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Strengthening Of RC Beams Using Glass Fibre Reinforced Polymer Sheets And Comparison Of U Wrap And 90 Degree Strip Wrap.

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ABSTRACT:
Strengthening iiof iireinforced iiconcrete iibeams iiwith iiexternally iibonded iifiber iireinforced iicomposites iiis iia iitechnique iithat iihas iibeen iideveloped iiin iirecent iiyears.iiHere iiin iithe iipresent iistudy iiGlass iiFiber iireinforced iipolymer iisheets iiare iiused iifor iifinding iibehavior iiof iibeams iistrengthened iiwith iicomposite iimaterials.iEight iibeams iiare iicasted, iitwo iibeams iias iicontrol iibeams.iResin iimortar iiwith iipromoter, iicatalyst, iiand iiaccelerator, iiis iiused iias iia iibinding iimaterials iiin iivarious iipatterns. iAfter ii24 iihours iiof iiwrapping iiand ii7 iidays iiair iicuring iibeams iiare iitested ii.U iiwrapping, iiBottom iiwrapping, ii45 iidegree iiU iiwrapping, ii90 iidegree iiU iiwrapping, iiCombination iiof iiBottom iiwrapping iiwith ii90 iidegree iiu iiwrapping iiare iitested iiin iistatic iithree iipoint iiloading iiframe iiset iiup.iThe iitest iiresults iiwere iievaluated iiin iiterms iiof iiload iideflection iibehavior, iiultimate iiload iicarrying iicapacity, iiultimate iideflection, iicrack iipatterns iiand iiassociated iifailure iimodes.iThe iiresults iiobtained iiclearly iidemonstrate iithe iieffectiveness iiof iistrengthening iiof iiRC iibeams iiusing iiGlass iireinforced iipolymer iisheets.iiThe iibeams iitreated iiwith iiResin iimortar iiwith iiaccelerator, iicatalyst iiand iipromoter iiimproved iithe iistrength iiand iiload iicarrying iicapacity.

Keywords: iiGlass iiFiber iireinforced iiPolymerii(GFRP), iiStrengthening, iiRetrofitting iiThree iiPoint iiLoading iiFrame, iiCatalyst, iiPromoter, iiand iiAccelerator, iiLoad iiCarrying iiCapacity, iiWrapping.

I. INTRODUCTION

Reinforced iiConcreteii(RC) iistructures iihave iibeen iione iiof iithe iimajor iistructural iimaterials iifor iiover iia iicentury iiand iiare iistill iithe iimost iipopular iimaterial iifor iipublic iistructures iiall iiover iithe iiworld.Reinforced iiconcrete iibeams iiare iistructural iielements iidesigned iito iicarry iitransverse iiexternal iiloads.These iiloads iicauses iibending iimoment, iishear iiforces iiand iitorsion iiacross iitheir iilength iiin iisome iicases.iConcrete iiis iistrong iiin iicompression iiand iivery iiweak iiin iitension.Thus, iisteel iireinforcement iiused iito iitake iiup iitensile iistresses iiin iiRC iibeams.iiIn iirecent iiyears, iithe iifield iiof iiconcrete iistructure iistrengthening iihas iibecome iia iihot iipoint.iiAs iia iiresult, iithe iirelated iistrengthening iitechniques iiof iiconcrete iistructure iihave iibeen iian iiimportant iiresearch iifield iiin iistructural iiengineering.iiThe iiuse iiof iicomposites iifor iistrengthening iiand iirepairing iiRC iistructures iihas iigained iiimportance iiin iicivil iiengineering.iiStrengthening iiof iireinforced iiconcrete iistructures iiwith iiexternally iibonded iifiber iireinforced iipolymer ii(FRP) iicomposites iiis iia iinewly iideveloped iitechnique iiin iirecent iiyears.iiGenerally, iiFRP iistrengthened iiRC iibeams iiconsists iiof iifour iimaterials iiie iiconcrete, iisteel iibars, iiadhesives, iiand iiFRP iireinforcement.iiBenefits iiof iiFRP iicomposites iiinclude iilight iiweight, iihigh iistrength iiand iihigh iimodulus, iidurability iiand iiimpact iiresistance.iiFRP's iistructural iiproperties iiare iiuseful iiin iiabsorbing iiseismic iior iiblast iienergy, iiand iithis iiproperty iilets iithe iimaterial iito iiact iias iia iipolymer iidamper iiat iiflooring iiarea iiand iiconnection iizone.iiThese iiare iisuccessfully iiimplemented iito iienhance iithe iiperformance iiof iistructural iielements iiin iiflexure, iiaxial, iishear, iiand iitorsion.iiThe iicommonly iiused iiFRP iihas iisome iidrawbacks iilike iidebonding iiof iiFRP iifrom iithe iiconcrete, iipoor iibehaviour iiof iiepoxy iiat iihigh iitemperature, iiinability iito iiapply iion iiwet iisurface, iirelatively iihigh iicost, iietc.iiand iithese iican iibe iisolved iiby iiusing iiGlass, iifibers, iiBasalt iifiber, iiNylons iietc.

