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CARBON FIBER AS CONSTRUCTION MATERIAL

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***Abstract*—Over the times as we have grown, so our engineering and exploration skills are set. Today, we are consistently innovating, researching and developing technology in pursuit of a sustainable future. All through these researches and evolution, engineers are in constant search for unique and better material which peerlessly execute the performance worth trade-off in the construction field. Many new raw materials have been discovered and many groundbreaking composite have been developed, of which not all but some have proved to be phenomenal success. Carbon fiber is one of these materials, which is normally used in combination with different materials to form composite. The properties of carbon fiber like high tensile strength, high stiffness, low weight, high temperature tolerance, high chemical resistance and low thermal expansion makes them one of the most popular materials in civil engineering occupying strength up to five times that of steel and one-third of its weight.**

***Keywords*— Carbon fiber, Construction Material, tensile strength, Stiffness.**

I. INTRODUCTION

A large number of existing reinforced concrete (RC) infrastructure in developed countries including bridges, municipal buildings, transportation systems and parking facilities are suffering from distress due to overuse or inadequate maintenance. Demolition and building a new structure is very costly and time consuming. Structural strengthening is a more economical solution and hence frequently required to extend the functional service lives of deficient RC structures. Reinforced concrete and grout injected steel jacketing systems are the most common methods developed in the past to upgrade RC columns. Although both methods are effective in increasing the structural capacity, they are labor consuming and sometimes difficult to implement on site. In addition, the RC jacketing system would result in substantial increase in the column's cross section. A steel jacketing system is often heavy and performs poorly resisting adverse environmental conditions. Hence, an innovative, durable, easy-to-install and cost effective strengthening system is required to replace outdated techniques. Carbon fiber fabric has emerged as a promising alternative strengthening material for upgrading deficient RC infrastructure. His fabric can be easily wrapped around the column's cross-section with a high-strength adhesive to provide a confining. Carbon fiber and other composite materials are highly performative; they have a very small weight but can take enormous loads, because carbon fiber has such unique properties, which makes it an ideal building material. Composites represent a very interesting opportunity for rapid fabrication and customization; it would take just weeks to build the enclosure for a small house out of carbon fiber, versus months with conventional materials. Composite structures can be erected rather quickly and do not require much in terms of specialized labor and work flows from general contractors and subcontractors, to material supplies, for example. We can therefore go faster, the delivery chain is shorter, the amount of material is reduced, and it's less expensive.`` Thanks to its flexibility and light weight, carbon fiber can be easily moved.Modules can be picked up, taken elsewhere, and chained together to produce larger assemblies as needed, that makes composite structures far more flexible than traditional buildings, where there's an assumption of permanence that is not always a good thing." Says Architect Simon Kim, principal at Ibañez Kim, an architecture and design firm in Cambridge, Massachusetts.

II. AIM

A. To study the life cycle of carbon fiber for lightweight engineering structures.
B. To study the behavior of various types of carbon fiber sheets , carbon fiber reinforced polymers, carbon fiber strands etc. that can be used for various civil

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engineering work and problems.

C. To study the strengthening of axially and eccentrically loaded reinforced concrete columns with carbon fiber reinforced polymers wrapping systems.

III. METHODOLOGY

Research Methodology

In our research we, firstly study the different properties of carbon fiber, application of carbon fiber in construction industry and other, types and classification of carbon fiber Carbon fiber and other composite materials are highly performative, they have a very small weight but can be take enormous loads because carbon fiber has such unique properties which makes it as ideal building material.

