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Experimental Investigation of Concrete Beams and Columns with Fiber Reinforced Polymer Rebars

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Abstract: Repair and refit of existing structures have been among the most pressing concerns in civil engineering in recent years. One of the most significant problems limiting structure service life is the corrosion of steel bar reinforcing. Furthermore, the cost of maintaining concrete corroded reinforced parts is prohibitively high. The use of corrosion-resistant materials, such as Fiber Reinforced Polymer (FRP), is one answer to this problem. This technique has lately emerged as one of the alternatives to steel utilization. There is a scarcity of dependable data regarding durability. Experiment with flexural behavior of GFRP beam and column. For M25 mix, a total of eighteen beams were tested. All of the beams were evaluated with two-point static loading. The studies demonstrated, the study of beam reinforced with steel bars and GFRP bars related to deflection, first load at which crack appeared and their crack pattern. The study of cylinder reinforced with steel bars and GFRP bras related to compressive strength.

Keywords: *Concrete beams, GFRP Bars, Deflection.*

1. INTRODUCTION

The reinforced concrete beam is one of the most important structural parts that can primarily absorb load. Steel bar corrosion reinforcement is one of the most serious issues limiting the service life of constructions. Furthermore, maintaining concrete with corroded reinforced portions is too expensive.

One solution is to use corrosion-resistant materials, such as Fiber Reinforced Polymer (FRP). This technique has recently emerged as one of the alternatives to steel use. There is a scarcity of reliable durability data. Furthermore, there have been few trials in the domain of concrete design and reinforced structure construction using Glass Fiber Reinforced Polymer (GFRP). Engineers must consider the varieties within the physical qualities and the characteristics of execution when choosing whether to utilize FRP bars. The truth that all of the FRP bars stay straightly versatile until break and show no ductility in comparison to conventional steel bars could be a exceptionally vital thought for the creator. The committee 440 ACI's design rules exhort utilizing a least sum of FRP area instead of a greatest sum when utilizing FRP bars.

Concrete will serve as a witness and a caution of a potential break as a result. The steel reinforcement in concrete absorbstensile 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. Fibre strengthened Polymer (FRP) is used as a structural engineeringclothincivilengineeringclothinCivilEngineeringfieldwhich includes strengthening of shape made of concrete, masonry, steel and even timber. Manyresearches 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.

TheFRPsubstances,haveprogressedstructuraloverallperformance,intermsofstability,energy(Includingimprovedresistancetofatigueloading) and sturdiness. Other Factors consist of comfort in mass manufacturing with relative economic system and high nice control. In our project we made anattempt to study strength properties of GFRP bars and steel bars. Replacing the steel bars with GFRP bras in the beams.

2. METHODOLOGY

Thesevariouspropertiesandtestarecarriedoutarefollowed,

a.ToStudyofcomparativepropertiesofFRPrebars and steel rebars.

b. Tostudyofflexuralpropertiesofbeambyusingsteelbarsand GFRPrebars.

c. Tostudyofshearpropertiesofbeambyusingsteelbarsand GFRP rebars.To study compression strengthofcolumnbyusingGFRPrebars.

CastingofSpecimen&ExperimentalMethodology

A total of eighteen beams were tested for M25mix. From this, six beam reinforced with steelbars, six beam reinforced with GFRP rebars andsix beam reinforcedwith combinationof steelbarsandGFRP rebars.Also6cylinderswerecasted and tested for compressive strength. Fromthem three reinforced with steel bars and threereinforced with GFRP bars. The reinforcementwas designed considering a balanced section forthe expected characteristic strength. All the beamtested under two-point static loading. The studiesdemonstrated, the study of beam reinforced withsteel bars and GFRP bars related to deflection,first load at which crack appeared and their crackpattern.Thestudyofcylinderreinforcedwithsteel bars and GFRP bras related to compressivestrength.

Materials-

Steel bars-the steel bars incorporated in beamsectionareFe500.Whereyieldstrengthof500 N/mm2as per IS 1786.

