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Comparative Study between Analytical and Theoretical Retrofitting of RC Beam with Different Resins Bonded CFRP Laminates

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Abstract: ***This thesis details experimental work and finite part simulation of concrete beams retrofitted with carbon fiber strengthened compound (CFRP).The objectives of this study were to analyze the behavior of retrofitted beams to develop finite part model describing the beams, supportive the finite part model against the experimental results and eventually investigation the influence of chemical compound resins(GP, ISO, Epoxy) on the sweetening of strengthening of retrofitted beams. The experimental results square measure performed to analyze the behavior of beams designed in such approach that either flexural or shear are going to be expected. The beams rectangle measure loaded at exploitation 2 purpose bending till cracks square measure developed. The beams were then blank and retrofitted with CFRP. Finally the beams were loaded till failure. The ANSYS program is employed to develop finite part models for simulation of behavior of beams.***

Keywords: CFRP, ANSYS.

I. INTRODUCTION

Fiber strengthened compound (FRP plays a notable role within the retrofitting and renovation of ferroconcrete (RC) structural fundamentals as evident reinforcements. modern advancements in these fields area unit unbounded. Performance of carbon (CFRP) composites retrofitted by the entire of columns, concrete beams, and block is dole out by divergent researchers over experimental and suspect investigations. The technique logy of bonding FRP laminates or plates to toward the sting surfaces is granted worldwide as a technically counsel and much rational method for strengthening and upgrading of ferroconcrete bearing members that area unit structurally broken, inadequate or deteriorated. supported their unimaginable blessings, overall all distinctive materialsat hand within the producing as plate behavior modification, carbon fiber strengthened compound (CFRP) composite materials area unit suggested by the engineers.

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This section deals by the entire of the foremost notable revealed proof of side arm a handle on one thing connection to the experimental perform delineated during this thesis.
Anumol Raju et al. (2013) by experimentation study was conducted in R.C.C. beams strong by all of assorted styles of fibers outwardly. all thirty beam Casted reciprocally cross section of a hundred and fifty millimetre × a hundred and fifty millimetre × a thousand millimetre. They crammed by the entire of divergent styles of fiber sheets i.e. Carbon, Glass, Steel, polypropene and fibre mistreatment all ver wrapping technique around all the edges of the beams to guage the strength. They ended that the last word strength increment in carbon, glass, steel and fibre sheet strong beam by a hundred and twenty fifth, 89.6%, 45.02% and 37.9% severally. however considering price effectiveness and strength increment, they most popular Glass FRP sheets to be.used. Lakshmikandhan et al. (2013) checked performance of the beams beneath cyclic loading. Firstly, applied load on beam over hydraulic jack in historical cyclic load increment with an acceptable increment for 2 purpose bending. The stiffness degradation in every cycle had been determined for the same injury assessment then beam is repaired by CFRP at bolster and once more drunk till the failure. within the finish they suspend that the repaired beam improved the first strength with regarding half-hour further load capability.
They moreover} found that the continuation of injury improves the performance of repaired RC beam with more energy dissipation and delays debonding or delamination. Henrik Thomsen et al. (2014) analysed the consequences of strengthening of RC beam utilized in FRP sheet affixed on tension facet and weakness modes determined.RudyDjamaluddin et al. (2015) experimental investigation the bonding behavior of GFRP sheets on the strong concrete beams thanks to flexural loading. concrete beams were ready by for the foremost a part of parameter of the bonding space of GFRP sheets. The specimen were divided into 2 sorts, that strong on all span (BFL) and strong on such third span at the span middle ground (BFH), severally. In last, instigator all over that bonding length of GFRP sheet was considerably influenced the utmost moment capability. They besides found that the increasing of bonding length reduced the typical bonding stress on GFRP sheets.

II. MATERIALS AND METHODOLOGY

The materials used for the concrete area unit given below and their properties are mentioned during this chapter.

2.1. Cement

cement of grade fifty three confirming to IS 8112(2013) was used for the experimental analysis .The show once and for all on cement relish relative density, setting time check, normal consistency check, compressive strength, soundness check were meted out in accordance by the full of IS:1727-1967,IS:4031-1968 severally.

2.2. Fine aggregate

Fine aggregate collected from caver watercourse bed close to Trichy has been used for experimental study having fineness modulus of two.65, relative density of 2.62 and bulk density of one.65 g/cm3. Sand confirming zone-III and while not wetness content keep during a area and used for casting specimens. The properties of sand were determined as per the IS-383:1970.