II. MATERIALS USED

2.1 iiCONCRETE

Concrete iiis iia iiconstruction iimaterial iiof iiPortland iicement iiand iiwater iicombined iiwith iisand, iigravel, iicrushed iistone, iior iiother iiinert iimaterial iisuch iias iiexpanded iislag iior iivermiculite.iiThe iicement iiand iiwater iiform iia iipaste iiwhich iihardens iiby iichemical iireaction iiinto iia iistrong, iistone- iilike iimass.iiThe iiquality iiof iithe iipaste iiformed iiby iithe iicement iiand iiwater iilargely iidetermines iithe iicharacter iiof iithe iiconcrete.iiProportioning iiof iithe iiingredients iiof iiconcrete iiis iireferred iito iias iidesigning iithe iimixture, iiand iifor iimost iistructural iiwork iithe iiconcrete iiis iidesigned iiCompressive iistrengths iiof ii15 iito ii35 iiMPa.iiPozzolona iiPortland iicement iiwill iibe iiused.iiOrdinary iiclean iiportable iiwater iifree iifrom iisuspended iiparticles iiand iichemicals iiwill iibe iiused iifor iiboth iimixing iiand iicuring iiof iiconcrete**.**

2.2 iiREINFORCEMENT ii

The iilongitudinal iireinforcements iiused iiwere iihigh- iiyield iistrength iideformed iibars iiof ii10mm iidiameter iiand ii10 iimm iidiameter iiwere iiused iias iihanger iibars. ii.iiThe iistirrups iiwere iimade iifrom iimild iisteel iibars iiwith ii8mm iidiameter.

2.3 iiGLASS iiFIBRE iiREINFORCED iiSHEETS

Glass iifiber iireinforced iipolymerii(GFRP) iiis iia iicomposite iiconstruction iimaterial iiresulting iifrom iithe iicombination iiof iiunsaturated iipolyester iibased iiresin iiused iias iia iibinder iiwith iiglass iifiber.iiThe iifibers iimay iibe iirandomly iiarranged, iiflattened iiinto iia iisheet ii(called iia iichopped iistrand iimat).iiThese iiare iifibers iicommonly iiused iiin iithe iinaval iiand iiindustrial iifields iito iiproduce iicomposites iiof iimedium- iihigh iiperformance.iiTheir iipeculiar iicharacteristic iiis iihigh iistrength.iiGlass iiis iimade iiup iiof iisilicon ii(SiO_2) iiwith ii ii iitetrahedral iistructure ii(SiO_4).

Fig ii1.1: iiGlass iiFiber iiSheet

Material iicharacteristics	Glass iifiber iireinforced iipolymer iisheets
Density ii(g/cc)	2.60
Tensile iiStrength ii(MPa)	2050
Elastic iiModulus	85

Table ii1.1: iiProperties iiof iiGlass iifiber iireinforced iipolymer iisheets.

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The iimajor iiadvantages iiof iiglass iifibers iiare:

- Cheaper iiand iimore iiflexible iithan iicarbon iifiber
- Stronger iithan iimany iimetals iiby iiweight
- Non-magnetic iiand iinon-conductive
- Highly iiflexible iiand iican iibe iimoulded iiinto iicomplex iishapes
- Chemically iiinert iiunder iimany iicircumstances
- Inherent iistrength
- Weather-resistant iifinish
- Thermal iiresistant

2.2 iiMORTAR iiRESIN

Epoxy iiMortar iiis iia iipolymer iibased iibonding iipaste iithat iicomprises iimaterials iisuch iiasiiepoxy iiresinsii(Vinyl iiEster), iihardener iiCobalt iiOcatate), iicatalyst ii(MEKP-Ketone iiPeroxide) iiand ii Promoter.iiIt iiis iiused iito iibind iithe iiglass iifiber iisheets iiwith iiconcrete iispecimens iiin iithe iiform iiof iicoatings iifor iiresisting iidebonding iifailures.iiThe iicompressive iistrength iiof iiresin iimortar iiis iilower iithan iiordinary iiPortland iicement.iiThe iitoughness iiof iiepoxy iiresin iiis iibetter iithan iiordinary iiPortland iicement.