GFRPBars-

GFRPbarsaremanufacturedbypultrusionprocesswith75%ofglassfibercomposition. These bars are available with outerdiameterfrom4to20mmwithevenlydistributed spiral relief of any construction lengthbasedonrequirementSincefixturehasmorefibercontenthasgoodphysical,chemicalandstrength characteristics which is compared withsteelbarand summarized in Table 1.

Beamspecimen-

Concretebeams,1000mmx200mm x150mmarecastedfortestingofspecimen.Allthespecimenswerepreparedinaccordancewith IndianStandardSpecificationIS516-1959.Everyspecimen consisting18beams.

Cylinder:

Concrete cylinders, 200mm x 400mm are castedfor testing of specimen. All the specimens werepreparedinaccordancewithIndianStandardSpecificationIS516-1959.Everyspecimenconsisting6 cylinders.

Experimentalsetupandinvestigation

The experimental beams with nominal length of1000mm and the distance between load appliedbeing 420 mm were loaded by two point loading.Eachspecimenwassupportedonrollerassemblies with knife edges in order to locate theexactsupportingpointFig2.Showsthetestsetup.

Fig1.Experimental setup

Testing of beams were conducted under UTM ofcapacity1200KN.Thebehaviorofbeamisinspectedoverconnectingseveralparameterslike, deflection, crack pattern and crack width,wasrecorded and analyzed.

Flexuralstrength

Tableno1:AverageValueofflexuralstrength:

Sr No.	Beams	28 daysstrength	Average(MPa)28 days
1	Beam reinforcedwith steelbars	8.2	7.5
2		7.6	
3		7.5	
1	Beam reinforcedwithGFRPbars	7.7	7.6
2		8	
3		7.5	
1	Beam reinforcedwith steel bars attop and GFRP barsatbottom.	8.5	9.4
2		9.8	
3		10.2	
1	Beam reinforcedwith GFRP bars attop and steel barsatbottom.	8.7	8.2
2		7.6	
3		8.1	

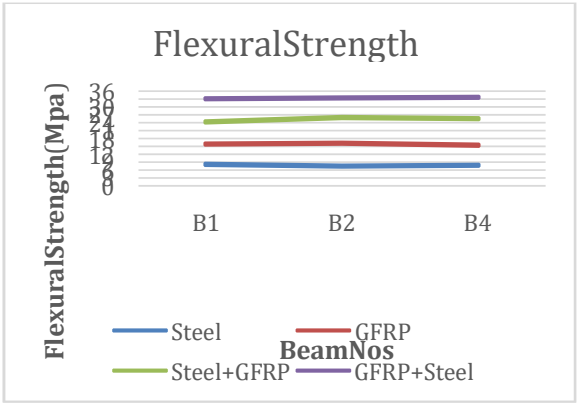
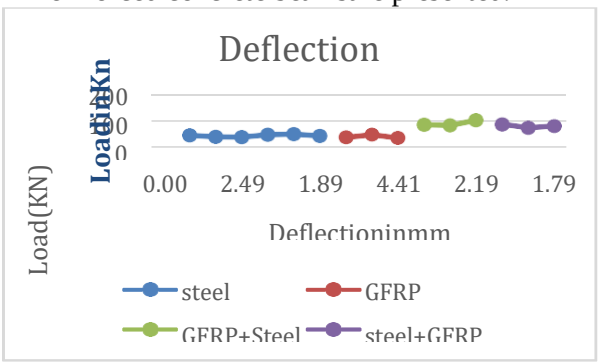


Fig2Flexuralstrength

Load-deflectionbehavior-

Theexperimentalloadtomid-spandeflectioncurves and failure loads of the steel bars, GFRPbars, and composite reinforced concrete beamsare presented.



FigNo3:Deflection

Table 3: First crack load of steel beam and GFRPBeams.