2.3. Coarse aggregate

The coarse aggregate collected from Quarry (srinivasa blue metals,ofReddiyarchatram, Dindigul) crushed granite of most size 20mm and 12mm orthodox to IS 383-1970 is employed. The fineness modulus of coarse combination is vi.74, bulk density of one.54 g/cm3 and relative density of two.60.

2.4. Reinforcement

The yield stress, final tensile stress and proportion of elongation of eight millimetre diameter TMT bar area unit 462 N/mm2, 597 N/mm2 and terrorist organization severally. and 6mm diameter for TMT bar are289,385.9N/mm2 and twenty one nada, severally. All the beams were given zero.785% main tensile reinforcement and zero.534% as compression reinforcement.

2.5. Carbon fiber

The properties of carbon fibers area unit as an example, high materiality, steep rigidity, peaceful weight, high substance safety, extreme temperature conflictand low heat development. Superior Carbon low calorie food is employed and delineated by high young modulus of skillfulness E = (240-830Gpa), lastingness (2200-5600Mpa), strength failure (0.5-0.8), constant of thermal growth (1.45), density (1800-2200kg/m3.

2.5. Polyurethanes

Polyurethanes area unit shaped by merging polyisocyanate and polyol in a very response infusion embellishment method or in a very fortified response infusion molding strategy. they're cured into very intense and high consumption safety materials, that area unit found in varied elite paint coatings.

2.7. Phenolic

The phenolplast resins area unit created mistreatment phenols and gas, and that they area unit isolated into furbish up and novolac resins. The resoles area unit organized beneath antacid conditions with formaldehyde/phenol (F/P) degrees a lot of distinguished than one. in reality, novolacs area unit organized beneath acidic conditions with minimum F/P degrees than the initial issue. Resoles area unit cured by applying heat and/or by together with acids. Novolacs area unit cured once responding synthetically with methylene radical amasses within the hardener.

2.8. Epoxies

Epoxies area unit for the foremost half found in marine, auto, electrical and material applications. The high density in epoxy resins limits its handle to unwavering methodologies, for concrete illustration, shaping, fiber speed full, hand lay-up. The privilege hardening specialists behind be direct chosen in bump of the very fact that it'll influence the shape of compound response, pot existence, and be material properties. In provocation of the very fact that epoxies will be fantastic, it perchance even at some future timetually despite the extra charge once fine and dandy is required. . The Properties of special compound resin, for concrete illustration, such epoxy glue, Orthophthalic resin (GP), Isophthalic resin area unit supposed within the consequently Table a pair of.3,2.4 and 2.5.

Figure 2.3 Three resins (GP, ISO, Epoxy)

Table 2.3 Properties epoxy resin

Glass transition temperature (Tg)	120°C - 130 °C
Tensile strength	85 N/mm²
Tensile Modulus	10,500 N/mm²
Elongation at break	0.8%
Flexural strength	112 N/mm²
Flexural Modulus	10,000 N/mm²
Compressive Strength	190 N/mm^2
Coefficient of linear thermal expansion	34 10-6
Water absorption - 24 hours at 23°C	5-10 mg (0.06-0.068%) ISO 62 (1980)

Table 2.4 Properties for isophthalic resin

Properties	Unit	Value
Barcol hardness	BHU	40
Temperature	ºC	80±5
Specific gravity	-	1.20±0.02
Volume shrinkage on cure	%	7-8

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Tensile strength	N/mm^2	55±5
Tensile modulus	N/mm^2	3300±100
Elongation at break	%	2.5-3.5
Flexural strength	N/mm^2	125±5
Flexural modulus	N/mm^2	3400±100

Table 2.5 Properties for GP resin

Properties	Value
Elastic modulus (Mpa)	-
Flexural modulus (Mpa)	3.7Gpa
Tensile modulus (Mpa)	$3450N/mm^2$
Compressive strength (Mpa) at yield or break	-
Flexural strength (Mpa) at yield or break	$90N/mm^2$
Elongation at break (%)	2.2%
Hardness	50BHC

III. EXPERIMENTAL METHODS AND INVESTIGATION

3.1 Loading Arrangement For Cfrp Laminted Beams

All the twenty four beams (1200mm x100mm x150mm) and 500mmx100x100mm square measure subjected to check againsthe scene of essentially supported finish conditions. 2 purpose loading is invariably followed for testing. For the cluster of twelve beams, 3 square measure used as management beams, and therefore the remaining 9 cube measure preloaded until the looks of flexural crack and thenceforth retrofitted with CFRP and any, 3 various organic compound secure CFRPs were engaged. within the long haul, the retrofitted beams square measure loaded until breakdown and therefore the outcomes assessed and analyzed with the management beam. The testing of beams is dole out by means that of the hydraulic operated jack coupled to the load cell. Moreover, the load is exerted on the beam with competence aided by the hydraulic jack and therefore the knowledge is recorded from the LVDT system, that is coupled with the load cell.

