"EXPERIMENTAL STUDY OF REPLACEMENT OF STEEL BARS WITH FRP BARS"

[1]Vishwal Deshmukh, [2]Phadatare N. P.
[1]M.Tech Structure PVPIT Budhgaon, [2]Associate Professor, PVPIT Budhgaon.

ABSTRACT -In this experimental examine, concrete confirming to M20 grade is used. To maintain the identical quality of concrete during the examine, numerous take a look at specimen had been forged and trendy check like compression check, spit tensile check, modulus of rupture and modulus of elasticity on hardened concrete have been performed , confirming to Indian standards.

Constructing cubes and beam through the usage of steel bars and additionally via the usage of FRP bars is executed and also comparing the effects acquired by using metallic sections and FRP sections with the aid of taking checks like tensile check, flexural test, compression take a look at, and so forth is finished. Glass fiber reinforced plastic (GFRP) are the sort of FRP kinds. They are synthetic the usage of various manufacturing methods. Pultrusion system is a verified production approach for acquiring lengths of high exceptional GFRP that used inside the production as a primary or secondary load bearing factors. The in this examine the use of GFRP bars and urban adherence were investigated.

GFRP has been confirmed to be the answer as a primary improvement in bolstered concrete technology. Synthesis of GFRP rebars by using the usage of the longitudinal glass fibers (reinforcement material) and unsaturated polyester resin with 1% MEKP (matrix fabric) thru manual method. GFRP rebar have diameter 12.5mm this fee is equal to 0.Five inch; it's most 7 GFRP surfaces are changed by the inclusion of coarse sand to increase the bond power of rebar with concrete.

GFRP bars have strong resistance to corrosion. GFRP bars are increasingly used rather than steel bars to solve corrosion problems in reinforced concrete systems. Then, the mechanical characterization of bolstered concrete with GFRP rebars are done and compared with that of steel rebar. The guidance of concrete samples (unreinforced concrete, clean GFRP strengthened concrete, sand covered GFRP bolstered concrete and metal reinforced concrete) with constant ratio of substances (1:1.5:3) and 0.5 W/C ratio had been completed at two curing a while (7 and 28) days in ambient temperature.

The fee of extent fraction of GFRP and metallic rebar in the strengthened concrete become (5 vol. %) similarly disbursed with specific distances inside the mold. The end result show the tensile energy of GFRP rebar is 595 MPa and bend energy is 750 MPa. The compressive electricity was inside reasonable variety of concrete is 25.36 MPa. The flexural strength of unreinforced concrete is four MPa and bolstered concrete with GFRP rebar, specifically sand lined GFRP RC show off flexural power is 13.7 MPa as end result to growth bonding with concrete and higher pressure is 10.5 MPa at 28 days than that of metal strengthened concrete at the expense of flexural modulus.

INTRODUCTION: concrete is recognized as a brittle and has tremendously excessive compressive power. It has tensile strength roughly about one 10th of its compression strength. As end result of these characteristic, concrete flexural participants can't aid greater tensile hundreds that usually takes vicinity in the course of their lifetime. Hence, concrete has to be strengthened with substances which might be strong in tension like, continuous reinforcing bars to resist tensile stresses and to compensate the lack of ductility and power.

The steel reinforcement in concrete absorbs tensile stress, shear pressure or even compressive pressure within the strengthened concrete shape. The compressive power of concrete and tensile strength of metal works collectively in bolstered concrete member to maintain diverse stresses that stumble upon its lifetime for considerable span.

fiber strengthened polymer (FRP) is used as a structural engineering cloth in civil engineering cloth in civil engineering field which includes strengthening of shape made of concrete, masonry, steel and even timber. Many researches proved that the use of FRP in RCC flexural contributors improves flexural strength.

FRP materials are used as vital materials of the modern-day concrete structures. The FRP substances, have progressed structural overall performance, in terms of stability, energy (including improved resistance to fatigue loading) and sturdiness. Other factors consist of comfort in mass manufacturing with relative economic system and high nice control.

