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Study of Confinement of a Column by Carbon Fibre Reinforcement Polymer Mesh

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ABSTRACT

Carbon fiber reinforced polymers (CFRP) are very attractive to use in civil engineering applications due to its high strength, high durability, corrosion resistance, potentially high elasticity and high tensile strength criteria. This paper deals with Experimental and analytical studies of different parameters on concrete column wrapped with carbon fiber reinforced polymer (CFRP) are taken and investigated. Wrap thickness (1 Layer), fiber orientation and the combinations of them were investigated. The results demonstrated significant enhancement in the compressive strength, stiffness and ductility of the CFRP- wrapped concrete column as compared to unconfined concrete column. An analytical model for ultimate stress and strain of confined concrete has been proposed.

Keywords : Carbon Fiber Reinforced Polymer, Reinforced Concrete, ANSYS

I. INTRODUCTION

Columns are more important structural element in any structure that transfers the entire loads to the foundation because of this it is necessary to confined column with external confining material. It improves the properties of concrete by confining it. In most of the damaged structures it can be seen that in several failure of the entire structure was occurred by the failure of columns by chain action. Traditional steel ties reinforcement cannot provide better confinement for reinforced concrete (RC) column, due to the spacing between two ties and disturbance of concrete continuity. Since, effectiveness of the design approach involving strong column weak beam concept is still controversial matter, it will be dangerous to design the structures without considering the formation of plastic hinges in columns. It is taken into consideration the failure of structures due to sudden loading like earthquake, flood attack and consequently the loss of lives, the design on the premise that plastic hinge may occur in the column may be eventually more economical, even though the initial cost of detailing will be higher. Transverse reinforcements in columns in the form of hoops, cross-ties, or spirals which play an important role in protect the columns, especially when they are subjected to strong lateral loads. The environmental effect like pollutants, high humidity which causes corrosion and develops cracks which occurs failure of structural element. Replacement of damaged structural element is very costly and difficult process so, by providing external confinement across periphery of column is more effective process for confinement.

The current detailing for confine reinforcement is in IS 13920 code do not provide consistent level of safety against deformation and damage associated with flexural yielding during earthquakes. Hence an equation for the design of confinement reinforcement for ductile earthquake resistant rectangular and circular columns is suggested for inclusion in the next revision of the code. These equations take into account the various parameters that affect the performance of confining reinforcement, such as effective confining pressure or ratio of concrete strength to tie strength, unconfined cover concrete thickness, longitudinal reinforcement and spacing, and curvature ductility factor, load bearing elements, axial load level of any structure. Column support the beams and slabs and transfer the loads to the foundations. Hence column has to be designed and detailed adequately to resist both gravity and lateral loads. In our country columns are more misused than other structural elements; minimum size as per codes not provided, rebar are bend for better alignment, they are made porous due to the difficulty of concreting and vibrating in narrow, tall formwork, they are not cured properly, due to the difficulty of curing vertical elements, only minimum transverse reinforcement are provided and only 900 hooks are provided. We do not witness many failures because the working loads are only about 67% of the failure loads and also due to the partial safety factors of materials. However, during earthquakes or accidental lateral loading, plastic hinges will form in columns and beams. With inadequate design, detailing or construction, the columns are bound to fail, as we have witnessed in several earthquakes (e.g., like the ones in Bhuj, and Haiti). Hence it is important to design the transverse reinforcement of columns and detail them to provide external confinement with required amount of ductility.

II. Problem Statement

Traditional steel ties reinforcement cannot provide better confinement for reinforced concrete (RC)column due to the spacing between two ties and disturbance of concrete continuity & replacement of damaged structural element is very costly and difficult process.

III. Objectives

1. 1.To assess the feasibility and calculate percentage increase in strength of column with FRP.
2. 2. To compare axial compressive strength of column with and without confinement.
3. 3.To achieve the economy of the column construction without reducing the strength of column.
4. 4.To Study The Stress Strain Behavior Of Concrete Cylinders Confined With CFRP Composi

IV. Scope

The objectives is to increase the capacity of column, and therefore the strengthening measures aims at enlarging the cross sectional area or at enhancing the compressive strength of concrete by applying a confining action. The present study is to investigate the performance of RC rectangular columns with carbon fibre reinforced polymer wrap. The influence of key parameters such as materials properties, stiffness of CFRP wrap and concrete strength will be critically assessed.