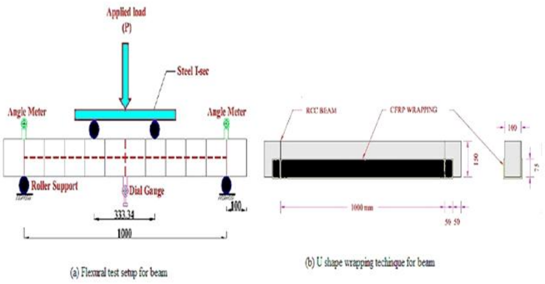

Figure 3.1 Experimental setup on beam

To evaluate the enhancement within the flexural strength of the beams when retrofitted with varied rosin (Epoxy, Orthophathlic (GP), ISO) secured carbon Fiber strengthened chemical compound, beams area unit therefore organized that they're scarce in shear ultimately resulting in the failure within the flexure. For the aim of An acceptable bonding between the beam and therefore the sheets, the surface of the sheets is cracked by means that of brush or sure totally different roughening materials. Roughening is initiated with the help of sand paper or exhausting brush or little chisel. when the roughening of beam surface, the method of preparation of the rosin begins, during which various rosin is ready within the quantitative relation of 1:5 wherever 1 element of hardener is employed with five elements of rosin and therefore the mixture is thenceforth merging fully. it's to be borne in mind that the mixture should be deployed quickly therefore on forestall from setting. once the resin is mixed entirely, 3 various resins area unit accustomed change surface finish of the beam by means that of brushes by applying various reasonably resins to ech 3 beam. when the acceptable application off rosin, the sheets area unit fixed on the whole sides of the beams, whose surfaces area unit clean with the assistance of a brush. a bit pressure is applied on the surface for correct fixing of the sheets. equally the sheets area unit wrapped on all the faces of the beam for the U-shape wrapping technique.

3.2 Loading Setup on management RC Beams

The testing of the beams in 2 purpose loading settings is finished from this load case is chosen because it is equipped by the consistency most moment and nil shears within the section between hundreds, and consistent most shear force in support and cargo. The span between the supports set up 1000mm and therefore the total was activated at points that area unit divided to 3 equivalent segments. The testing was performed by a testing tool of loading frame with one hundred ton capability. A linearly variable differential electrical device was used to judge the deflection at middle span as illustrated in Figure 4 .2 that effectively incontestable

Figure 3.2 Loading of control beams

3.3 Loading Setup on Retrofitted RC Beams

The 9no's beams were unbroken except the check machine and turned over to retrofit them with numerous rosin secure CFRP. For the aim of guaranteeing acceptable

Figure 3.4 Carbon fiber Retrofitted beam with resins (ISO, Epoxy, GP)

Application of the external strengthening materials, it had been extremely essential to fine-tune the concrete surface traits on the contact region to be secure.

when the bonding between the beam and also the sheets, the surface of the sheets is chapped with the assistance of brush or sure completely different roughening material, followed up by the preparation of the Isophthalic rosin within the quantitative relation of one:5 wherever 1 fraction of hardener is deployed with five fractions of rosin. The mixture is thenceforth mingling absolutely.
correct attention had to be taken to make sure that the mixture was consumed like a shot to avoid the setting of the rosin. once the Isophthalic is entirely mingling, the rosin was initiated on the chapped finish of the sheets victimization brushes. when the Isophthalic is correctly applied within the sheets, the sheets area unit fastened on all sides of the beams, whose surface was clean employing a brush. for correct fixing of the sheets, some pressure is exerted over the surface. Likewise sheets area unit wrapped over rock bottom of the beam and sides sort of a formed wrapping technique shows in Figure three.4. and also the same procedure is perennial for applying epoxy secure CFRP and Orthophthalic (GP),sheets to the RC beams for U- formed wrapping technique. Operated jack connected to load cell. The load is initiated on the beam with the help of hydraulic jack and also the information is recorded from the LVDT system, that is connected with the load cell. Moreover, the worth of deflection is gathered from the dial gauge system.