In current years, for all of the structural factors the use of fiber wrapping over the reinforced structural contributors appears to be the maximum competitive method. Therefore fiber reinforced polymers (FRP) acts as an outer strengthening layer for structural members because wrapping improves the integrity of the structure.

The essential objective of the existing research is to experimentally discover the maximum suitable approach to strengthen and rehabilitate the flexural member the use of different wrapping techniques under static loading conditions which include woven roving mat, chopped strand mat and jacketing strategies and many others.

Fiber reinforced polymer (FRP) is sincerely defined as a composite cloth which is made from polymer matrix bolstered with fibers. Commonly used polymers are epoxy, vinyl ester or polymer thermosetting plastic. In the FRP composites, the implemented load is carried more often than not by using the fibers. Matrix inside the composites offers bonding and protection to the fibers and it facilitates within the transfer of strain. FRP composites were utilized in various industries which include motors, aerospace and electronics for many years. But their advent in production industries happened currently. More tremendous use of FRPs is expected in coming years due to the fact lot of research carried via the researchers which helped us in higher knowledge of the properties and behavior of FRPs under exclusive conditions.

FRPs have a lot better energy-to-weight ratio and still have noncorrosive in nature while compared with steel FRPs is good cloth for software in restore, strengthening works and rehabilitation. FRPs are to be had inside the shape of prefabricated strips or in vital shapes and size that can be applied thru a moist lay-up techniques to any structural member such as beams, columns, slabs

and masonry walls. Especially in beams they're used to enhance their flexural power and flexural stiffness in addition to their shear energy.
GFRP bars have strong resistance to corrosion are used as opposed to metal bars to solve corrosion issues in RCC and also GFRP increase of the flexural stiffness, lowering the structural deformability, and the increase of the shape strength capability. Sanded floor GFRP bars display higher concrete adherence values than regular GFRP bars as end result of experimental studies concrete bond is growing about two times in sanded floor GFRP bars. Especially, FRP bars use in marine and coastal structures might be superb profits. The fiber reinforced polymer (FRP) composite cloth consists of sturdy fibers embedded inside a light polymer matrix has grown to be an attractive construction material. Many researchers are actively investigating FRP as reinforcement in concrete to beautify durability and extend lifestyles time over the serviceability of civil engineering structures. Research associated with this superior construction material has been achieved notably within us, Canada, Europe, and japan. Although the preliminary cost of the usage of FRP composites are higher in comparison to that of metal, they'll even up in the end for the reason that expensive repair and preservation because of steel corrosion may be prevented.
The tensile and shear power of GFRP bars by using 4 various diameter (20, 22, 25, 28 mm) have been mentioned with the aid of authors. The GFRP bars have been anisotropic and they are characterized via high tensile energy simplest in the path of the reinforcing fibers. The young's modulus of GFRP bars changed into same (1-five) of young's modulus of metal. The move phase dimensions didn't affect the GFRP bar modulus. The GFRP bars exhibited brittle behaviour and the relationship among pressure and pressure become linearly elastic up to failure. Variation of the shear energy of all GFRP bars diameter changed into little, but higher load brought on failure. The tiers of GFRP bars shear power have been sixteen% - 20% lower than the longitudinal tensile power.

The results concluded that GFRP as an opportunity of steel rebar, the use of GFRP in tensile loads path of beam have displayed flexural homes similar to the metallic rebar and GFRP bolstered concrete has offered excessive bending properties, except suited shear houses. Authors studied a bending technique of ultra – high overall performance fiber –strengthened concrete beams strengthened with GFRP rebar in different ratios within the beams. The low elastic coefficient of GFRP manner that excessive deflection and more cracks, however presence of brief fibers in concrete will enhance the bending overall performance (much less deformation, high ductility and higher rigidity) due to strain hardening with a couple of micro cracks and increased bending energy with accelerated reinforcement ratio. All of the take a look at results showed a decrease deflection due to pressure hardening at a certain stage of provider.
Durability of FRP bars in concrete: there is not any degradation of the GFRP inside the concrete systems uncovered to the natural environmental situations, there is right bond among the GFRP and urban, indicating that the moist-dry cycles, freeze-thaw cycles and de-icing salt had no damaging impact on the GFRP and concrete. Up to now, these structures are appearing thoroughly with very minimal preservation, indicating the long carrier existence of concrete structures reinforced with FRP bars. The GFRP bars strongly have an effect on the failure mode by way of delaying the buckling of the longitudinal bars, initiation and propagation of volatile cracks.