SrNo.	Beams	First crackload(KN)	Deflection(MM)
1	Beam reinforcedwith steelbars	64	1.79
2		70	2.36
3		59	2.78
1	Beam reinforcedwith GFRPbars	39	5.26
2		49	4.81
3		37	4.41
1	Beam reinforcedwith steel bars at topand GFRP bars atbottom.	70	2.84
2		59	2.35
3		79	2.19
1	Beam reinforcedwith GFRP bars attop and steel bars atbottom.	70	2.81
2		58	2.36
3		64	1.79

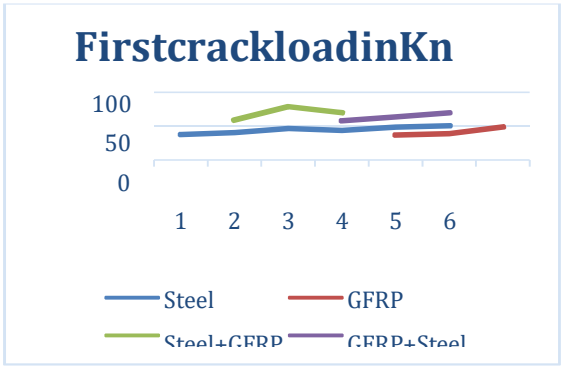
Crack Pattern:

TypesofShearFailure ofbeam:

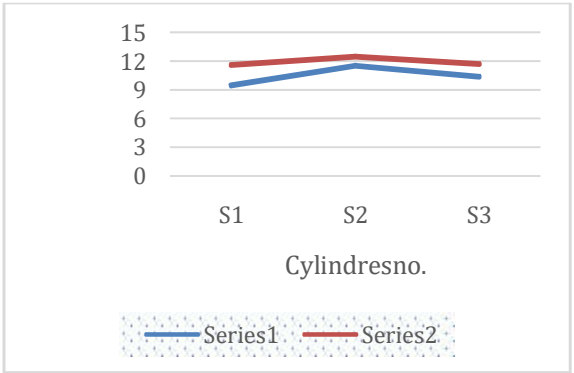
1) Diagonaltensionfailure: Diagonaltensionfailure occurs near the support where shear forceis large as compared to bending moment. Thecracksformedmakes45degrees withhorizontal.

2) Diagonal compression failure: This type offailure occurs at the span between support andmid-span.Atthatmovementshearforceandmoment shows approx. equal value. This type offailuremakes 45to 90degreeswith horizontal.

3) Flexural tension failure: This type of failureoccurs at mid span of beam. Value of moment ismore than shear force. Makes Exactly 90 degreeswithhorizontal.



Figno4:Firstcrackload inKn



Figno5:compressivestrength

1. RESULTANDDISCUSSION

After 28 days, steel-reinforced beams have aflexural strength of 7.7 N/mm2. Additionally, theflexuralstrengthofbeamsstrengthenedwithGFRP rebars is 7.5 N/mm2 after 28 days. Theflexuralstrengthofthebeams,whichare bottom mountedGFRPbeamsandtop-mountedsteelbarsforreinforcement,is9.5N/mm2.Beamsreinforced with GFRP bars at the top and steelbars at the bottom have a flexural strength of 8.3N/mm2.

1) After28days,theaverageultimateloadapplied to a steel-reinforced beam is 83.68 KN.Additionally, the average ultimate load placed onGFRP-reinforced beams after 28 days is 75.10KN.TheaverageultimateappliedonGFRP beamsatthebottomandsteelbarsatthetopis90.27KN.Onbeamsstrengthenedwithsteelbars at the bottom and GFRP bars at the top, theaverageultimate loadis86.38 KN.
2) The average deflection of the tested beams inthe group for steel-reinforced beams is 2.31 mm.Additionally, GFRP rebar-reinforced beams havea 4.82 mmdeflection.
3) The average deflection of all the tested beamsin the three groups—those reinforced with steelbars at the top and GFRP beams at the bottom—is 2.46 mm, and for those reinforced with GFRPbarsatthetopandsteelbarsbeamsatthebottom,itis2.32 mm.
4) The crack pattern in the two types of beamswas diagonal tension failure, however in someinstancesitwas flexural failure.
5) The average strength of the first crack in steel-and GFRP-reinforced beams is 64 KN and 45KN,respectively.
6) The average initial crack load in a beam that isstrengthened with steel at the top and GFRP barsatthebottomis70mm.andthe68mm-widebeam is reinforced with steel bars at the bottomandGFRP bars at the top.
7) Thesteel-bar-reinforcedcylinderhasacompressivestrengthof 10.42N/mm2.Andadditionally reinforced with GFRP bars, is 11.9N/mm^2.