IV. RESULTS AND DISCUSSION

4.1 Experimental results of controlled and retrofitted beam specimens

The failure load while not wrapped beam (CB) is twenty seven. 2 kN and its flexural strength is 12.08 N/mm^2, final load of epoxy glue warranted CFRP retrofitted beam (RB4) is fifty two.5 kN and its flexural strength is twenty three.33N/mm^2,ISO organic compound warranted CFRP laminated beam (RB8) final load is forty four.1kN and its flexural strength is nineteen.6 N/mm^2 and for same MD (Orthophthalic resin) warranted CFRP laminated beam(RB3) final load is 54kN and its flexural strength is twenty four N/mm^2 these strength RB4(Epoxy wrapped beam) is forty eighth, RB8(ISO wrapped beam) is 38 and RB3 (GP organic compound wrapped beam) is forty ninth bigger than strength of controlled beam.
Flexural strength analysis for the various specimens and therefore the control specimens of the flexural strength is 12.08N/mm^2 is compared to the retrofitted specimens of the epoxy glue and therefore the totally different is 11.25% and once it's compared to the MD the distinction is 11.92 once in a while its compared to the ISO the distinction is seven.52% 4.2 Load Vs Deflection for Controlled and Retrofitted Beams. The displacement malleability index (ultimate deflection divided by yield deflection) will offer associate estimate of the need of malleability of those beams. CFRP retrofitted beams (RB) reinforced were slightly stiffer and deflected ideally at the final word load the management beam (CB), The deflection watched within the linear variable electrical device for each art associate adjunct of load on the beams the deflection values are RB1,RB2,RB3,RB4,RB5,RB6,RB7,RB8 and RB9 that were computed relish eleven.3,10,12.4,23, 22.5,20,10,12.4 and 11.30mm,the deflection for controlled beams CB1,CB2,CB3 were 7.38,8.8 and7.6mm severally. the biggest deflection occurred in every retrofitted beams RB4 is 23 metric linear unit, RB3 is 12.70 and RB8 is 12.4mm at the cap prescribed load, the deflection is decreased due to U- shaped wrapping technique of retrofitted beams compare to controlled beams. Table 5.2 Load vs deflection characteristics of controlled and retrofitted beams.

Table 4.1 Load vs deflection characterstics of controlled and retrofitted beams

SPECIMEN ID	Ultimate Load in kN Pu	Yielding displacement in mm-δy	Ultimate displacement in mm δu
CB_1	24	2.6	7.38
CB_2	25.5	2.50	8.8
CB_3	27.2	3.02	7.6
RB_1	49.5	7	11.3
RB_2	53.4	7.5	10
RB_3	54	5.75	12.70
RB_4	52.5	11.75	23
RB_5	51.3	12	22.5
RB_6	48.3	11.80	20
RB_7	43.5	5.2	10
RB_8	44.10	6.10	12.4
RB_9	42	4.90	11.3

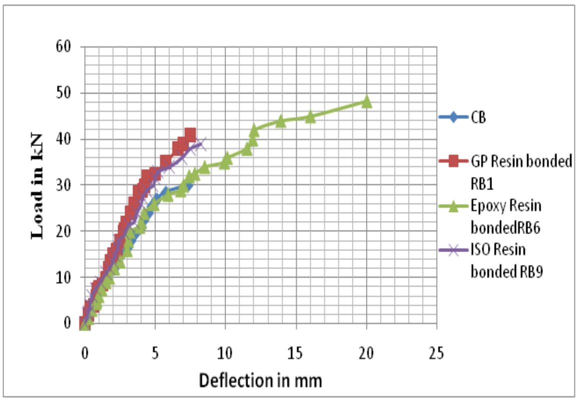

Figure 4.4 Load Vs Deflection for Controlled and Retrofitted beams with CFRP Laminates (ISO, Epoxy, GP)

Beam (CB) developed flexural tensile cracks within the lees face through the length gradual bending region at load of 15 kN, the tensile reinforcing steel yielded. Finally, the beam unsuccessful in flexure because of the crushing of utmost compression zone of concrete at a load 24 kN. equally as a matter of selection stage appeared on the doc rosin boned CFRP Laminated beam RB1,RB2 and RB3 is thirty-nine,41,35kN severally and supreme load for the connected specimen is forty nine.5,53.4 and 54Kn,

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1st crack appeared on the synthetic resin boned CFRP Laminated beam RB4, RB5and RB6 is 39,42.5,40.3 kN severally and supreme load for the alike specimen 52.5,51.3 and 48.3kN, flexural crack appeared on the ISO phthalic rosin boned CFRP Laminated beam RB6, RB7and RB9 is 43.5,44.1,42kN severally and supreme load for the connected specimen is 43.5,44.1and 42Kn,for all retrofitted beam failure because of most load and loss of bond occurred between the steel reinforcement and concrete that split of the concrete cowl at all-time low face of the beam.