IV. LITERATURE REVIEW

In particular, research studying the effect of externally applied FRP materials on the flexural performance of reinforced concrete beams will be reported. Triantafillou and Plevris (1991) used strain compatibility and fracture mechanics to analyze reinforced concrete beams applied with externally bonded carbon fiber reinforced plastics (CFRP) Same assumptions as Anetal. They were used with the inclusion of a rectangularcompression stress distribution in the concrete at failure. WasanI. Khalil and Akar Abdulrazaq: they mulled over those mechanical properties about Thigh performance carbon fiber cement would be contemplated. The test fill-in includes, transforming secondary execution cement utilizing superplasticizer Furthermore condensed silica fume strengthened with diverse volume portions (0%, 0.2%,0. 3%, 0.4% and 0.5%) about carbon fibers. Those impact about hacked carbon fibers on the mechanical properties (compressive strength, Part ductil Furthermore flexural strengths,) for high performance cement might have been likewise examined. Generally, those Outcomes indicate that's were as from claiming carbon fibers enhances the mechanical properties of high performance cement. Likewise the Outcome indicate that utilizing condensed silica fume concerning illustration proportion by weight about bond expands the compressive quality more than that concerning illustration supplanting replacement of weight cement. M. Kinayekar,V.D. Gundakalle and Kishor Kulkarni: High Quality Cement (HSC)is thick, homogeneous and has the enhanced building properties and sturdiness as customary cement. Lately, HSC has increased wide application in the development business. High Quality Cement is a solid having comparable fixings as customary concrete, for example, bond, fine total, coarse total and water. The glue of HSC requires high volume of concrete substance and less water to powder proportion. The soundness and stream capacity of HSC is finished by expanding the powder substance or work of powder admixtures. In any case, expanding the bond content causes surprising expenses, higher warmth of hydration and higher drying shrinkage. This can be decreased by work powder admixture, for example, fly cinder and ground granulated impact Theater slag and so forth. In the present examination, concrete substance for H.S.C blend is substituted with steady % of fly slag (10%) and carbon fiber is included vol. section (0 to 0.60%), additionally the carbon Fiber Strengthened Polymer (CFRP) turf are put in different layer (single, twofold and triple layer) with adjust width of CFRP strip (0 to 80mm).he sustained solid properties of HSC were contemplated and the relapse examination was completed on the trial examination. He investigated reasons that carbon filaments can be successfully utilized as a strengthening material in HSC [9]. Qais Hassan Fadel: He considered a test work to discover the advantage emerging from CFRP (Carbon Fiber reinf. Polymer. covers expansion to bond mix in diminishing the entire warm conductivity and the warmth exchange through development components, which increment warm protection and lessen utilization of power utilized for cooling gear. Eight solid examples of rectangular cross areas were cast to inspect the warm conductivity, notwithstanding that a 12 standard solid 3D squares were set up to discover the compressive quality of cement. Carbon strands were cut and added with various adds up to get its impact on warmth exchange and warm conductivity for cement to contrast it and the compressive quality. Test results for warm conductivity for testing time of (390) minutes for every example demonstrated an expansion in warm protection for the reinforced cement, and this protection increments with expanding measure of CFRP included. The solid examples and shapes were separated into four gatherings of various measure of CFRP, which were (0%, 0.45 %, 1.1 %, 1. 6 %) of concrete weight utilized in. the blend. Notwithstanding that, the protection was expanded in. the presence of CFRP, the compressive quality was diminished by (6.4-28.5) %, while expanding CFRP sum, as for control concrete.

Carbon fiber

Carbon fibers are fibers about 5-10 micrometer in diameter and composed mostly of carbon atoms. Carbon fiber has several advantages including high stiffness, high tensile strength, low weight, high chemical resistance, high temperature tolerance and low thermal expansion. These properties havemade carbon fiber very popular in aeroscape, civil engineering, military, motor sports along with other competition sports. To produce carbon fiber, carbon atoms are bonded together in crystals that are more or less aligned parallel to the long axis of the fiber as the crystal alignment gives the fiber high strength - to - volume ratio (making it strong for its size). Several thousand carbon fibers are bundled together to form a tow, which may be used by itself or woven into a fabric.

Properties of Carbon Fiber

- Carbon Fiber has high Strength to Weight Ratio

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(otherwise called particular quality). The strength of a material is the drive per unit range at disappointment, isolated by its thickness. Any material that is solid and light has a good Strength/weight proportion. Materials, for example, Aluminum, titanium, magnesium, carbon and glass fiber, high-quality steel combinations all have a great quality to weight proportions. It is not astonishing that Balsa wood comes in with a high strength to weightproportion.

- Carbon Fiber is the extremely inflexible rigidity or firmness of a material is measured by its Young Modulus and measures how much a material avoids under anxiety. Carbon fiber fortified plastic T is more than 4 times stiffer than glass strengthened plastic, just about 20 times more than pine, 2.5 circumstances more noteworthy than aluminum.
- Carbon fiber is corrosion proof and chemically stable. Regardless of the way that carbon fiber themselves don't deteriorate, epoxy is fragile to light and ought to be secured. Diverse frameworks (whatever the carbon fiber is embedded in) might in like manner be responsive.
- Carbon fiber is electrically conductive. This element can be valuable and be an aggravation. In boat building, it must be considered similarly as Aluminum conductivity becomes an integral factor. Carbon fiber conductivity can encourage Galvanic Corrosion in fittings. His watchful establishment can decrease this issue. Carbon Fiber clean can gather in a shop and cause starts or short circuits in electrical apparatuses and hardware.
- Weakness Resistance is great Resistance to Fatigue in Carbon Fiber Composites is great. However, when carbon fiber fizzles it as a rule flops disastrously without much to declare its inescapable break. Harm intractable weakness is viewed as decrease in solidness with bigger quantities of stress cycles; (unless the temperature is high) Test has demonstrated that disappointment is probably not going to be an issue when cyclic burdens correspond with the fiber introduction.
- Carbon fiber is better than glass in exhaustion and static quality and in addition solidness. The introduction of the strands and the distinctive fiber layer introduction, impact how a composite will oppose weakness (as it has firmness). The sort of powers connected likewise result in various sortsof disappointments. Strain, compression or Shear powers all outcome in particularly extraordinary disappointment comes about. Paper on trial of carbon fiber composite expected for car utilization. American Institute of Aeronautics and Astronautics, test for materials to be utilized as a part of wind turbines cutting edges.
- Carbon Fiber has great Tensile Strength. Rigidity or extreme quality is the greatest anxiety that a material can withstand while being extended or pulled before necking, or fizzling. Necking is the point at which the example cross segment begins to fundamentally contract. On the off chance that you take a piece of plastic pack, it will extend and at one point will begin getting restricted. This is necking. It is measured in Force per Unit region. Fragile materials, for example, carbon fiber don't generally come up short at a similar anxiety level due to inside defects. They fizzle at little strains. (at the end of the day there is not a ton of bowing or extending before cataclysmic disappointment)
- Imperviousness to fire/non flammability depending upon the assembling procedure and the forerunner material, carbon fiber can be very delicate and can be made into or all the more regularly incorporated into defensive attire for firefighting. Nickel covered fiber is an illustration. Since carbon fiber is likewise synthetically exceptionally dormant, it can be utilized where there is fire consolidated with destructive specialists. Carbon Fiber Blanket utilized as welding insurance.
- Thermal conductivity is the measure of warmth transmitted through a unit thickness, toward a way regular to a surface of unit area, in perspective of a unit temperature slant, under tenacious conditions. All things considered it's a measure of how easily warm travels through a material. Hereare various frameworks of measures relying upon metric or supreme units.

