ISSN: 2455 – 4200
International Journal of Engineering Research and Modern Education
Impact Factor 6.525, Special Issue, April - 2017
6th National Conference on Innovative Practices in Construction and Waste Management
On 25th April 2017 Organized By
Department of Civil Engineering, Sri Ramakrishna Institute of Technology, Coimbatore, Tamilnadu

EXPERIMENTAL STUDY ON MECHANICAL BEHAVIOUR OF CONCRETE COLUMN CONFINED WITH POLY VINYL CHLORIDE PIPES

P. Mahakavi*, S. P. Dinesh kumar*, L. Elamathi*, H. Mohammed Anees* & R. Selva**

* Assistant Professor, Department of Civil Engineering, Sri Ramakrishna Institute of Technology, Coimbatore, Tamilnadu

** UG Scholar, Department of Civil Engineering, Sri Ramakrishna Institute of Technology, Coimbatore, Tamilnadu

Cite This Article: P. Mahakavi, S. P. Dinesh kumar, L. Elamathi, H. Mohammed Anees & R. Selva, "Experimental Study on Mechanical Behaviour of Concrete Column Confined with Poly Vinyl Chloride Pipes", International Journal of Engineering Research and Modern Education, Special Issue, April, Page Number 72-74, 2017.

Abstract:

Columns are the most important elements of the structures, failure of one column in a critical location can cause a progressive collapse. PVC pipes has been used in recent years to strengthening the Reinforced concrete column members. Most of the research reported concerns testing specimens under concentric axial loads. In reality the loads on columns can be eccentric due to columns loacation (corner & edges columns) or due to construction errors. This paper presents the influence of PVC pipe on concrete columns carrying capacity of concentric and eccentric loads. Six high strength reinforced concrete columns were casted and tested. They were divided into two groups. On group consisted of reinforced concrete column; the second group consisted of reinforced concrete column confined with Poly vinyl chloride pipe. From each group 3 specimens were tested as columns and axial loads were applied at eccentricities of 0mm (concentric), 50 mm(eccentric). Load deflection curves were plotted from the tested specimens. Results of this study showed that PVC pipes is an effective material for strengthening of columns under eccentric loads.

Key Words: PVC Pipe, Columns, Confinement & Compressive Strength, Short Column

1. Introduction:

A new type of concrete columns was developed at the University of Alabama in Huntsville for new construction to achieve more durable and economical structures. Columns are compression members which transmit loads from the top to the lower levels, and then to the soil through the foundations. Poly vinyl chloride (PVC) pipes are extensively used in the building industry as a low-maintenance material. PVC pipe is known as having strong resistance against chemicals, sunlight, and oxidation from water and also increase compressive strength of concrete column. Poly Vinyl Chloride pipes acts as formwork and a protective jacket. Deterioration of reinforced concrete structures in marine environment has become a serious problem in the last decade. This phenomenon is mainly due to environmental effects. Cracking and spalling of concrete columns are accompanied with corrosion of internal steel reinforcements. Different methods have been proposed for rehabilitation and strengthening of such corroded concrete columns. Recently PVC has become one of the viable methods of strengthening columns as the lateral pressure exerted by PVC will increase the compressive strength of concrete resulting in higher load carrying capacity. In the case of PVC confined columns, as the PVC tube itself acts as the permanent formwork, it protects the concrete as well as the internal reinforcement from environmental effects such as chloride and corrosion. When the thickness of PVC pipes increased, the compressive strength of the plain concrete specimens also increased. In the case of reinforced concrete columns, when the thickness of PVC pipes is increased, the load carrying capacity of the columns gets increased. External confinement of concrete columns using PVC pipes increases the compressive strength, load carrying capacity and energy absorption capacity.

2. Advantages and Scope:

- ✓ Increase split tensile strength.
- ✓ Increase impact resistance.
- ✓ Increase abrasion resistance.
- ✓ Increase toughness.
- ✓ Increase fatigue resistance.
- ✓ Increase freeze thaw resistance.
- ✓ Increase shears strength.
- ✓ Increase antic rack strength.
- ✓ To promote the low cost structures to the down trodden society.
- ✓ To increase moment capacity and cracking moment.
- ✓ To increase the ductility.

