposes. But concrete is the cheapest engineering material available, and it requires very little in the way of expensive reinforcing filaments to be added to it to make it uncompetitive. Light-weight composite panelling for partitioning and similar applications have also been tried. CFRP have been less used until recently because of the cost, but are increasingly being considered for building light-weight structures, including a number of bridges. In recent years there has been a major surge of interest in the use of structural composites in civil engineering infrastructures.

9) MATS AND NONWOVENS:

Nonwovens are fibrous assemblies converted into fabric by chemical, thermal, or mechanical means and often a combination of these methods. The densities are somewhat lower than those suitable for structural applications as they range from 10g/cm2 to 100g/cm2. However, use of nonwoven preforms in automotive and marine applications is continually increasing. New developments, such as impregnation of nonwoven mat of continuous acrylic filaments with ceramic or metal matrix have extended applications of nonwoven composites to construction, aerospace, filtration, industrial, medical protection, sporting, and transportation fields. Mats are classified as either chopped strand mat or continuous strand mat (continuous filament mat). These two types of reinforcementsdo not show adramatic difference in the resulting mechanical properties of the composites. To produce continuous strand mats, continuous yarns are swirled onto a moving carrier film or belt and subsequently held together by a thermoplastic polymer binder. On the other hand, chopped strand mats are produced by chopping continuous fibers into lengths of 25mm and depositing them onto a carrier film or a perforated mould. A binder is used to hold the fibers together. The chopped mats can be compression molded to manufacture the preforms.

10) KNITTING:

Knitting is an alternative to weaving in which a looser and more flexible fabric is produced by either weft knitting (one yarn used) or warp knitting (multiple yarns used). Previously, knitted preforms were underutilized because of their perceived extensible and unstable structure. However, knitted preforms have rekindled attention with a growing awareness of their formability and 3D net-shaping. But as would be expected, the highly curved fiber architecture of knits causes lower in-plane strength and stiffness compared to unidirectional and woven fabric composites. But knitted composites show excellent out-of- plane properties and energy absorption capability. The high extensibility, previously considered a drawback to the use of knits as composite reinforcements, comes in handy in the manufacture of complicated composite parts. Further to the use of knitted structures in thermoplastic and thermoset reinforced rigid composites, these preforms are also used to reinforce elastomers. The energy absorption capacity of the loop structures has been shown to positively contribute to the good impact and delamination resistance of knitted preform composites. Though the impact performance of knitted composites is improved by the yarn architecture of the knit, the structural performance is low.

11) STITCHING:

Stitching methods were developed as a result of inherent poor impact, in-plane shear properties, and poor delamination resistance of composites manufactured from woven structures. But just like weaving, stitching also reduces mechanical properties of the reinforcing fibers. Stitching is either used to assemble and hold together single ormultilayered textile preforms or to increase impact resistance by addition of throughthethickness reinforcement. It offers distinct advantages particularly if the preforms are to be utilized for complex shaped structures. However, stitching of preforms creates faults in the plane of the material and this damage has an adverse effect on the mechanical properties of the composites.

5. SLUMP FLOW TEST:

- The slump flow test is used assess the horizontal free flow of self compacting concrete in the absence of obstructions. It was first developed in Japan for use in assessment of underwater concrete.

- The test method is based on the test method for determining the slump. T is the diameter of the concrete circle is a measure for the filling ability of the concrete.

Assessment of Slump Flow Test:

- This is a simple, rapid test procedure, though two people are needed if the T50 time is to be measured. It can be used on site, though the size of the base plate is somewhat unwieldy and level ground is essential.

- It is the most commonly used test, and gives a good assessment of filling ability. It gives no indication of the ability of the concrete to pass between reinforcement without booking, but may give some indication of resistance to segregation.

- It can be argued that the completely free flow, unrestrained by any foundries, is not representative of what happens in concrete construction, but the test can be profitably be used to assess the consistency of supply of supply of ready-mixed concrete to a site from load to load.

