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PVC Confining Effect on Axially Loaded Column

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Abstract: *Poly Vinyl Chloride (PVC) tubes filled with concrete are axially loaded until failure of the specimen to investigate their load carrying capacity. Twenty four specimens are cast and tested, out of which twelve are of PVC pipe and twelve of steel tube. PVC tubes are of dia. 152.4 mm, thickness 5mm with effective length of 500 mm and 600 mm. One of the main advantages in the interaction between PVC tube and concrete is, local buckling and PVC tube delayed by restraint of concrete and strength of concrete is increased by the confining effect of PVC tube. In current international practice, concrete filled tube (CFT) columns are used in the primary lateral resistance systems of both braced and unbraced building structures. CFTs are also used as bridge piers. Moreover, CFTs may be utilized for retrofitting purposes for strengthening concrete columns in earthquake zones. The CFT structural member has a number of distinct advantages over an equivalent steel, reinforced concrete, or steel-reinforced concrete member. The orientation of the pvc and concrete in the cross section optimizes the strength and stiffness of the section. The pvc lies at the outer perimeter where it performs most effectively in tension and in resisting bending moment. Also, the stiffness of the CFT is greatly enhanced because the pvc, which has a greater modulus of elasticity than the concrete, is situated farthest from the centroid, where it makes the greatest contribution to the moment of inertia.*

Introduction

As per IS code 456 -2000 design of column. The longitudinal reinforcement shall not be less than 0.8 % and not more than 6 % of gross cross sectional area of column. But practically, 6 % reinforcement was not possible due to difficulties in placing and compacting concrete. So to avoid complication max limit of the longitudinal reinforcement is 4 % of gross cross sectional area of column. This limits lead to used less than 4 percentage of steel in column. If the column carries heavy loads the cross section area of the column increases and ultimately reduces the floor space. It tends to increase the cost of the material, dead load of structure. As well as the time of construction. We introduced Concrete filled PVC tubes

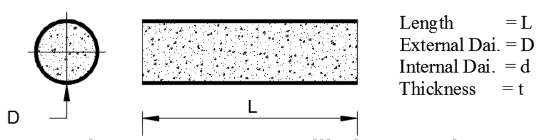


Figure 1. Concrete Filled PVC Tube.

1. Concrete Filled Steel Tube Uses

1. Improved strength and ductility due to confinement.
2. Prevent local bulking and compact cross section
3. Improved fire resistance by concrete heat sink effect.
4. Rapid construction.
5. CFT's gives aesthetical appearance to the structure
6. CFT's can be used as slender column.
7. Low workable concrete can be used effectively.

2. Advantages of Composite Hollow Sections

Slender columns reduce the application time and cost of applied finishes.

1.) We can get greater useable floor area.
2.) CFT tubes act as formwork and reduced in formwork cost.
3.) Aesthetically pleasant and reduced maintenance.
4.) Steel tube also prevents spalling of the concrete and minimizes congestion of reinforcement in the connection region, particularly for seismic

3. Experimental details;

Total Twelve sample of CFT were casted and tested on the 1000 kN capacity UTM. One PVC tube kept hollow for taking compression test of CFTs specimen the different sample is considered. Sampling should be such that it varies the geometric properties of the specimen for testing purpose the length of specimen is varied from 500 mm to 600 mm. There should be variation in material properties for testing PVC and normal RC column are the two different materials were used, Compressive strength of PVC Tubes 17.06 to 30 MPa and concrete M20 grade

3.1. Details of Specimens

For testing a short column the effective length of specimens was 500 mm and 600 mm and 152.4 mm, diameter. Total Twelve numbers of column specimen circular in cross section were taken for experimental study. Out of twelve, six specimens of PVC are of 500 mm and six specimens are of 600 mm Normal RC is of grade M 20 concrete. All dimension details of the specimen are shown in table no (1) with Identification code. PVC pipes are available in market with different diameter. Concrete filled tubes plastic (CFTP) specimens Reinforced with 6 nos. of 12 mm diameter and 8 mm @250 mm c/c. To prepare the specimens, PVC tubes having different geometric dimensions were procured from market. External diameter and thickness of pipes were checked as per tolerances given in ASTM-D 1785. The PVC were properly cut and finished in such a way that both the ends were horizontal, parallel to each other and exactly perpendicular to cylindrical surface. The Polyethylene sheet was tightly fixed in the bottom of the CFTPs, so that spilling of water does not occur. The freshly prepared concrete mix was then poured into the tube to obtain the concrete filled tubular column specimen placed in three layers and compacted in each layer properly the top surface of freshly filled concrete prepared plain. After 24 hours all casted specimens cured in tub bath, small hole was drilled for curing. For each batch of concrete, three concrete cubes were cast and tested on the 3 days, 7 days and 28 days. All composite column tests were conducted after 28 days.