Table 4.2 Shows the ductility index calculated for the CB and RB beams

Specimen id	Ultimate displacement in mm δu	Yielding displacement in mm-δy	Displacement Ductility Factor
CB_1	7.38	2.6	2.83
CB_2	8.8	2.50	3.52
CB_3	7.6	3.02	2.51
RB_1	11.3	7	1.61
RB_2	10	7.5	1.33
RB_3	12.70	5.75	2.20
RB_4	23	11.75	1.95
RB_5	22.5	12	1.87
RB_6	20	11.80	1.69
RB_7	10	5.2	1.92
RB_8	12.4	6.10	2.03
RB_9	11.3	4.90	2.30

It is seen in Table 4.2 that the share modification of plasticity of carbon fiber strong U-Shape wrapped beams cube measure RB1 to RB3 is42% (GP), RB4 to RB6 is 37.96% and RB7 toRB9 is twenty nine.49% severally as compared to it of controlled beam (single layer CFRP) beam. In general, completely different levels of CFRP strong concrete beams (RB1,RB2, RB3,RB4,RB5, RB6, RB7, RB8 and RB9) showed consistent will increase in flexural stiffness and supreme capability as compared to it of management beam. From the experimental investigation, it's known that the share improvement of cracking load of single layer CFRP strong beams square measure 61,63, and 54 for GP rosin boned laminates severally. 61,64 and 60.29% for synthetic resin guaranteed laminated beam severally and 55.22,56.52 and 48.38% wherever ISO rosin guaranteed laminated beam, whereas the share change of final load for retrofitted beam specimens (RB1,RB2, RB3,RB4,RB5, RB6, RB7, RB8 and RB9) square measure fifty one.26,52.22, and 49.62% for GP resin boned laminated head (RB1 to RB3) severally. 54.28, 50.29 and 43.68% for synthetic resin guaranteed laminated beam (RB4 to RB6) severally and 44.82,42.17 and 35.23% wherever ISO resin guaranteed laminated beam (RB7 to RB9) severally as compared to the management beam. the advance in 1st crack load of strong beams are often regarding the rise of stiffness because of the laminates commitment effects. However, it's terminated that the various resin guaranteed CFRP laminate thickness and U-shaped wrapping technique considerably influence the structural angle of the strong beams.

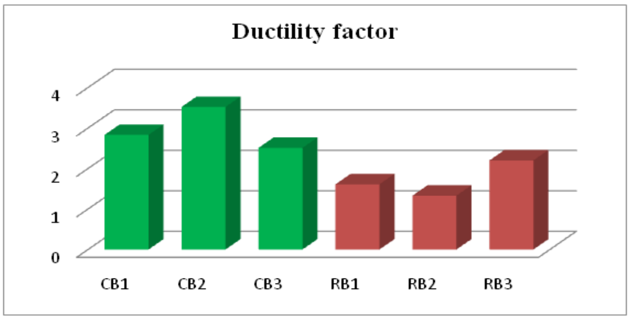

Figure 4.5 Shows ductility factor for CB and RB (GP Resin)

4.4 Crack Pattern and Failures Modes

The failure modes that square measure discovered on the CFRP reinforced beams square measure completely different from those of the management beam.

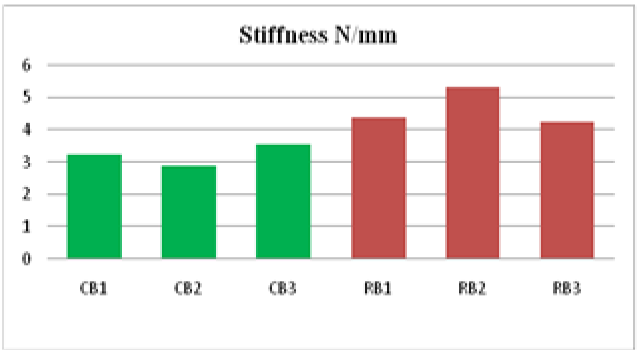

Figure 4.10shows stiffness value for CB and RB (ISO Resin)