AIM OF THE WORK:

1Glass fiber reinforced polymer (GFRP) was used as an alternative cloth to the steel rebar.

2. It is light weight, no-corrosion, advanced tensile strength, and excessive mechanical performance.

3. Installation of GFRP rebar is similar to metallic rebar, however with less coping with, transporting and garage troubles.

4. In this work, the unsaturated polyester resin and E-glass fibers are used to synthesis GFRP bars of 1.25 cm diameter to simulate the size of the metallic rebar. Their surfaces are changed by using the insulation of coarse sand to keep away from slipping in stress conditions.

5. The mechanical characterizations of strengthened concrete with GFRP bars are carried out and in comparison with that of metallic bars. To define that FRP reinforcement is quality method of strengthening than metallic reinforcement. FRP became used as an alternative technique to the metallic rebar. It is mild weight, no-corrosion, advanced tensile energy and high mechanic performance. Installation of FRP rebar is just like steel rebar, however with much less managing, transporting and storage problems. In this mechanical characterization of bolstered concrete with FRP rebar are implemented and compared with that of metal bars.

PROBLEM DEFINITION:

Constructing cubes and beam by using the usage of metallic bars and also by using the usage of FRP bars….Comparing the outcomes received with the aid of metallic sections and FRP sections by means of taking checks like tensile check, flexural check, compression check and so forth …and finding out best section used for construction.

OBJECTIVES:

1. The important objective of the studies work is to discover the ideal bars for strengthening of structural participants.

2. Comparison between the fractures of different samples have to be accomplished. Mechanical characterization of strengthened concrete with FRP rebar are carried out and compared with that of steel rebar.

MATERIAL USED:
1. The materials used for the studies and their residences are: Glass fibers within the shape of the mat of Weighing 610 g/m2 and additionally a length of 1255 mm.
2. The fibers are pulled from the mat and utilized to synthesis bars. To produce 86 fibers we required that 86 fibers and delivered resin element.

3. Natural sand as a high-quality combination, and Gravel of (five-nine mm) gradation become used as a coarse aggregate, and Tap water became used, and ordinary Portland cement used.

GFRP REBAR:

1. GFRP rebar changed into synthesized from glass fibers and unsaturated polyester resin, GFRP bars become produced through immersing the fibers longitudinally within the unsaturated polyester resin with (1%) of its hardener after which the extra polymer is eliminated. That become without using a mold, due to the fact in case of using a mold, the matrix will fail before fibers resistance when subjected to the forces of anxiety. Several efforts were made to get the desired diameter of the bar by means of the usage of one-of-a-kind range of fibers and measuring diameter on every occasion. Finally a bar of 12.5 mm turned into acquired which is usually used diverse FRP creation applications. The ensuing bar has polyester extent fraction of 20% and fibers volume fraction of 80%.
2. After obtaining GFRP bars of required diameter, tensile and bend strengths were measured and as compared with normal reinforcement bar. The bonding among reinforcement and the concrete have been improved via a coating of GFRP bars with coarse sand of above 300 µm.

MIXING METHOD:

As in step with ASTMC-192, the dry substances that changed into cement and sand have been thoroughly jumbled in a pan. The mixing share turned into (1:1.Five:3). Then the gravel was blended and combined with the whole batch by shovel until the gravel is uniformly distributed throughout the batch. After that for a particular period the water changed into poured and combined with the dry materials, until the concrete has preferred consistency and also homogeneous in look. The mixing procedure turned into paused after which lower back for a few minutes. To prevent evaporation in the course of the rest period, the open give up or top of the pan was included. This step become repeated in cycles to insure the homogeneity for aggregate. The general mixing time for complete process turned into 15 min.