3. Material Used:

3.1 Cement: Cement is a binder substance that sets and hardens as the cement dries and also reacts with carbon dioxide in the air dependently, and can bind other materials together. It is usually a grey powder before being mixed other materials and water. Cement used in construction can be characterized as being either hydraulic or non hydraulic depending upon the ability of the cement to be used in the presence of water. The OPC was classified into three grades namely 33 grade, 43 grade, 53 grade depending upon the strength of cement at 28 days when tested as per IS 4031-1988. 53 grade cement is a prime brand cement with a remarkably high C_3S (Tri calcium silicate) providing long-lasting durability to concrete structures. They produce highly durable

ISSN: 2455 – 4200
International Journal of Engineering Research and Modern Education
Impact Factor 6.525, Special Issue, April - 2017
6th National Conference on Innovative Practices in Construction and Waste Management
On 25th April 2017 Organized By
Department of Civil Engineering, Sri Ramakrishna Institute of Technology, Coimbatore, Tamilnadu

and sound concrete due to very low of alkalis, chlorides, magnesia and free lime in its composition. The specific gravity of cement is 3.15.

3.2 Fine Aggregate: It is the aggregate most of which passes through a 4.75mm IS sieve and contains only so much coarser material as is permitted by the specifications. Sand is generally considered to have a lower size limit of about 0.07mm. A good fine aggregate should always be free of organic impurities, clay or any deleterious material. River sand is procured from river streams and banks and is fine in quality unlike pit sand. This type of sand has rounded grains generally in white grey colour. River sand many uses in the construction purpose such as plastering. River sand is a product of natural weathering of rocs over a period of million of years.

3.3 Coarse Aggregate: Aggregate are inert granular materials such as sand, gravel, or crushed stone that, along water and Portland cement, are an essential ingredient in concrete. For a good concrete mix, aggregate chemicals or coatings of clay and other fine materials that could cause the deterioration of concrete. Coarse aggregates are any particles greater than 0.19 inch, but generally range between 3/8 and 1.5 inches in diameter. Local aggregates, comprising 20mm coarse aggregates in saturated surface dry condition, were used. The coarse aggregate is the strongest and least porous component of concrete. Coarse aggregate in cement concrete contributes to the heterogeneity of the cement concrete and there is weak interface between cement matrix and aggregate surface in cement concrete. This results in lower strength of cement concrete by making the transition zone stronger. The specific gravity of coarse aggregate has found to be 2.74. Hence, the selection of coarse aggregate would be an important step in concrete mix design.

3.4 Water: Water is an important ingredient of coarse as it actively participates in the chemical reactions with cement. The strength of cement concrete comes mainly from the binding action of the hydrated cement gel. The requirement of water should be reduced to that required for chemical reaction of unhydrated cement as the excess water would end up in only formation of undesirable voids in the hardened cement paste in concrete. An excessive amount of water will impair the water tightness of concrete. Water used in mixing concrete must be clean and free from oils, alkalis, acids, and organic materials. The pH range of water for construction purpose should not be less than 6. Ordinary potable water was used for the production of concrete and curing.

3.5 Poly Vinyl Chloride Pipes: A Poly vinyl chloride (PVC) pipe is made from a plastic and vinyl combination material. PVC is common, strong but lightweight plastic used in construction. PVC pipe is manufactured by extrusion in a variety of sizes and dimensions. PVC pipe is available in both solid wall or cellular core construction.

4. Experimental Study:

Three cylindrical specimen of 200mm dia and 900mm height and three cylindrical specimen of 230mm dia and 900mm height were cast and tested. All specimens were made of concrete and reinforced with the same amount of steel reinforcements, 5 nos of 12mm dia (deformed bars of 12mm dia& 415 MPa nominal tensile strength) longitudinal reinforcement and 8mm dia (deformed bars of 8mm dia and 415 MPa nominal tensile strength) at 300mm c/c. The six specimens were subdivided into 2 groups with 3 specimens each. The specimens of first group RC were made of Reinforced concrete column, the specimens of second group were made of reinforced concrete column confined with PVC pipe. Two specimens from each group were tested as column at eccentricities of 0mm, 50mm. These specimens have the notation 0, 50mm respectively. The third specimen denoted as ST was tested as a cylindrical column under split tensile loading. The test plan was to allow for direct deflections and split tensile strength.

5. Test on Concrete:

4.1 Compressive Strength Test (Axial and Eccentric): The column size of diameter 200 mm& 230mm and length 900mm are placed in the machine such that load is applied on the opposite side of the columns as casted. Align carefully and load is applied, till the specimen breaks.