2. CONCLUSION

AdetailedstudyhasbeencarriedoutontheflexuralandshearstrengthofsteelreinforcedbeamsandGFRPbarsreinforcedbeams.Andcompressivestrengthoncylinder.Hencethefollowing conclusion are considered based on theresultsandobservations are following.

1) The flexural strength of beam reinforced withcombinationSteelandGFRPbarsisslightlymorethanthatofbeamreinforcedwithsteelbars. Also, flexural strength of beam reinforcedonly GFRP bars is lesser than beam reinforcedwithonly steel.

2)GFRP barshaveaweakerelasticitymodulus,whichgeneratemoredeflectionforequalloadsandspans. Comparing. LoadandDeflectionrates,deflectionofGPCbeams reinforced with combination of Steel barsand GFRP bars is slightly less as load bared bythis beamismore.

3) Deflection in beam reinforced with steel barsis slightly more as load bared is less as comparedto beam reinforced with combination of steel andGFRP.
4) First crack occurred in GFRP reinforced beamis at that particular load is 24% greater than thatbeamreinforced withsteel bar.
5) Crack pattern observed was Diagonal tensionfailure in both the types of beams while in somecases it wasflexuralfailure.

3. REFERENSES

[1] DenvidLaua,b, HoatJoenPam.*"Experimental study of hybrid FRP reinforced concrete beams".* DepartmentofCivilandEnvironmentalEngineering, MassachusettsInstitute of Technology, Cambridge, MA, USA bDepartment of Civil Engineering, The University of HongKong, Pokfulam Road, HongKong,China. www.elsevier.com

[2] AbdelmonemMasmoudia,MongiBenOuezdouaJamelBouaziz*"NewparameterdesignofGFRP RC beams".*

[3] D.ShanthaKumaraandR.Rajkumar*"ExperimentalInvestigationonFlexural Behavior of Concrete Beam with GlassFiberReinforcedPolymerRebarasInternalReinforcement."*P.G.Student,M.Tech.,DepartmentofCivilEngineering,CHENNAI(T.N.) Int. J Chem. Sci.: 14(S1), 2016, 319-329ISSN0972-768X. (2012)

[4] AliS.Shanour,AhmedA.Mahmoud,Maher A. Adam, Mohamed Said (2014),*"ExperimentalInvestigation of Concrete Beams Reinforced withGFRP Bars."*Department of Civil Engineering,Faculty of Engineering, Benha University, 108Shoubra St.,Shoubra, Cairo, Egypt.Volume5,Issue11,November(2014),pp.154-164©IAEME:www.iaeme.com/Ijciet.asp(2014).

[5]R.Murugan,G.Kumaran.*"ExperimentonRCBeamsReinforcedwithGlassFiberReinforcedPolymerReinforcements"***.**International journal ofInnovativeTechnologyandExploringEngineering.(IJITEE)ISSN:2278-3075,Volume 8,Issue6S4,

[6] ZeyangSuna, LinchenFua, De-Cheng Fenga,Apete R. Vatulokaa, Yang Weib, Gang Wua, c,*"Experimental study on the flexural behavior ofconcrete beams reinforced with bundled hybridsteel/FRPbars."*SoutheastUniversity,KeyLaboratory of Concrete and Prestressed Concrete Structures of the Ministry of Education,

Nanjing210096,China.www.elsvier.com.
[7] Vishwal Deshmukh, 2Phadatare N. P (2020),*"ExperimentalStudyofReplacementofSteelBarswithFRPBars"*MTechStructurePVPITBludgeon,AssociateProfessor,PVPITBludgeon.InternationalResearchJournalofEngineering and Technology (IRJET) e-ISSN:2395-0056Volume:07Issue:08 12/10