MOLDS USED:

For compressive strength and flexural power, the wooden mold was used during this research. Cubic shapes of part length of a hundred mm of molds have been used to prepare specimens for compressive strength and for flexural take a look at, Prismatic specimens of a hundred x 100 x 400 mm were used. Concrete casting became finished in one-of-a-kind layers, each layer of fifty mm. Each layer turned into compacted by using Tamping Rods until no air bubbles emerged within the concrete and to put off all of the air bubbles in concrete, and then the floor of concrete turned into leveled off absolutely to the upper of the molds with the aid of the usage of metallic trowel. Concrete is strengthened through five vol. % GFRP and steel bars calmly distributed with particular distance in the mildew. Polyethylene sheets are used as covers for specimens after casted for 24 h in room temperature (24 +- 2)ˆ0 C to inhibit moisture content from evaporation.

To benefit of durability, energy, and balance of volume, the powerful curing in first stage is critical.

Basic situations that must be provided to maintain a response is the good enough moisture and appropriate temperature. The green concrete incorporates sufficient water to complete the hydration process of cement, however in maximum situations a large quantity of water is evaporated via warmness. Moisture curing technique is the fine technique changed into utilized to make amends for the water that evaporates throughout the casting procedure. Specimens had been absolutely submerged inside the water tanks at 21+- 2 ^zero C till the time of measurements (7 or 28 days) as a curing age.

STRENGTH OF REBAR.

1. Tensile Strength:

The tensile power was measured consistent with ASTM D7205-06 for GFRP rebar and ASTM A496-02 for metal rebar using specimen of 25 +_ five cm duration, 1.25 cm diameter.

GFRP has better yield electricity than traditional metal rebar due to specific anisotropic property of composites makes them strong in anxiety. The yield strain of GFRP is higher than steel rebar, this could give the engineer untimely caution of the failure.

The concrete may be bonded with reinforcing bars, so that the greater tensile stresses, which can't be resisted through concrete, might be transported to the reinforcing bars therefore, the rebar should have a distinctly high tensile strength.

Bending Strength

The end result of bending are in table (2). Bending energy is measured in step with ASTM D 790 for GFRP and metal rebar using specimen 25 +_ five cm period, 1.25 cm diameter. This dimension is executed to decide an approximate values of the bending (electricity and stress) of a bare GFRP Reinforcing bar and it's as compared with bare steel reinforcing bar.

The basic difference between GFRP and metallic rebar. The results for the bending electricity of GFRP showed that the highest point of stress involve the stress which creates on the crack, after that the pressure will lower however the crack will grow until the failure. The use of the GFRP bars suggests more deflection before beginning to fail. This can supply greater threat to be alerted earlier than failure takes vicinity. The preliminary failure of the metallic rebar at stress 16.21%, at the same time as the initial failure of the GFRP starts at strain 20.23%. As a result using the GFRP bars shows greater deflection earlier than beginning to fail. This can supply extra

Table 1. Results of tensile measurement of bars.

Property	Samples	Samples
	Steel	GFRP
Yield Strength (MPa)	510	595
Yield Strain	15	37

Table 2. Results of bending measurement of bars.

Property	Sample	Sample
	Steel	GFRP
Yield strength (MPa)	1042	750
Yield Strain	17	22

Table 3. Compressive strength Results of concrete

Sample Type	Compressive Strength (MPa)	Compressive Strength (MPa)
	7 Days	28 Days
Unreinforced Concrete	20.76	25.36

CHARACTERIZATION OF REINFORCED CONCRETE

1. Compressive strength

The take a look at samples were 100 mm cubes and the consequences are in Table 3, according to the compressive strength is measured BS 1881: element 116. The enough compressive electricity could be supplied via concrete. The basis is nice example of creation programs that require compressive electricity consistent with blending proportions used.

The compressive loads will withstand by concrete only due to powdered ingredients of concrete. The outcomes showed the compressive power of unreinforced samples at 28 days is good for foundations software.