3.5 Experimental results and discussions

An experimental investigation was carried out on fie high strength concrete columns. The parameters included ultimate load, axial stress, and axial deflection.

	specimen 1				specimen 2				specimen 3				specimen 4					specimen 5		
Lo ad		Axi al	Axia l	Lo ad		Axi al	Axial	Lo ad		Axi al	Axial	Lo ad		Axi al		Axia l	Lo ad		Axi al	Axial
(k N)		Stre ss	Defl ect	(k N)		Stre ss	Defle cti	(k N)		Stre ss	Defle cti	(k N)		Stre ss		Defl ec	(k N)		Stre ss	Defle cti
		(Mp a)	ion			(Mp a)	on from			(Mp a)	on from			(Mp a)		tion			(Mp a)	on from

			from				Dial				Dial					from				Dial
			Dial													Dial				
0		0	0	0		0	0	0		0	0	0		0		0	0		0	0
25		1.41	0	25		1.41	0	25		1.41	0.06	25		1.41		0	25		1.41	0
50		2.83	0.02	50		2.83	0.01	50		2.83	0.13	50		2.83		0.01	50		2.83	0
75		4.24	0.04	75		4.24	0.04	75		4.24	0.19	75		4.24		0.02	75		4.24	0
100		5.66	0.07	100		5.66	0.06	100		5.66	0.26	100		5.66		0.03	100		5.66	0.01
125		7.07	0.11	125		7.07	0.08	125		7.07	0.3	125		7.07		0.04	125		7.07	0.02
150		8.49	0.15	150		8.49	0.13	150		8.49	0.35	150		8.49		0.05	150		8.49	0.03
175		9.9	0.2	175		9.9	0.16	175		9.9	0.4	175		9.9		0.06	175		9.9	0.04
200		11.3	0.25	200		11.3	0.18	200		11.3	0.48	200		11.3		0.08	200		11.3	0.05
225		12.7	0.32	225		12.7	0.24	225		12.7	0.53	225		12.7		0.12	225		12.7	0.06
250		14.1	0.38	250		14.1	0.29	250		14.1	0.58	250		14.1		0.16	250		14.1	0.07
275		15.6	0.45	275		15.6	0.35	275		15.6	0.65	275		15.6		0.19	275		15.6	0.08
300		17	0.49	300		17	0.38	300		17	0.7	300		17		0.24	300		17	0.09
350		19.8	0.58	350		19.8	0.47	350		19.8	0.83	350		19.8		0.31	350		19.8	0.12
375		21.2	0.6	375		21.2	0.5	375		21.2	0.88	375		21.2		0.35	375		21.2	0.14
400		22.6	0.63	400		22.6	0.54	400		22.6	0.94	400		22.6		0.38	400		22.6	0.16
425		24.1	0.68	425		24.1	0.59	425		24.1	0.99	425		24.1		0.41	425		24.1	0.18
450		25.5	0.72	450		25.5	0.62	450		25.5	1.06	450		25.5		0.44	450		25.5	0.2
475		26.9	0.78	475		26.9	0.65	475		26.9	1.11	475		26.9		0.46	475		26.9	0.24
500		28.3	0.83	500		28.3	0.69	500		28.3	1.17	500		28.3		0.5	500		28.3	0.26
525		29.7	0.89	525		29.7	0.73	525		29.7	1.21	525		29.7		0.55	525		29.7	0.28
550		31.1	0.92	550		31.1	0.81	550		31.1	1.26	550		31.1		0.59	550		31.1	0.32
575		32.5	0.99	575		32.5	0.88	575		32.5	1.3	575		32.5		0.64	575		32.5	0.36
600		34	1.14	600		34	0.92	600		34	1.35	600		34		0.66	600		34	0.39
625		35.4	1.27	625		35.4	0.99	625		35.4	1.4	625		35.4		0.7	625		35.4	0.4
650		36.8	1.39	650		36.8	1.16	650		36.8	1.46	650		36.8		0.75	650		36.8	0.42
				675		38.2	1.31	675		38.2	1.52	675		38.2		0.79	675		38.2	0.45
								700		39.6	1.58	700		39.6		0.82	700		39.6	0.48
								725		41	1.63	725		41		0.84	725		41	0.5
								750		42.4	1.72	750		42.4		0.87	750		42.4	0.52
								775		43.9	1.84	775		43.9		0.9	775		43.9	0.53
								800		45.3	1.97	800		45.3		0.95	800		45.3	0.56
								825		46.7	2.22	825		46.7		0.98	825		46.7	0.58
												850		48.1		1.05	850		48.1	0.63
												875		49.5		1.12	875		49.5	0.68
												900		50.9		1.19	900		50.9	0.73

V. ANALYTICAL STUDY

4.1 ANSYS

One of the reasons for wide application of the finite element software is due to the availability of number of package programs. Today the most effective and commonly used software is ANSYS. They are mostly graphics oriented. The processor modules involve mathematical computations that requires large arithmetic operations i.e., number of crunching operations in the computer. ANSYS is a complete software package developed by ANSYS lnc – USA.

VI. CONCLUSION

The element analysis of the concrete column wrapped with carbon fiber reinforced polymer (CFRP) are taken and investigated. The study considered the ultimate load carrying capacity, deflection and cracking pattern of the confined and confined Columns. Two set of reinforced concrete columns, in two column for control column and three columns for confined CFRP Columns. From the test results and calculated strength values, the following conclusions.

1. 1.The ultimate load carrying capacity of the strengthened column is more than the controlled column.
2. 2.Analytical analysis is also carried out to find the ultimate moment carrying capacity and compared with the experimental results.
3. 3.Use of CFRP columns improves load carrying capacity, delay crack formation and energy absorption capability of column reinforced with CFRP.

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