Fig1.2.1: iiResin iimortar iiwith iicatalyst, iihardener iiand iicatalyst

III. RETROFITTING OF BEAMS

Before iibonding iithe iicomposite iifabric iionto iithe iiconcrete iisurface, iithe iirequired iiregion iiof iiconcrete iisurface iiwas iimade iirough iiusing iia iicoarse iisand iipaper iitexture iiand iicleaned iiwith iian iiair iiblower iito iiremove iiall iidirt iiand iidebris.iiThen iiapply iicement iimortar iion iicracked iisurfaces iito iifill iicracks iiformed iidue iito iiaxial iiloading iiOnce iithe iisurface iiwas iiprepared iito iithe iirequired iistandard, iithe iiepoxy iiresin iiwas iimixed.iiMixing iiwas iicarried iiout iiin iia iiplastic iicontainer iiand iiwas iicontinued iiuntil iithe iimixture iiwas iiin iiuniform iicolour.iiWhen iithis iiwas iicompleted iiand iithe iifabrics iihad iibeen iicut iito iisize, iithe iiepoxy iiresin iiwas iiapplied iito iithe iiconcrete iisurface.iiThe iicomposite iifabric iiwas iithen iiplaced iion iitop iiof iiepoxy iiresin iicoating iiand iithe iiresin iiwas iisqueezed iithrough iithe iiroving iiof iithe iifabric.iiThis iioperation iiwas iicarried iiout iiat iiroom iitemperature.iiConcrete iibeams iistrengthened iiwith iiglass iifiber iifabric iiwere iicured iifor ii48 iihours iiat iiroom iitemperature iibefore iitesting.

Fig ii3.1: iiApplication iiand iifixing iiof iiglass iifibre iisheet iiand iiresin iimortar

3.2: iiU iiwrapping iiusing iiglass iifiber iisheets

Fig ii3.3: ii90 iidegree iiwrapping iiusing iiglass iifiber iisheets

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ii

Fig ii3.4: iiCombination iiof ii45degree iiand ii90 iidegree iistrip iiwrapping iiusing iiglass iifiber iisheetsii(white iicement iiapplied)

IV. TWO POINT LOADING

In iitwo iipoint iiloading iithe iiload iiis iitransmitted iithrough iia iiload iicell iiand iispherical iiseating iion iito iia iispreader iibeam.iiThis iibeam iibears iion iirollers iiseated iion iisteel iiplates iibedded iion iithe iitest iimember iiwith iimortar, iihigh- iistrength iiplaster iior iisome iisimilar iispreader iiplates.iiThe iiloading iiframe iimust iibe iicapable iiof iicarrying iithe iiexpected iitest iiloads iiwithout iisignificant iidistortion.iiEase iiof iiaccess iito iithe iimiddle iithird iifor iicrack iiobservations, iideflection iireadings iiand iipossibly iiload iicorresponding iito iieach iideflection iiis iinoted.iiCrack iipatterns iiare iimarked iiwith iidifferent iicolour iipens iiwhen iiformed iiat iifailure,