2 Flexural Strength: To decide ability of sand covered GFRP reinforced concrete to face up to flexural hundreds this size turned into completed and then compared it with reinforced concrete and unreinforced concrete samples.

The check samples have been 100x100x400 mm prism and tested thru 3 points loading. The specimen had been measured after (7-28) days of immersion in water. Measurement of flexural residences was achieved in step with ASTMC- 293. The Curves confirmed ductile conduct of GFRP strengthened concrete at 7 & 28 curing ages which offers extra danger to alert earlier than the failure. This outcomes showed the flexural electricity of sand covered GFRP bolstered concrete is excessive and it's near steel reinforced concrete. This is because it has better pressure than the steel strengthened concrete at the expense of the flexural modulus. And additionally flexural power of the unreinforced concrete is low and it's appreciably advanced by using strengthened concrete. Due to low flexural modulus the electricity of easy GFRP reinforced concrete is lower than the sand lined GFRP bolstered concrete. Sand grains reason an increase in brittleness of the GFRP bars. This ends in increased strength at the rate of the flexural pressure**.**

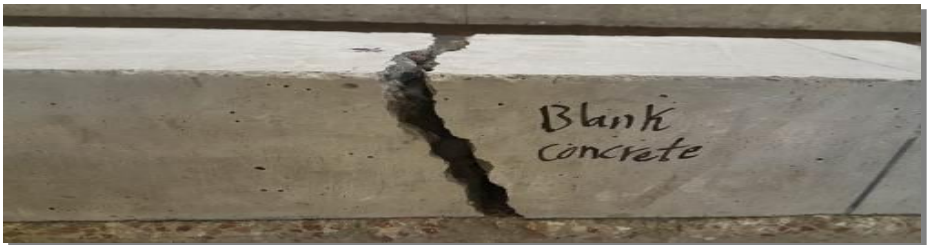
Table 4. Average flexural characteristics values of samples (7 days curing)

Property	**Samples**			
	Unreinforced concrete	Smooth GFRP Reinforced Concrete	Sand Coated GFRP Reinforced Concrete	Steel reinforced concrete
Flexural Strength (MPa)	3	10	12	13
Strain	4.8	18	12	9
Modulus of elasticity (MPa)	510	510	995	2010

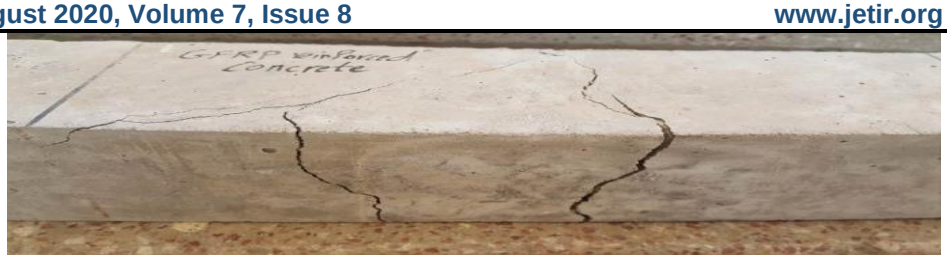
Table 5. Average flexural characteristics values of samples (28 days curing).

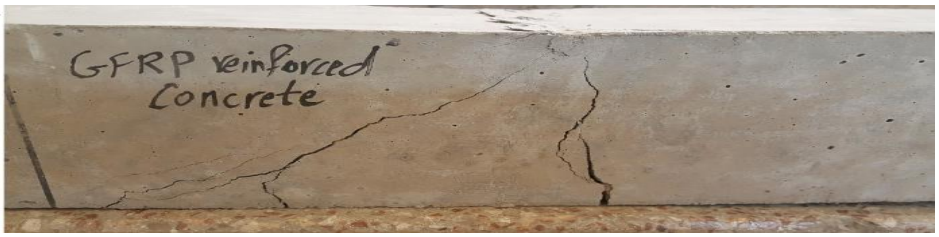
Property	**Sample**	**Sample**	**Sample**	**Sample**
	Unreinforced Concrete	Smooth GFRP reinforced concrete	Sand coated GFRP reinforced concrete	Steel reinforced concrete
Flexural Strength (MPa)	4	12	13.7	18
Strain	2.5	17	10	9.5
Modulus of elasticity (MPa)	1010	510	1000	1500