It absolutely was discovered from the experimental investigation that each one beams reinforced with CFRP laminates have failing within the same manner. once de-bonding was prevented victimization U-shape wrapping techniques, failure is because of crushing of concrete within the compression zone close to the middle span region this can be conjointly clearly indicates that, the employment of U-shape wrapped technique within the beam RB1 to RB3, RB4 to RB6 and RB7 to RB9 modified the failure mechanisms than that of while not wrapped management beam. In beams RB1 to RB9, CFRP rupture and failure because of concrete crushing were outstanding once strengthening was done victimization each the wrapping schemes.

4.5 Stiffness Calculation for Controlled and Retrofitted Beams

Table 5.6 shows the controlled beam (CB1 to CB3) stiffness is 3.25,2.89 and 3.57N/mm and retrofitted beam specimens $RB_1$to RB_3(GP resin) is 3.8,5.34,4.25N/mm. Epoxy resin bonded CFRP laminates were RB_4 TO RB_6 is 2.28,2.28 and 2.41N/mm, ISO resin bonded CFRP laminates were RB_7 to RB_9 is 4.35,4.55 and 3.71 N/mm. Stiffness value for Retrofitted beams (GP resin) is 28.25, Epoxy wrapped RB is 28.17 and ISO wrapped RB is 23.09 % increased from controlled beams as shown in Figure 4.8 to 4.10.

Table 4.3 Stiffness for controlled and retrofitted beam

Specimen id	Ultimate Load in kN Pu	Yielding displacement in mm-????	Utimate displacement in mm ????	$K = \frac{Pu}{\delta u}$
CB_1	24	2.6	7.38	3.25
CB_2	25.5	2.50	8.8	2.89
CB_3	27.2	3.02	7.6	3.57
RB_1	49.5	7	11.3	4.38
RB_2	53.4	7.5	10	5.34
RB_3	54	5.75	12.70	4.25
RB_4	52.5	11.75	23	2.28
RB_5	51.3	12	22.5	2.28
RB_6	48.3	11.80	20	2.41
RB_7	43.5	5.2	10	4.35
RB_8	44.10	6.10	12.4	3.55
RB_9	42	4.90	11.3	3.71

Table 5.1 Energy absorption for Controlled and Retrofitted beams

Specimen details	CB	GP Resin bonded beam	Epoxy resin bonded beam	ISO Resin bonded beam
Energy absorption (N-mm)	143	357.8	656.12	328.27
Perimeter in mm	68.91	111.60	123.6	99.6

Table 4.6 Shows energy absorption curve premeditated by mistreatment machine cad 2014, initial deflection price entered in coordinate axis and cargo price noted in coordinate axis and connected all the points X and Y-value in graph mistreatment polyline and verify space and perimeter for every specimen. Controlled beam space is 143 N-mm,retrofitted specimens like physician rosin secured beam space is 357.8N-mm ,Epoxy resin secured space is 656.12 N-mm and ISO rosin secured space is 328.27 N-mm these values of space compared to controlled beam is sort of less, great deal of energy absorption determined in mistreatment CFRP laminated divergent rosin secured wrapped beams.

5.FINITE part ANALYSIS

5.1 ANSYS CONCRETE parts kind The factual principle as unprotected in draw was utilised to epitome the concrete for the 3-D modeling of solids by all of or while not reinforcement bars. The solid equipped for cracking in strain and crushing in compression. as an example, in concrete applications, the robust ability of the part commit be utilised to ideal the concrete mean the rebar how with is clear for demonstrating reinforcement behavior. totally different cases that the part is likewise understandins and outs would be strengthened composites,(for example, fiberglass) and geologic materials,(for example, rock). solid65 part is happiness to eight nodes having 3 degree of freedom at one by one node: substance within the nodal X,Y and Z direction. Figure 6.1 shows the solid sixty five part pure mathematics for concrete.