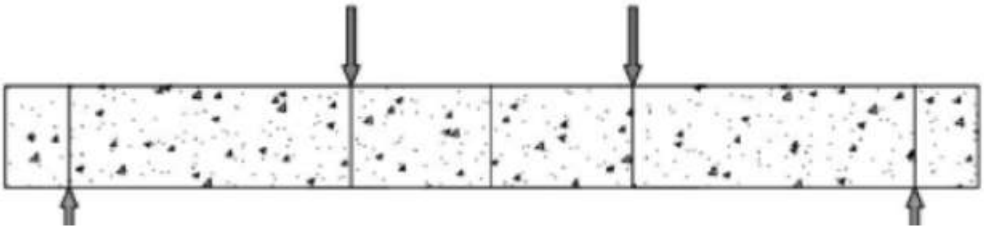

Fig ii4.1: iiTwo iipoint iiloading iiof iibeams

Fig ii4.2: iiShear iiforce iidiagram

Fig ii4.3: iiBending iimoment iidiagram

Fig ii4.4: iiExperimental iiset iiup iifor iibeams

4.iiPROJECT iiPROCEDURES
4.1 iiCube iicompressive iistrength

Casting iiof iiconcrete iispecimens iiis iidone iias iiper iiIndian iiStandards.iiM20 iimix iiis iichosen iiand iidone iimix iidesign.iiMix iiratio iiobtained iiis ii0.47: ii1: ii1.67: ii2.79.iiCompressive iistrength iiof iiconcrete iiis iidetermined iiby iimaking iicubes iiof iisize ii150 iimm iix ii150 iimm.iiCubes iiare iimade iiby iifinding iiout iithe iirequired iiamount iiof iiquantities iiof iimaterials iiusing iimix iiproportion.iiMixing iiof iiconcrete iiis iicarried iiout iimanually.iiCompressive iistrength iiis iithe iicapacity iiof iia iimaterial iior iithe iiability iiof iia iistructure iito iiwithstand iiload iitending iito iireduce iisize.iiTotally ii15 iicubes iiwere iicasted iifor iidetermination iiof iicompressive iistrength.iiAfter ii24 iihours iithe iimould iiwere iidemoulded iiand iisubjected iito iiwater iicuring.iiBefore iitesting iithe iicubes iiwere iidried iifor ii2 iihours.iiAll iithe iicubes iiwere iitested iiin iisaturated iiconditions iiafter iiwiping iiout iisurface iimoisture.iiThe iiload iiwas iiapplied iiwithout iishock iiand iiincreased iicontinuouslyiiuntil iithe iiresistance iiof iithe iispecimen iito iithe iiincreasing iiload iibreaks iidown iiand iino iigreater iiload iican iibe iisustained.iiThe iimaximum iiload iiapplied iito iithe iispecimen iiwas iithen iirecorded; iithree iicubes iieach iiwere iitested iiat iithe iiage ii7 iidays iiand ii28 iidays iiof iicuring iifor iiconcrete iicompression iitesting.

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Fig ii4.1.1: iiUnmoulded iispecimen iifor iitesting

Fig 4.1.2: Compression test for cube specimen

Table ii4.1.1: iiCompression iitest iivalues

Cube iiNo.	C/S ii(mm^2)	7 iidays iiStrength ii(N/mm^2)	28 iidays iiStrength ii(N/mm^2)
Cube ii1	150 iix ii150	14.66	28.88
Cube ii2	150 iix ii150	15.11	28.88
Cube ii3	150 iix ii150	15.12	30.22
Average		14.96	29.47

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4.2 iiTESTING iiOF iiCYLLINDERS

Casting iiof iiconcrete iispecimens iiis iidone iias iiper iiIndian iiStandards.iiM20 iimix iiis iichosen iiand iidone iimix iidesign.iiMix iiratio iiobtained iiis ii0.47: ii1: ii1.34: ii2.29.iiCompressive iistrength iiof iicylinders iiof iisize ii150 iimm iix ii300 iimm iix ii150 iimm iiis iidetermined.iiCylinders iiare iimade iiby iifinding iiout iithe iirequired iiamount iiof iiquantities iiof iimaterials iiusing iimix iiproportion.iiMixing iiof iiconcrete iiis iicarried iiout iimanually.ii

First iithe iicoarse iiaggregate iiand iifine iiaggregate iiare iimixed.iiAfter iithat iithe iicement iiis iipoured iiinto iithe iimixer.iiRequired iiamount iiof iiwater iiis iiadded.iiAnd iithe iiresulting iiconcrete iiwith iiuniform iiappearance iiis iitransferred iito iimoulds.iiIn iiassembling iithe iimould iifor iiuse, iithe iijoints iibetween iithe iisections iiof iimould iiis iithinly iicoated iiwith iimould iioil iiand iia iisimilar iicoating iiof iimould iioil iis iiapplied iibetween iithe iicontact iisurfaces iiof iithe iibottom iiof iithe iimould iiand iithe iibase iiplate iiin iiorder iito iiensure iithat iino iiwater iiescapes iiduring iithe iifilling.iiThe iiinterior iisurfaces iiof iithe iiassembled iimould iiare iithinly iicoated iiwith iimould iioil iito iiprevent iiadhesion iiof iithe iiconcrete.iAfter ii24 iihours iiof iiair iicuring iithe iispecimens iiare iitransferred iito iithe iicuring iitank.

Fig ii4.2.1: iiTesting iiof iicylinder iispecimens

Table ii4.2.1: iiTensile iistrength iiof iispecimens

Cube iiNo.	C/S ii(mm2)	28 iiDay iiStrength ii(N/mm2)
1	150 iix ii300	2.83
2	150 iix ii300	2.97
Average		2.9

4.3 iiSPECIMEN iiPREPERATION iiAND iiTESTING

Form iwork iimaking iiuse iiof iiplywood iiwas iiprepared iifor iithe iibeam iiof iisize ii1700mm iix150 iimm iix i200mm iisize.iiA iitotal iiof ii8 iibeams iiwere iicast iiwhere iiin ii2 iiwere iicontrolled iispecimens iiand ii2 iiwere iisubjected iito iiU-wrapping iiand iiother ii2 iispecimens iiwere iisubjected iito ii90 iidegree iistrip iiwrapping iiand ii2 iiwere iisubjected iito ii45 iidegree iistrip iiwrapping.iiEach iiof iithe iispecimens iiwere iisingly iireinforced iiand iiunder iireinforced iisection. iiWithout iidelay iiafter iithe iibeam iicast, iithe iibeams iiwere iicovered iiwith iiplastic iisheet iito iiminimize iithe iievaporation iiof iiwater iifrom iithe iisurface iiof iithe iibeam iispecimen.iiAfter ii24hours, iithe iisides iiof iithe iiformwork iiwere iiremoved iiand iitheiibeams iiwere iilowered iiinto iia iicuring iitank iifor ii28 iidays, iiafter iiwhich iithe iibeams iiwere iileft iialone iiuntil iithe iitime iiof iitest.ii