Images of the Work

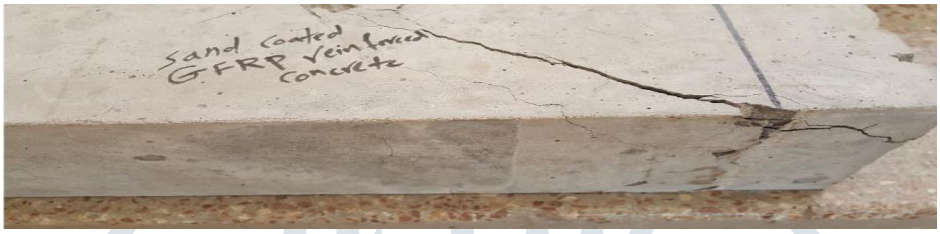


A) Fig 10. Typical fracture of unreinforced concrete

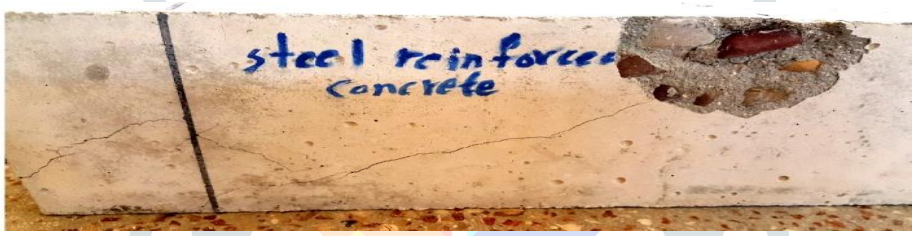




B) Fig11. Typical fracture of smooth GFRP RC.



C) Fig 12. Typical fracture of sand coated GFRP RC.



D) Fig 13. Typical fracture of steel RC

CONCLUSIONS: From this work following conclusions are made:

1. GFRP reinforcing bars have better corrosion resistance and higher tensile energy than steel rebar

2. GFRP bar has slight flexural strength consequently GFRP is good alternative to steel

A) According to end result mechanical characteristics can be concluded as the following:
1. GFRP bars are anisotropic composite materials because they have got high tensile electricity
2. According to end result GFRP rebar accomplished yield tensile strength about 14% better than metallic rebar and yield stress of GFRP is higher than metal approximately 60%.
3. Bending strength of GFRP bar is right, in bending yield electricity of GFRP rebar accomplished 72% of metal rebar electricity at the same time as yield pressure of GFRP is better than steel about 23%.
4. Compressive strength of unreinforced concrete is 25.36 MPa: this value is acceptable consistent with British Standard Specifications.
5. Flexural strength is right of sand coated GFRP RC in any respect curing a long time. Increase of clean GFRP RC flexural strength was about 66-71 % and sand lined GFRP RC about 71-76% as compared to unreinforced concrete strength.
6. Flexural power of smooth GFRP completed 66-71% while sand coated strength achieved 76-81% of flexural energy of metallic RC.
7. Flexural modulus of easy GFRP RC decreases around 66% and sand lined GFRP RC round 34% in comparison with steel RC.
8. The flexural pressure of smooth GFRP RC is accelerated around 44% and sand lined GFRP multiplied around 5% as compared with steel RC at curing age of 28 days
9. As end result of experimental research, Sanded floor GFRP bars show higher concrete adherence values than normal GFRP bars, and additionally concrete bond is increasing about twice in sanded floor GFRP bars

2. COMPARISON BETWEEN THE FRACTURES OF THE DISTINCTIVE SAMPLES

1. In the case of the unreinforced concrete, the brittle fracture is very clean as proven. While the smooth GFRP reinforced concrete additionally display a couple of fracture line, however without complete fragmentation. On the other hand, the sand lined GFRP strengthened concrete. The fragmentation after fracture is lower than that of clean GFRP reinforcement. The concrete remains in one piece which can be useful in decreasing damaged after failure. The appearance of the fractures of sand coated GFRP bolstered concrete is corresponding to that of the steel strengthened concrete.

