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High Tensile Strength Corrosion Free FRP Rebars using Chemical Application

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***Abstract* -- It is well known that steel rebars are used to improve tensile strength of the concrete for the all type of structural application. Steel reinforced concrete posses excellent mechanical properties but lacks in chemical composition due to corrosion resistance. When the steel rebars starts corroding, the shape of the steel rebars is destabilized and results in detrimental failure of the concrete. To overcome this draw backs several approaches have been done to prevent the corrosion of the steel rebars. One of the approach is to replace the steel with non-corrosive reinforce material, namely Fiber reinforced polymers. Therefore this work is to create a new innovative researching material about rebar's [Sisal Fiber] using chemical application. More recently these techniques have been refined by embedding the steel bars in the concrete, and by the introduction of deformed bars to improve bonding, thus producing modern reinforced concrete now a day's. Research has been proved, to replace the iron with other materials such as sisal. fibre reinforced plastic and even galvanized iron because iron can rust easily and weaken the structure. But the sisal fiber is a natural fiber, so its free from corrosion and prevent the structure safely. In particular, the sisal fiber is one of the most investigated and being used in engineering systems.**

Keywords*: *Sisal Fiber, Resin, Chemical Application.

I. INTRODUCTION

A Rebar is also known as reinforcing steel, steel bar or mesh of steel wires used as a tension device in reinforced concrete and reinforced masonry structures, to strengthen and hold the concrete in tension. The surface of the rebar may be patterned to form a better bond with the concrete. Concrete reinforced with steel bars is an extremely popular construction material. The material system is used in flexural members in various critical applications such as bridges, viaducts, and building frames. The corrosion of steel reinforcement in these members can lead to their premature failure. In humid conditions, atmospheric pollutants particularly chlorides, sulfates, and carbon dioxide percolate through the concrete cover or cracks and cause the corrosion of steel reinforcement. After corrosion initiation, its progression forms additional corrosion products that have an increase in volume compared to the non corroded metal. Longitudinal corrosion cracks are formed along the corroding reinforcing bar when the tensile stress in the concrete surrounding the reinforcing bar exceeds the tensile strength of the concrete. The cracking ultimately results in the delaminating and spalling of the concrete. This exposes the reinforcement to direct environmental attack and the corrosion is further accelerated. Along with its unpleasant appearance, it weakens the concrete structure to a high degree. Moreover, the bond between steel and concrete is reduced. Pitting corrosion may also reduce the ductility of the steel bar by introducing notches on the surface of the steel bars that leads to a premature necking.

One best solution for this is use of in concrete is Fibre Reinforced Plastics (FRP) rebar is having well resistant to the corrosion and also it natural fiber is having good tensile strength. Due to such many advantages of steel can be replaced by FRP rebar in concrete.

II. SISAL FIBER

Sisal Fiber is one of the most widely used natural fiber and is very easily cultivated. It is obtain from sisal plant. The plant, known formally as Agave sisalana. These plants produce rosettes of sword-shaped leaves which start out toothed, and gradually lose their teeth with maturity. Each leaf contains a number of long, straight fibers which can be removed in a process known as decortication. During decortication, the leaves are beaten to remove the pulp and plant material, leaving the tough fibers behind. The fibers can be spun into thread for twine and textile production, or pulped to make paper products. Sisal fiber is fully biodegradable, green composites were fabricated with soy protein resin modified with gelatin. Sisal fiber, modified soy protein resins, and composites were characterized for their mechanical and thermal properties. It is highly renewable resource of energy. Sisal fiber is exceptionally durable and a low maintenance with minimal wear and tear. Its fiber is too tough for textiles and fabrics. It is not suitable for a smooth wall finish and also not recommended for wet areas. Sisal plants, *Agave sisalana*, consist of a rosette of sword-shaped leaves about 1.5–2 metres (4.9–6.6 ft) tall. Young leaves may have a few minute teeth along their margins, but lose them as they mature.