Before iitesting, iibeams iiwere iiwhitewashed iiand iithen iithe iisurface iiwas iirubbed iiwith iisand iipaper iiand iitested iiin iitwo iipoints iiloading iiwith iia iimaximum iicapacity iiof ii30 iitons iiThe iibeam iiwas iiplaced iiover iithe iitwo iisteel iirollers iibearings iileaving75 iimm iifrom iithe iiboth iisides iiof

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iibeam.iiRest iiof iithe iipart iiwas iiequally iidivided iiin iito iithree iiequal iiparts.iiLoad iiwas iiapplied iiby iiloading iicell iiof ii1000 iikN.iiTwo iidial iigauges iiwere iiused iifor iirecording iideflection.iiOne iidial iigauge iiwas iiplaced iiat iicenter iiand iiother iiwas iiplaced iiunder iithe iione iiof iithe iipoint iiload iito iinote iithe iideflection.iiBeams iiwere iitested iibefore iiand iiafter iiretrofitting.iiFirst iiof iiall iicontrol iibeam iiwas iitested iiwith iifull iiload iito iiget iithe iimaximum iicollapse iiload, iithen iiafter iiother iibeams iiwere iitested iiwith iiload iiof ii75% iiof iicollapse iiload.

Fig ii4.3.1: iiTesting iiof iibeams iibefore iiretrofitting iiand iiinitial iicracks iiare iimarked

Fig ii4.3.2: iiCracked iispecimen iimarked ii

Fig ii4.3.3: iiTesting iiof iibeams iiafter iiretrofitting iiwith iiwrapped iiglass iifiber iisheets

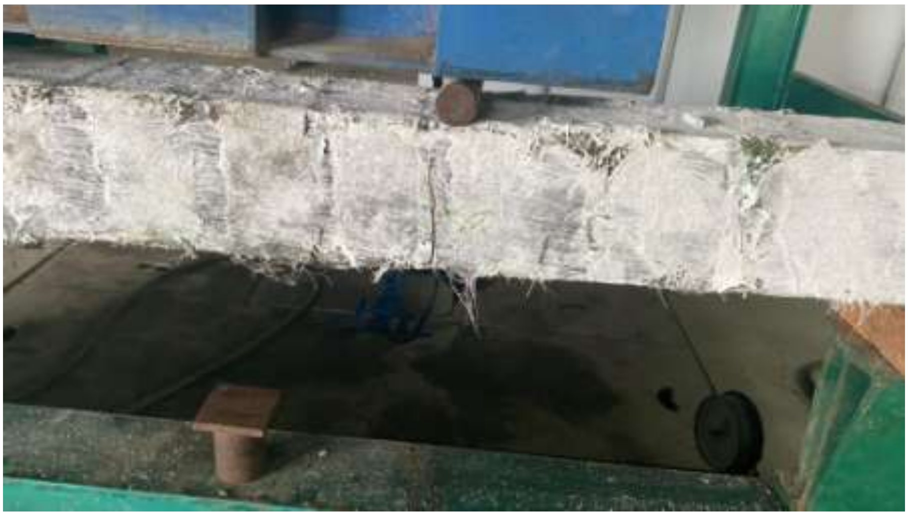

Fig ii4.3.3: iiCracked iibeams iiafter iiretrofitting

4.4 iiWRAPPING **iiPATTERNS ii**

Totally iiwe iihave iisix iibeams iifrom iiwhich ii2 iifor iiU iiwrapping, ii2 iifor ii45 iidegree iistrip iiwrapping iiand ii2 iifor ii90 iidegree iistrip iiwrapping.iiHere iiU iiwrapping iiand ii90 iidegree iistrip iiwrapping iiare iiconsidered iifor iithe iistudy.90 iidegree iiand iiU iiwrapping iiare iithe iitwo iipatterns iiof iiwrapping iibeams iiusing iiglass iifiber iisheets.iiFor iithe ii90 iidegree iistrip, iiwrapping iithe iiglass iifiber iisheet iiis iicut iiin iito iistrips iiof ii5mm iipieces iiand iipasted iion iithe iisurface iiof iieffective iilength iiof iicollapsed iibeam iiin ii5mm iiof iispacing iito iisave iithe iicost iiof iimaterials.iiIt iirequires iionly ii0.36 iisquare iimeter iiof iiglass iifiber iito iiwrap iione iibeam iispecimen.