Classification and types of carbon fiber

Based on modulus, strength, and final heat treatment temperature, carbon fibers can be classified into the following categories:

- Ultra-high-modulus, type UHM(modulus>450 Gpa)
- High-modulus, type HM(modulus between 350-450Gpa)
- Intermediate-modulus, type IM(modulus between 200-350 Gpa)
- Low modulus and high-tensile, type HT(modulus < 100Gpa, tensile strength >3.0Gpa)
- Super high-tensile, type SHT(tensile strength>4.5Gpa) Based on precursor fiber materials, carbon fibers are classified into:
- PAN-based carbon fibers
- Pitch-based carbon fibers
- Mesophase pitch-based carbon fibers
- Isotropic pitch-based carbon fibers
- Rayon-based carbon fibers
- Gas-phase-grown carbon fibers

Based on final heat treatment temperature, carbon fibers are

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classified into:

- Type-I, high-heat-treatment carbon fibers (HT), where final heat treatment temperature should be above 2000°C and can be associated with high-modulus type fiber.
- Type-II, intermediate-heat-treatment carbon fibers (IH), where final heat treatment temperature should be around or above 1500°C and can be associated with high-strength type fiber.
- Type-III, low-heat-treatment carbon fibers, where final heat treatment temperatures are not greater than 1000°C. These are low modulus and low strength materials.

Application Of Carbon Fiber

- **Civil Engineering**:

Use of Carbon fiber for Precast Concrete Construction-The use of carbon fibers in precast concrete elements is gaining massive popularity in the USA. he standard steel mesh reinforcement used in the outer and the inner section of concrete precast wall elements can be replaced by the sheet or grids of carbon fibers. By the use of carbon fiber instead of steel mesh, the overall weight of the structural unit decreases. A welded grid used in concrete slab construction can be replaced by a carbon fiber grid, which reduces total weight and gains needful chemical protection. Sandwich wall panels can make use of carbon fibers as a shear grid or as a truss. Carbon Fiber as Reinforcement-Carbon fibers are gaining more popularity in strengthening the concrete structures externally. It is used as an external reinforcement for columns. Hence it is taking a role in rehabilitation also. His strengthening method reduces the need for extra anchoring works and installation, which is very time consuming and costly. Carbon Fiber in. Bridge Construction Construction of main load-bearing structures, cables, decks, and supports also make use of carbon fibers.

- **Carbon Fiber in Flight**:

Carbon fiber has gone to the moon on rocket, however it is additionally utilized broadly in flying machine segments and structures, where it's better quality than weight proportion far surpasses that of any metal. 30% of all carbon fiber is utilized as a part of the airplane business. From helicopters to light weight planes, warrior planes to miniaturized scale lights, carbon fiber is having its influence, expanding range and streamlining support.

- **Sporting Goods**:

Its application in game merchandise ranges from the hardening of running shoes to ice hockey sticks, tennis racquets and golf clubs. "Shells" (frames for paddling) are worked from it, and many lives have been saved money on engine hustling circuits by its quality and harm resilience in body structures. It is utilized as a part of crash caps as well, for shaking climbers, horse riders and engine cyclists in actuality in any gamewhere there is a peril of head harm.

- **Carbon Fiber at Home**:

The employments of carbon fiber in the house are as wide as your creative energy, regardless of whether it is style or down to earth application. For the individuals who are style cognizant, it is regularly labeled as 'the new dark'. On the off chance that you need a sparkly dark bath worked from carbon fiber, or an end table then you can Have quite recently that, off the rack. iPhone cases, pens and even ties the look of carbon fiber is one of a kind.

V. CONCLUSIONS

Carbon fiber plates are thin, solid and adaptable. They can be outlined and introduced to give a practical arrangement which does not reduce outwardly from the first plan of the structure. It has high solidness, high rigidity, low weight, high substance resistance, high temperature resilience and is a standout amongst the most prominent materials in structural building. It has strength up to five times that of steel and being 33% its weight. It has more applications in structural building, military, donning merchandise, In medicine, in car industry, and so forth so utilization of carbon fiber in development is constantly viable and give high quality to the structures.

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