Figure 1 (Sisal Fiber)

The sisal plant has a 7–10 year life-span and typically produces 200–250 commercially usable leaves. Each leaf contains an average of around 1000 fibers. The fibers account for only about 4% of the plant by weight. Sisal is considered a plant of the tropics and subtropics, since production benefits from temperatures above 25 degrees Celsius and sunshine. In the 19th century, sisal cultivation spread to Florida, the Caribbean islands, and Brazil, as well as to countries in Africa, notably Tanzania and Kenya, and Asia.

The first commercial plantings in Brazil were made in the late 1930s and the first sisal fiber exports from there were made in 1948. It was not until the 1960s that Brazilian production accelerated and the first of many spinning mills was established. Today Brazil is the major world producer of sisal. There are both positive and negative environmental impacts from sisal growing. Sisal farming initially caused environmental degradation, because sisal plantations replaced native forests, but is still considered less damaging than many types of farming. No chemical fertilizers are used in sisal production, and although herbicides are occasionally used, even this impact may be eliminated, since most weeding is done by hand. The effluent from the decortication process causes serious pollution when it is allowed to flow into watercourses. Traditionally, sisal has been the leading material for agricultural twine (binder twine and baler twine) because of its strength, durability, ability to stretch, affinity for certain dyestuffs, and resistance to deterioration in saltwater. The importance of this traditional use is diminishing with competition from polypropylene and the development of other haymaking techniques, while new higher-valued sisal products have been developed.

Apart from ropes, twines, and general cordage, sisal is used in low-cost and specialty paper, dartboards, buffing cloth, filters, geotextiles, mattresses, carpets, handicrafts, wire rope cores, and Macramé. Sisal has been utilized as an environmentally friendly strengthening agent to replace asbestos and fiber glass in composite materials in various uses including the automobile industry. The lower-grade fiber is processed by the paper industry because of its high content of cellulose and hemicelluloses. The medium-grade fiber is used in the cordage industry for making ropes, baler and binder twine. Ropes and twines are widely employed for marine, agricultural, and general industrial use. The higher-grade fiber after treatment is converted into yarns and used by the carpet industry. Other products developed from sisal fiber include spa products, cat scratching posts, lumbar support belts, rugs, slippers, cloths, and disc buffers. Sisal wall covering meets the abrasion and tearing resistance standards of the American Society for Testing and Materials and of the National Fire Protection Association.

As extraction of fiber uses only a small percentage of the plant, some attempts to improve economic viability have focused on utilizing the waste material for production of biogas, for stock feed, or the extraction of pharmaceutical materials. Sisal is a valuable forage for honey bees because of its long flowering period. It is particularly attractive to them during pollen shortage. The honey produced is however dark and has a strong and unpleasant flavour. Global production of sisal fiber in 2007 amounted to 240 thousand tonnes of which Brazil, the largest producing country, produced 113,000 tonnes. Tanzania produced approximately 37,000 tons, Kenya produced 27,600 tonnes, Venezuela 10,500 tonnes and 9,000 tonnes were produced in Madagascar. China contributed 40,000 tons with smaller amounts coming from South Africa, Mozambique, Haiti, and Cuba. Sisal occupies 6th place among fiber plants, representing 2% of the world's production of plant fiber (plant fibers provide 65% of the world's fibers). As one of the world's important natural fiber, sisal is covered by activities of the International Year of Natural Fibers 2009. In particular, the sisal fiber is one of the most investigated and being used in engineering systems.

III. CHEMICAL METHODOLOGY

The resins that are used in fibre-reinforced composites are sometimes referred to as 'polymers'. All polymers exhibit an important common property in that they are composed of long chain-like molecules consisting of many simple repeating units. Man made resins is generally called 'synthetic resins' or simply 'resins'. resins can be classified under two types, 'thermoplastic' and 'thermosetting', according to the effect of heat on their properties.