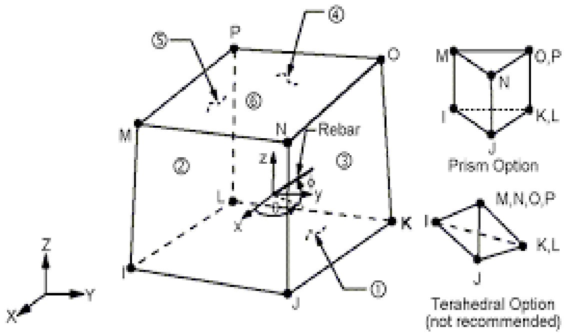

Figure 5.1 Solid 65 element geometry for concrete

5.2 ANSYS REINFORCEMENT BAR ELEMENT

A link 180 principle as shown in figure was accustomed ideal the steel reinforcement as implicit the Table half dozen.1. This 3D spar part may be a uniaxial tension-compression part having mutually degree of freedom and every nodal X, Y, and Z directions. This part includes physical property, creep, rotation, giant deflection and enormous strain capabilities

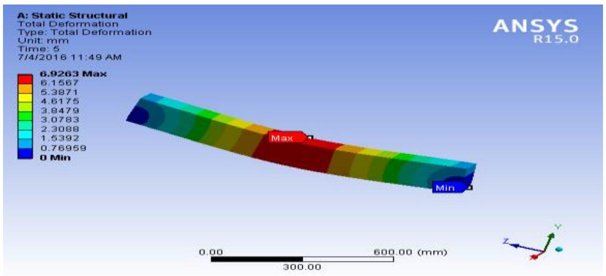

Figure 5.2 Link 180 element geometry for reinforcement

The steel reinforcement bars in finite component ideal are reinforced in concrete components (solid65) in distinct modeling. Therefore, buried link 180 (reinforcement) component in nodes engaged sequential PRN aside model. The distinct ideal of concrete (solid65) reinforcement (link180) share the uniform node. The model for reinforcement in ferroconcrete by distinct methodology (Tavarez 2001) is shown in Figure five.2 and also the ANSYS reinforcement bar material property for link a hundred and eighty component is given in Table5.1.

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COMPARISON OF FEA AND EXPERIMENTAL RESULTS FORCFRP RESIN BONDED RETROFITTED BEAM

Figure 5.3 shows the results obtained for accumulation deflection from the FEA by ANSYS15 for subdued and retrofitted specimens. A euphemism of the total deformation predetermined from the experimental results and the result obtained for collection deformation from the FEA has been spotted in Figure 6.8. Figure 5.4 shows the result obtained for stresses from the FEA by ANSYS 15 for reticent and retrofitted specimen. Figure 5.5 shows the result obtained for strain from the FEA using ANSYS 15 for controlled and retrofitted specimen.