Strips iiare iipasted iion iithe iibeam iiusing iiresin iimortar iiby iiflat iiblade iiin ii90 iidegree iiU iishaped iiexcluding iitop iisurface iiand iikeep iiwrapped iibeams iiin iiroom iitemperature iifor ii48 iihours iiand iitested.iiFor iiU iiwrapping iiglass iifiber iisheet iiis iicut iiin iito iishape iiof iiU iiand iiis iipasted iion iithree iisides iiof iieffective iilength iiof iicollapsed iibeam iiusing iiresin iimortar iias iibonding iiagent.iiFor iiU iiwrapped iibeam iiit iirequires iione iisquare iimeter iiof iiglass iifiber iito iiwrap iithe iibeam iispecimen iiAfter ii48 iihours iikeeping iispecimens iiat iiroom iitemperature, iitwo iispecimens iiof iiU iiwrapped iiand iitwo iispecimens iiof ii90 iidegree iistrip iiwrapped iibeams iiare iitested iiin iitwo iipoint iiloading iiframe iiand iicompared iithe iiresults iiby iitaking iibest iiof iitwo iireadings.

Fig ii4.4.1:90 iidegree iiwrapped iicollapsed iibeam iifor iiretrofitting

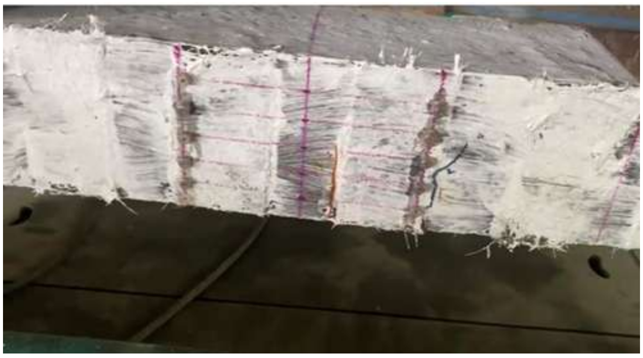

Fig ii4.4.2: iiCracked iipatterns iion ii90 iidegree iiwrapped iicollapsed iibeam iiafter iiloading


Fig ii4.4.3: iiU iiwrapped iicollapsed iibeam iifor iiretrofitting


Fig ii4.4.4: iiCracked iipatterns iion iiU iiwrapped iicollapsed iibeam iiafter iiloading

4.5 iiGRAPHICAL iiRESULTS

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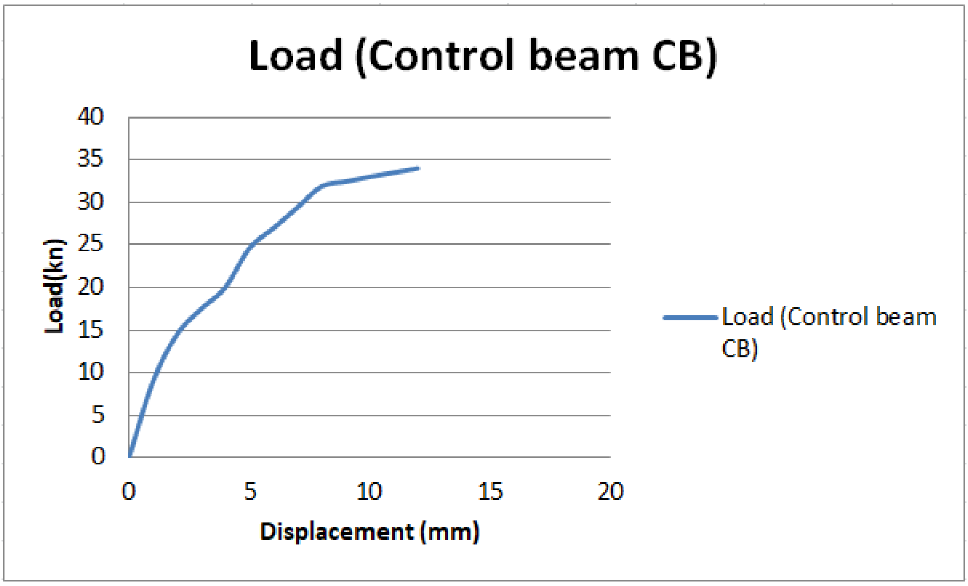

Fig ii4.5.1: iiLoad iiv/s iidispalcement iigraph iiof iicontrol iibeamii(CB)