Resin in the most specific use of the term is a hydrocarbon secretion of many plants, particularly coniferous trees. More broadly, the term is also used for many thick liquids that harden into transparent solids. Resins - Both thermosets and thermoplastics can be used. Short fibers are generally used in thermoplastics. Long fibers are generally used with thermosets. Thermoset – polyester, vinyl ester, Epoxy. Thermoplastics – polyprolene, nylon, Peek.

A. RESIN TYPE

Unsaturated Polyesters**,** Epoxies**,** Vinyl Esters **,**Polyurethanes**,** Phenolics .In civil engineering purpose epoxies and vinyl ester are excellent in strength. Epoxies - Glycidyl Ethers ,

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Amines, Customized Properties, Limited Workability, Sensitive to Curing Agents, High Performance, High First Cost. Vinyl Ester - Good Workability, Fast Curing, High Performance, Toughness, Excellent Corrosion Resistance.

B. BOND STRENGTH

Bond mechanism – for an optimal design of reinforced concrete structures, the force between the reinforcement and the concrete should be transferred efficiently and reliably through the bond between the two materials. In reinforced concrete member the transfer of forces between a reinforced bar and concrete occur by three mechanism. Chemical adhesion between the bar and the concrete. Frictional forces arising from the roughness of the interface between the bar and surrounding concrete. Mechanical interlocking arising from the textures on the rebar surface. In addition of these forces can be resolved in to an outward component and a shear component parallel to the bar that is effective bond force. To prevent bond failure the rebar must be anchored long enough in the concrete or should enough confinement. If adequate anchorage length of rebar or sufficient confinement to the concrete is not provided then radial and shear force may be higher than the concrete capacity which can lead to bond failure. The bond stress transferred between fiber reinforced polymer (FRP) ribbed rebar's and the surrounding concrete is the basis of the theory of reinforced concrete, which is made up of three components.

- Chemical adhesion
- Friction resistance
- Mechanical action

Bond of ribbed rebars depends primarily on the bearing of the ribs against the surrounding concrete. Friction resistance and chemical adhesion are not negligible but are secondary to the mechanical interaction. Friction resistance between rebar and concrete along the face of rib play on importance role in developing bond strength by helping to prevent the concrete between the ribs from sliding, relative to the rib. The force due to friction adds to the bearing components of bond acting to the rib. The vertical component of the resultant bond force is the radial pressure exerted on the surrounding concrete. The horizontal component of the resultant is the effective bond strength.

C. BOND BEHAVIOUR

Bond behaviour of FRP bars with concrete is not the same as that of steel bars because of marked differences in force transfer and failure mechanism of steel and FRP bars. This is attributed to the difference in the material properties and interaction mechanism of concrete and reinforcement. The most fundamental difference is that steel is an isotropic, homogeneous, and elasto – plastic material, where FRP is anisotropic, non-homogeneous and linear elastic material. The anisotropy of the FRP bar result from the fact its shear and transverse properties are dependent on both the resin and fiber type and direction, even though the longitudinal properties are dominated by fibers.

IV. HARDERNING STAGE OF TIME FOR THE SAMPLES IN THE OVEN

In this stage which one is suitable for the good sample for making a FRP rebar. The best sample resin for civil engineering purpose is good for making a rebar's is EPOXIES & VINYL ESTERS. The epoxies & vinyl esters are poor in setting time. Because its setting time normally 6 hour's sometimes one day , so we can change the properties. The sample should be making a epoxy resin adding a (DGEBA epoxy + TETA) .The problem in setting time. And try another sample to change all the properties.

The sample should be making a bisphonol vinyl epoxy – VER + amine + MEKP (catalyst) + cobalt naphathalen (accelerator). The same problem coming in setting time. So again try to change all the chemical properties. New sample – (Araldite GY 257, Aradur 140, Accelerator 061) making a sample and 60°c to the oven for 1 hour's & 30 minutes. This sample give a good result. Take a 10 sample & for solution of araldite, aradur, accelerator in the percentage of (88+10+2). All the sample should be keep on oven and each sample should take out from 15 minutes, the sample should be hard or not.