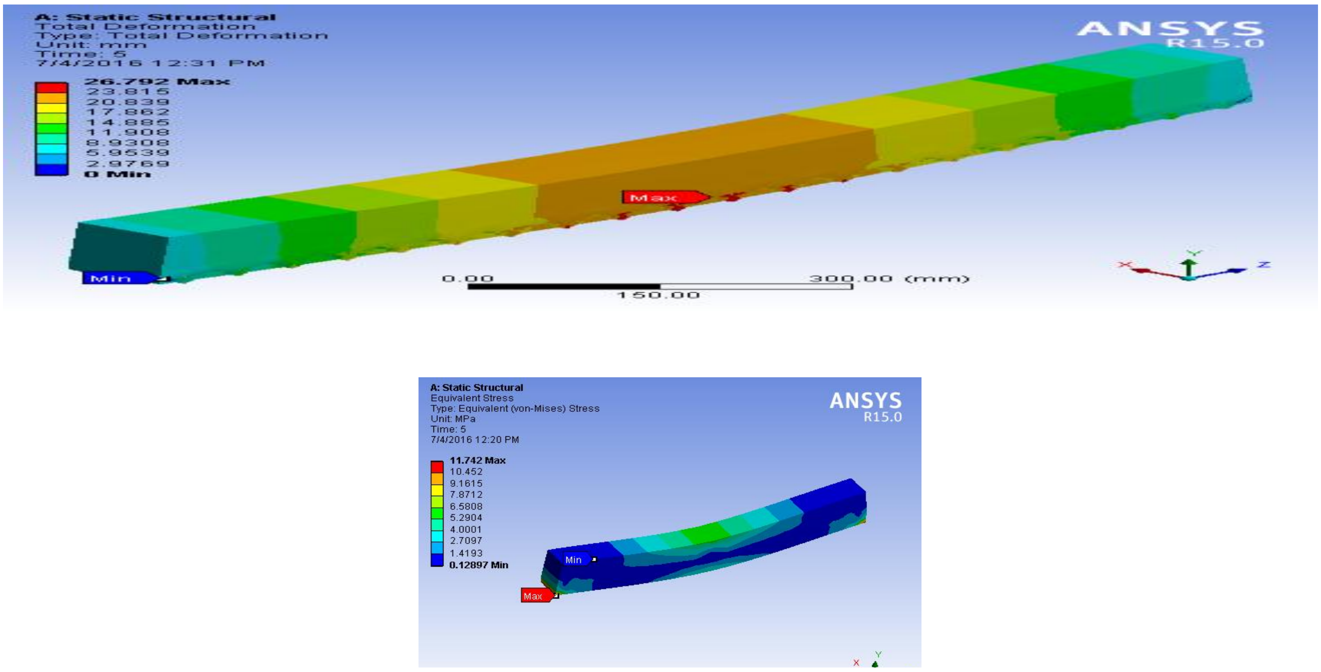

Figure 5.3 Shows the results subdued and retrofitted specimens

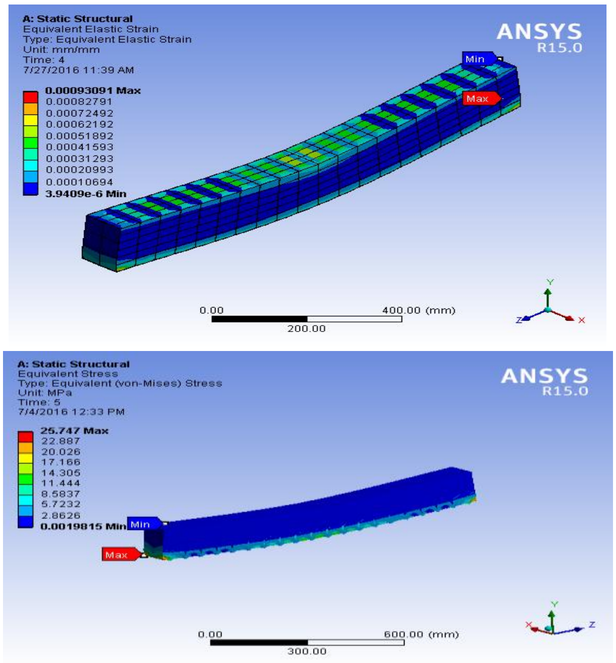

Figure 5.4 Stress for controlled and GP, Epoxy, ISO resin bonded CFRP laminated beams

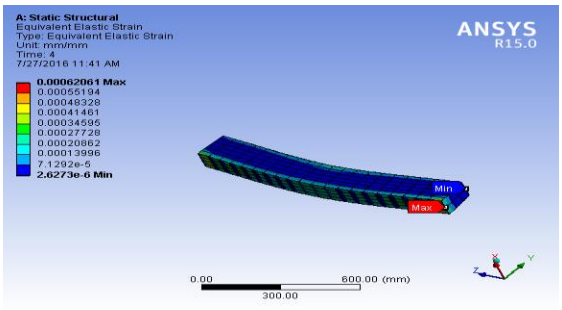

Figure 5.5 Strain for controlled and GP, Epoxy, ISO resin bonded CFRP laminated beams

V. CONCLUSION

- At the utmost prescribed load, the deflection was accrued for the retrofitted beams RB1, RB2,RB3, RB4 RB5,RB6, RB7, RB8, RB9 that were found to be 11.3, 10,12.4, 23,22.5,20,10,12.4 and 11.30 mm, the deflection for control beams CB1,CB2 were 7.38 and 8.8mm severally.
- All the beams strong with CFRP laminates in single layer expertise flexural failures. None of the beams exhibit premature brittle failure.
- Three resins can make sure that the bond line in single layer CFRP strong beams doesn't break before failure and participate absolutely within the structural resistance of the strong.
- The flexural strength of retrofitted beams RB1, RB2, RB3, RB4, RB5, RB6, RB7, RB8 and RB9 was 65th larger than in regard to those of the management beams. From the outcomes, the retrofitting of RC beams with outwardly secured CFRP sheet in single layer is applied. Orthophthalic resin (GP) was instrumental that offers 49kN to extend in final load carrying capability and what is more the tip of anchorage was used to urge obviate the deboning breakdown additionally the} value was also found to be so much less.
- From the experimental and analytical results were minimum in single layers of CFRP laminates ought to be bonded to urge the required results. during this experimental work, the flexural strength of controlled and retrofitted beam specimens created minor variation once compare to analytical flexural strength of beams.

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