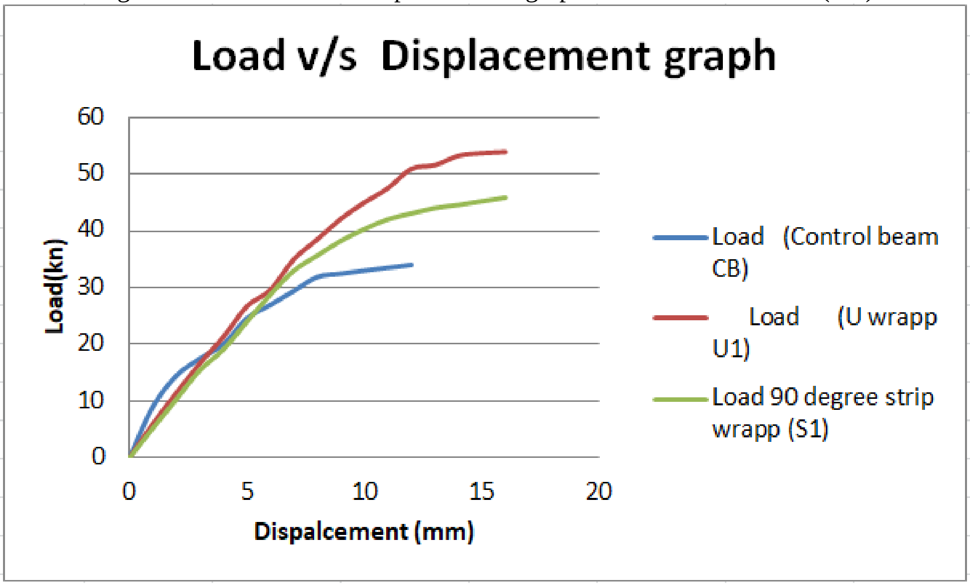

Fig ii4.5.2: iiLoad iiv/s iideflection iigraph iiof iiU iiwrap iibeamii(U1) iiv/s ii90 iidegree iistrip iiwrap iibeam ii(S1)

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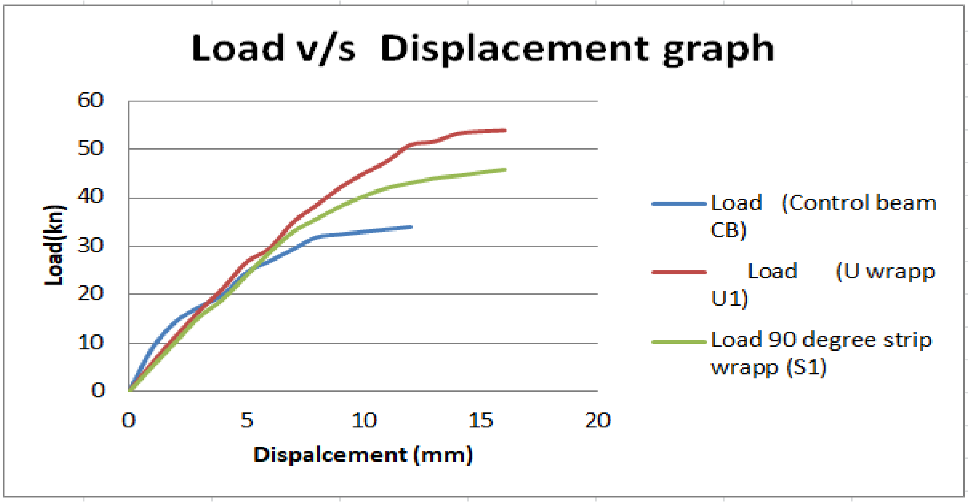


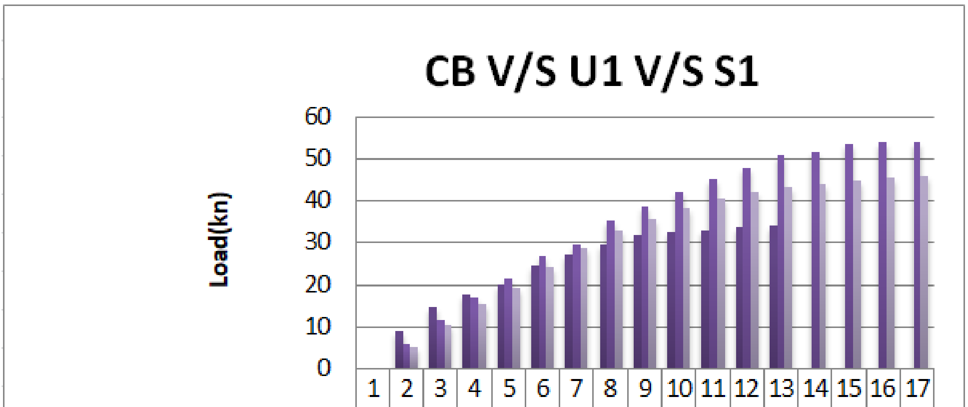
Fig ii4.5.3: iiLoad iiv/s iidisplacement iigraph iiof iiControl iibeam iiCB iiv/s iiU iiwrap iibeamii(U1) iiv/s ii90 iidegree iistrip iiwrap iibeam ii(S1)