4. Test Results

4.1. Experimental results

Table 1 Test Results of all specimens

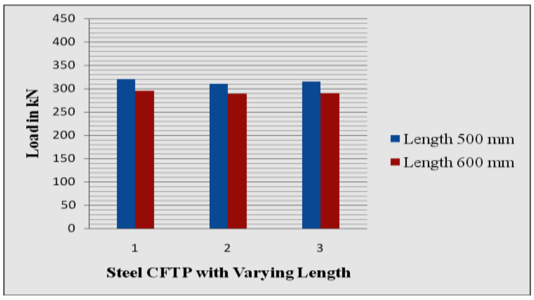
Sr.No	I.D.	Length (mm)	Diameter (mm)	Failure Load (kN)	Displacement (mm)
1	A	500	152.4	320	4.6
2	B	500	152.4	310	4.7
3	C	500	152.4	315	4.8
4	A1	500	152.4	210	3.5
5	B1	500	152.4	220	3.4
6	C1	500	152.4	212	3.2
7	a	600	152.4	295	4.7
8	b	600	152.4	289	4.6
9	c	600	152.4	290	4.5
10	a1	600	152.4	200	3.1
11	b1	600	152.4	205	3.2
12	c1	600	152.4	206	3.1

Table 2: Comparison between CFTP and NRC

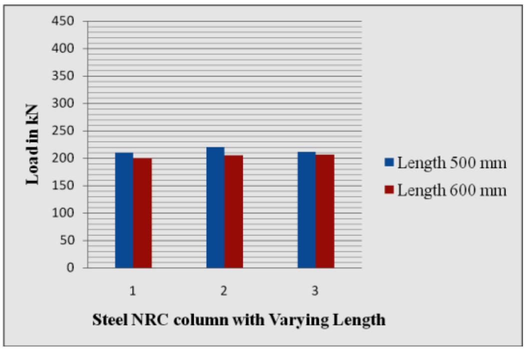
Length	Displacement	Compressive Load in kN	
		PVC CFT	Normal RC Column
600	4.6	289	210
600	4.5	295	220
600	4.4	290	212
600	4.2	296	215
600	4.4	294	216

Table 3 Load vs. deformation of CFTP and NRC column

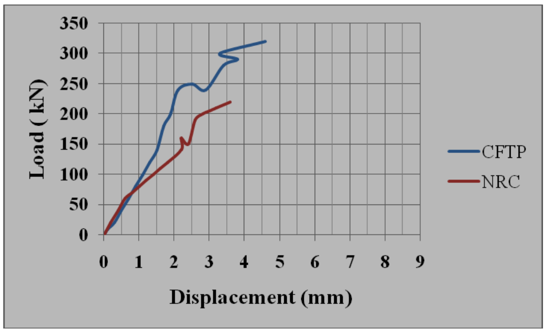
Sr. no	Normal		PVC	
	Load (kN)	Displacement (mm)	Load (kN)	Displacement (mm)
1	0	0	0	0
2	20	0.2	10	0.1
3	40	0.4	20	0.3
4	60	0.6	40	0.5
5	70	0.8	60	0.7
6	80	1.0	80	0.9
7	90	1.2	100	1.1
8	100	1.4	120	1.3
9	110	1.6	140	1.5
10	120	1.8	180	1.7
11	140	2.2	200	1.9
12	160	2.2	240	2.1
13	150	2.4	250	2.5
14	190	2.6	240	2.9
15	200	2.8	280	3.4
16	205	3.0	290	3.8
17	210	3.2	300	3.3
18	220	3.6	320	4.6



Graph 1: Load carrying capacity with length variation of CFTP



Graph 2: Load carrying capacity with length variation of RC column



Graph 3: Load deformation curve for CFTP and RC column

Photograph 1 Tested Specimen

5.2 Discussion:

Behaviors of the CFTP's columns have been studied with respect to displacement characteristics in the axial direction. The load carrying capacity due to the PVC confinement effect M20 grade of concrete is used for twelve specimen of length 500 mm and 600 mm with constant diameter 152.4 mm were tested. The table (1) represents the comparison between the strength parameters CFTP and normal RCC of variation in length. Result shows that shows that the smaller length will give higher compressive strength. In the graph the load vs. displacement is plotted for M20 grade of concrete with 20 mm size of coarse aggregates for length varied from 500 to 600 mm and the following points are observed likewise PVC CFT 600 fails at an early stage than PVC CFT 500. But it is hard to tell at what exact point the concrete fails, because of the early failure of concrete bulging is very high in PVC specimens due to this reason the displacement is high. Graph 2 shows that the PVC CFT carry maximum load than normal RCC compared with corresponding length. Tests to investigate the axial strength of CFT columns have been performed on various specimens. The two types of failure patterns observed. The columns failed either by local buckling combined with concrete crushing or by sudden failure without any local buckling.

The bond between PVC and concrete depends on three factors, including radial enlargement of wet concrete due to its pressure on PVC tubes, roughness of the tube wall, and shrinkage of the concrete. The increase in concrete strength due to confinement of the concrete core by the PVC tube has been found to be valid.

Photograph 2 Casted CFTP Specimens

5. Conclusion

1. 1. Confinement of concrete columns with PVC tubes improves their compressive strength.
2. 2. The improvement in strength is dependent on the concrete strength and geometrical properties of the tubes.
3. 3. As the Length increases, the ultimate axial strength of the column decreases considerable.

4. 4. Local buckling is less due PVC confinement, where RCC buckles early.
5. 5. The corresponding experimental result is compared with the theoretical results. The experimental result is about 1.19% greater than theoretical result.
6. 6. The failure pattern can be seen by local buckling. i.e., Decrease in length and increase in diameter about 5 mm decrease in length and 3 mm increase in diameter.
7. The PVC CFT was not completely failed till 4.8 mm of compression in displacement.
8. Therefore PVC CFT absorbs considerable energy.

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