Equipment for Slump Flow Test The apparatus is show in figure;

- Mould in the shape of a truncated cone with the internal dimensions 200 mm diameter at the base, 100mm diameter at the top and a height of 300 mm.
- Base plate of a stiff non-absorbing material, at least 700mm square, marked with a circle marking the central location for the slump cone, and a further concentric circle of 500mm diameter.
- Trowel
- Scoop
- Ruler
- Stopwatch(optional) Procedure:

About 6 litre of concrete is needed to perform the test, sampled normally.Moisten the base plate and inside of slump cone. Place baseplate on level stable ground and the slumpcone centrally on the base plate and hold downfirmly.Fill the cone with the scoop. Do not tamp, simply strike off the concrete level with the top of the conewith the trowel.Remove any surplus concrete from around the base of the cone.Raise the cone vertically and allow the concrete to flow out freely.Simultaneously, start the stopwatch and record the time taken for the concrete to reach the 500mmspread circle.(This is the T50 time).Measure the final diameter of the concrete in two perpendicular directions.Calculate the average of the two measured diameters. (This is the slumpflowin mm).Note any border of mortar or cement paste without coarse aggregate at the edge of the pool of concrete.

Fig.4.slump flow test

6. V-FUNNEL TEST:

V funnel test and V funnel test at T 5 minutes on Self Compacting Concrete. The equipment for V funnel test on self compacting concrete consists of a v shaped funnel as, shown in Fig. An alternative type of V-funnel, the O funnel, with circular. The test was developed in Japan and used by Ozawa et al.The equipment consists of V-shaped funnel section is also used in Japan. The described V-funnel test is used to determine the filling ability (flowability) of the concrete with a maximum aggregate size of 20mm.The funnel is filled with about 12 litre of concrete and the time taken for it to flow through the apparatus measured. After this the funnel can be refilled concrete and left for 5 minutes to settle. If the concrete shows segregation then the flow time will increases significantly.

Assessment of test:

- Though the test is designed to measure flowability, the result is affected by concrete properties other than flow. The inverted cone shape will cause any liability of the concrete to block to be reflected in the result if, for example there is too much coarse aggregate.
- High flow time can also be associated with low deformability due to a high paste viscosity, and with high inter-particle friction. While the apparatus is simple, the effect of the angle of the funnel and the wall effect on the flow of concrete is not clear.

Equipment:

- V-funnel
- Bucket (±12 litre)
- Trowel
- Scoop
- Stopwatch Procedure flow time:
- About 12 litre of concrete is needed to perform the test, sampled normally.
- Set the V-funnel on firm ground.
- Moisten the inside surfaces of the funnel.
- Keep the trap door open to allow any surplus water to drain.
- Close the trap door and place a bucket underneath.
- Fill the apparatus completely with concrete without compacting or tamping, simply strike off the concretelevel with the top with the trowel.
- Open within 10 sec after filling the trap door and allow the concrete to flow out under gravity.
- Start the stopwatch when the trap door is opened, and record the time for the discharge to complete (theflow time).
- This is taken to be when light is seen from above through the funnel.
- The whole test has to be performed within 5 minutes.

Fig.5.V-funnel test

PROCEDURE FOR TEXTILE FIBRE REINFORCED CONCRETE:

- A wooden mould is made in the carpentary section.
- Plywood and flexible wood are used to make the mould.
- On 23rd February, Concrete mix is made by mixing the cement, water, fine aggregate, coarse aggregate and superplasticizer.
- The self compacting concrete mix is poured on to the mould after placing the fibre in the shape of the mould.
- The same way concrete mix is poured into the slab mould of the specified dimensions and 3 cubes of 100mm dimensions.

- It is allowed to dry in room temperature for 2 days and then placed in curing tank for the rest 5 days.
- Thus, the 7 day compressive strength is achieved. MIX PROPORTIONS:

Grade of concrete	:	M50
Size of aggregate	:	6 mm
Water – cement ratio	:	0.45
Weight of water	:	221 kg /m^3
Weight of cement	:	500 kg / m^3
Weight of fine aggregate	:	880 kg / m3
Weight of coarse aggregate	:	750 kg / m3
Weight of textile fibre	:	5 % of the total volume

7. CONCLUSION:

The fine-grained textile fibre-reinforced types of self- compacting concrete on the developed composite binder, which achieve compressive strength of 30 - 35 MPa in 7 days, have the best physical and mechanical properties. As can be seen from the test results, composite binder of cement.

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