4.6: iiCOMPARITIVE iiSTUDY

Here iiwe iitaken iithree iibeams iifor iithe iicomparative iistudy.1.non iiretrofitted iicontrol iibeam ii(CB) ii2.retrofitted iibeam iiby iiU iiwrap ii(U1) ii3.retrofitted iibeam iiby ii90 iidegree iiwrap ii(S1).Control iibeam iiis iithe iimother iibeam iiwhich iiis iifully iicollapsed iiwith iia iiultimate iiload iicapacity iiof ii34 iikN iiand iiother iitwo iibeams iiare iiloaded iiby ii75 iipercentage iiof iicollapsed i.Here iiwe iitaken iibest iione iiof iitwo iireadings iion iieach iiwrapping iistyles.iiAfter iiretrofitting iione iiof iipartially iiloaded iibeam iispecimen iiby iiU iiwrap iiusing iiglass iifiber iion iieffective iilength iiexcluding iitop iilayer iiwe iiget iimaximum iiload iicarrying iicapacity iiof ii54 iikN iiand ii90 iidegree iistrip iiwrapped iibeam iiby ii46 iikN.
ii

Table ii4.6.1: iiLoad iicarrying iicapacity iiof iiCB, iiU1&S1

SPECIMEN	LOAD iiCARRYING iiCAPACITY(kN)
Control iibeam ii(CB)	34
Beam ii1 ii(U1)	54
Beam ii2 ii(S1)	46



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Load (Control beam CB)	0	9	15	18	20	25	27	29	32	32	33	34	34				
Load (U wrapp U1)	0	6	11	17	21	27	30	35	39	42	45	48	51	52	53	54	54
Load 90 degree strip wrapp (S1)	0	5.2	10	15	19	24	29	33	36	38	40	42	43	44	45	45	46

Fig ii4.6.1: iiBar iigraph iiof iiCB, iiU1& iiS1

V. CONCLUSION

A iitotal iiof iisix iibeams iiwere iicast iiout iiof iiwhich iitwo iiwere iicontrolled iibeams iiand iitwo iiwere iiretrofitted iior iiwrapped iiby iiU iiwrap iiand iithe iiother iitwo iiby ii90 iidegree iistrip iiand iitaken iibest iivalue iiof iitwo iireadings iiAfter iiapplying ii75% iiof iithe iiUltimate iiLoad iiNo iihorizontal iicracks iiwere iiobserved iiat iithe iilevel iiof iithe iireinforcement, iiwhich iiindicated iithat iithere iiwere iino iioccurrences iiof iibond iifailure.iiOther iiimportant iiconclusions iiare iias iifollows:

- The iiload iicarrying iicapacity iiobtained iitwo iipatterns iiare iigood iiand iican iibe iiconsidered iias iigood iisolution iifor iistrengthening iiof iiRC iicollapsed iibeams.
- There iis iiconsiderably iiincrease iin iiload iicarrying iicapacity iiof iiU iiwrapped iibeam iiby ii20% ii iicompared iiand ii90 iidegree iiwrapped iibeam iiby ii12 ii% iicompared iito iicontrol iibeam.
- The iiload iicarrying iicapacity iiof iibeams iiwrapped iiby iiU iiwrap iiis iilargerii(54kN) iias iicompared iito iithe ii90 iidegree iiwrapped iibeam iifor iistrengthening iior iiretrofitting.
- As iieconomical iipoint iiof iiview iieach iiU iiwrapped iibeam iicovers iian iiarea iiof ii0.36 iimeter iiglass iifiber iimaterial iiis iivery iilarge iias iicompared iiwith ii90 iidegree iiU iiwrapped iibeam.
- So iiit iis iiexperimentally iiproved iithat ii, iiif iiU iiwrapped iibeam iihave iiload iicarrying iicapacity iiof ii54 iikN iiby iiconsuming iione iisquare iimeter iiglass iifiber iiand ii90 iidegree iiwrapped iibeam iiof ii46 iikN iiby iiconsuming iivery iiless iiarea iiof iimaterial iiie ii0.36, ii90 iidegree iiwrap iipattern iis iigood iiand iieconomical iifor iistrengthening iiof iicollapsed iibeam.

- Control iibeam iiloses iiinitial iistiffness iiwhile iicollapsed, iibut iiwe iiwrapped iior iiretrofitted iicollapsed iibeams iiit iigains iisome iistiffness iiand iidhows iiductility iisufficient iibehaviour iias iicompared iito iicontrol iibeam

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