2. As a result of experimental studies sanded floor GFRP bars show better concrete adherence values than ordinary GFRP bars and additionally, concrete bond is increasing approximately twice in sanded floor GFRP bars.

SCOPE OF FUTURE WORK:

This research work has been achieved with the M20 grade concrete. In future, this paintings might be executed with the high electricity concrete.

The Scope of the prevailing investigation is to the most appropriate techniques that can be used to construct, give a boost to the construction member.

The scope of the present investigation includes locating the ultimate load carrying capability, stiffness, ductility thing.

By the study of the these work we get FRP as appropriate material for alternative of steel bars and additionally the software of FRP for strengthening of RC columns, RC slabs, and also existing vintage structures, for shear wall structures.

Use of FRP bars have proven the fine effects to provide most strength together with excessive ductility and durable structures with little protection requirement.

Load sporting ability of flexural bolstered masonry partitions with FRP bars and strips extended than that of unstrengthened masonry partitions.

The corrosion resistance, mild weight, excessive energy, and electromagnetic neutrality of FRP rebars have led to the actual creation of latest infrastructure tasks using them as the main reinforcement in concrete structure.

REFERENCES:

[1] ASTM A496- Standard Specification for metallic wire, deformed for concrete Reinforcement.2002.

[2] ASTM D790.Standard check technique for flexural homes of unreinforced and reinforced plastics and electrical insulating material, 1997.

[3] B.S. 1881: Part 116, Method for Determination of Compressive Strength of Concrete Cubes, British Standards Institution, 1989.

[4] ASTM C150-02 Standard Specification for Portland cement ASTM International, West Conshohocken, PA, 2002.

[5] D.Y Yoo, N. Banthia, Y.S Yoon. Flexural behaviour of ultra-excessive-overall performance fiber-bolstered concrete beams reinforced with GFRP and metallic rebars. Eng. Struct. 111(2006)246-262.

[6] ASTM C33-02a, Standard Specification for concrete Aggregates, ASTM International.

[7] ASTM C293, Annual Book of ASTM Standards, Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Center-Point Loading), 04.02.2002

[8] ASTM D7205-06, Standard Test Method for Tensile Properties of Fiber Reinforced Polymer Matrix Composite Bars, ASTM International, 2003

[9] ACI Committee 308R -01 Guide to Curing Concrete, Reported by means of ACI Committee 308, ACI Manual of Concrete Practice, 2009,p.2.

[10] S. Solyom , G.L. Balazs, A. Borosnyoi. Bond behaviour of FRP rebars- parameter have a look at, in: SMAR 2015 – Third Conference on Smart Monitoring. Assessment and Rehabilitation of Civil Structures. Antalya, Turley, September. 2015, pp. 7-9

[11] D.Y Yoo. N. Banthia, Numerical simulation on structural behaviour of UHPFRC beams with metallic and GFRP bars, Comput, Concr. 16 (five) (2015) 759-774.

[12] R. Okelo, R.L. Yuan, Bond energy of fiber strengthened polymer rebars in ordinary energy concrete, J. Compos. Constr. Nine (three) (2005) 203-213.

[13] A.El –Nemr, E.A. Ahmed, B. Benmokrane, Flexural behaviour and serviceability of regular and excessive energy concrete beams strengthened with glass fiber bolstered polymer bars, ACI Struct. J. One hundred ten (6) (2013) 1077.

[14] ACI 440. IR- 06, 2006. Guide for the Design and creation of concrete bolstered with FRP bars. ACI, Farmington Hills, MI, USA, pp. Forty four p.P.

[15] Benmokrane, B., Chaallal, O., and Masmoudi, R.1995. Flexural response of concrete beams strengthened with FRP bars, ACI structural Journal, Vol. Ninety one, No.2 pp.-forty six-47.