SAMPLE	STAGE – 1 @ 60°C on the Oven	STAGE – 2 @ ROOM TEMPERATURE
1	15min – liquid stage	4.30 hour's @ Liquid stage.
2	30min – liquid stage	4.30 hour's @ Liquid stage.
3	45min – liquid stage	4.30 hour's formed gelly.
4	1hour – liquid stage	4.30 hour's formed gelly.
5	1.25min – liquid stage	3.30 hour's @ Hard.
6	1.30min – liquid stage	2.00 hour's @ Hard.
7	1.45min – liquid stage	1.50 hour's @ Hard .
8	2hour – liquid stage	2.00 hour's @ Hard.
9	2.25min – liquid stage	2.15 hour's @ Hard.
10	2.30min – liquid stage	2.30 hour's @ Hard .

Table 1

V. MODIFY THE ACCELLERATOR CONTENT

The sample should be hard but very less sticky and sample 5 & 6 is better compare to other. And the setting time to hard the sample for one day. All the sample should be heating the oven at the temperature of 80°c for 2 hour's. Sample 5 & 6 its gelly to forming the stage of hard. The setting time 6.30hour's for sample-5 & sample-6 for 6.00hour's. After taken out the oven its too hard the sample & good strength. Take out from oven the sample it too hard & no sticky.

ARALDITE-GY 257	ARADUR -140	ACCELERATOR-061
100% - 3g	10% - 0.3g	1% - 0.03g
100% - 3g	10% - 0.3g	2% - 0.06g
100% - 3g	10% - 0.3g	3% - 0.09g
100% - 3g	10% - 0.3g	5% - 0.15g
100% - 3g	10% - 0.3g	7% - 0.21g
100% - 3g	10% - 0.3g	9% - 0.27g

Table 2

VI. MODIFY THE HARDERNER CONTENT

ARALDITE-GY 257	ARADUR -140	ACCELERATOR-061
100% - 3g	20% - 0.6g	2% - 0.06g
100% - 3g	30% - 0.9g	3% - 0.09g
100% - 3g	40% - 1.2g	4% - 0.12g
100% - 3g	50% - 1.5g	5% - 0.15g

Table 3

The sample should be hard but less sticky. And the setting time to hard the sample for one day. All the sample should be heating the oven at the temperature of 80°c for 2 hour's. After taken out the oven its too hard the sample & good strength. Take out from oven the sample it too hard & no sticky.

VII. CHEMICAL COMPOSITION OF RESIN

Chemical composition of resin based on the civil engineering purpose to solve a various problem for which conventional materials have proven inadequate. To illustrate the losses due to corrosion in india are estimated at Rs 8000 crores every year. So that resin based epoxy protective coatings help in controlling losses and hence are of considerable importance. Critical industry component having spent over half a century in to the construction industry, resin system have now become a determinant for engineers and technical experts when it comes to choosing thermosetting polymeric materials. Today building casting, electrical, electronic industries heavily using epoxy resin and aradur hardeners for protection from chemical corrosion, industrial protective floor coatings, grouting, repairing, concrete rehabilitation etc. Epoxy gives far better mechanical properties than any other system. In most cases the bonding strength of epoxies is better than tensile strength of cement concrete, making the repair more durable and hence epoxies are obvious choice for various users. In this resin used for most advanced materials has been challenging because of proven a good strength. This resin should manufactures and development laboratory backed by an international team for research & technology is now fulfilling the most complex of demands.

VIII. RESULT AND DISCUSSION

Research has to prove the good resin component of sample to be prepared. for making a "fiber reinforced plastics (FRP) – rebar's". In the content of EPOXY, CLAY (nano clay, hydrophilic, bentonite), METAKAOLIN, POP, etc.

1	Epoxy	85%
2	Clay	5%
3	Metakaolin	5%
4	Pop	5%

Table 4

It will gives a excellent tensile strength compared to some other chemical of resin component. So this research has to show a Influence of different chemical ingredients in FRP properties of rebars.

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