Compressive strength for axial load $= \frac{P}{A}$ (N/mm^2)

Where, P is the compressive load on the cylinder, A is a cross sectional area

Compressive strength for eccentric load = $\frac{P}{A}(1 + \frac{e}{y})$ (N/mm^2)

e is the eccentricity

y is the centroidal distance

4.2 Split Tensile Strength Test: The test is carried out by placing column specimen of dimension 200mm& 230mm diameter and 900mm length, horizontally between the loading surface of compressive testing machine and the load is applied until failure of the column along the vertical diameter. The failure load of the specimen is noted.

Split tensile strength = $\frac{2P}{\pi LD}$ (N/mm^2)

Where, P is the compressive load on the cylinder, L is length of the cylinder & D is the diameter of the cylinder

5. Results: (Test Results for Compressive Strength of Columns)

Table 5.1: Test results for compressive strength of Columns

Axial load test in Reinforced Concrete Column (e=0mm)		Axial Load test in Concrete Column Confined with PVC pipe (e=0mm)		Eccentrical load test in Reinforced Concrete Column (e=50mm)		Eccentrical load test in Concrete Column Confined with PVC pipe (e=50mm)	
Loads (kN)	**Deflections (mm)**	**Loads (kN)**	**Deflections (mm)**	**Loads (kN)**	**Deflections (mm)**	**Loads (kN)**	**Deflections (mm)**
0	0	0	0	0	0	0	0
15	0.24	15	0	15	0.27	15	0
30	0.29	30	0	30	0.48	30	0

ISSN: 2455 – 4200
International Journal of Engineering Research and Modern Education
Impact Factor 6.525, Special Issue, April - 2017
6th National Conference on Innovative Practices in Construction and Waste Management
On 25th April 2017 Organized By
Department of Civil Engineering, Sri Ramakrishna Institute of Technology, Coimbatore, Tamilnadu

45	0.41	45	0	45	0.57	45	0.12
60	0.5	60	0	60	0.81	60	0.31
75	0.55	75	0.06	75	1.29	75	0.51
90	0.73	90	0.15	90	1.64	90	0.65
105	0.87	105	0.28	105	1.98	105	0.75
125	1.06	125	0.51	125	2.22	125	0.9
140	1.08	140	0.63	140	2.41	140	1
155	1.32	155	0.71	155	2.6	155	1.15
170	1.43	170	0.75	170	2.8	170	1.29
185	1.64	185	0.78	185	2.99	185	1.41
200	1.72	200	0.79	200	3.18	200	1.44
215	1.78	215	0.8	215	3.36	215	1.46
230	1.8	230	0.82	230	3.55	230	1.48
245	1.95	245	0.82	245	3.79	245	1.5
260	1.97	260	0.81	260	4.02	260	1.53
275	2.15	275	0.76	275	4.25	275	1.54
290	2.33	290	0.73	290	4.5	290	1.55
		305	0.75	305	4.55	305	1.57
		320	0.78	320	4.75	320	1.59
		335	0.80			335	1.63
		350	0.82			350	1.65
		365	0.85			365	1.69
		380	0.89			380	1.70
		395	0.90			395	1.72
		410	0.91			410	1.73
		425	0.93			425	1.75
		440	0.95			440	1.77
		455	0.97			455	1.80

Table 5.2: Split tensile strength test of columns

Specimen	Load(kN)	Split tensile strength(N/mm^2)
RC-ST	182	0.56
PVC-ST	320	1.13

6. Conclusion:

Based on the experimental program of this study the following conclusions are drawn

- ✓ Column made of reinforced concrete and vertically confined with PVC pipes performed better than the reference column which for reinforced with steel. The better performance applies both for strength and lateral deflection.
- ✓ Although tested under eccentric loads the reinforced column confined with PVC pipes performed better than the steel reinforced column.

Finally based on the result of the study it could be concluded that PVC pipe is an effective material for enhancing the strength and lateral deflection of concrete. However, this present study the concrete used had a compressive strength of 30MPa and reinforced with high tensile strength steel of 415MPa further research is required to cover more strength of concrete.

7. References:

1. Ahmadi, M. Kheyroddin, A. and Naderpour, H. (2015) 'Compressive Strength of Confined Concrete in CCFST Columns ', Vol 2-1, Pp 106-113.
2. Ata El-kareim Shoeib Soliman, (2011)'Behavior of long confined concrete column'.
3. Ata El-Kareim Shoeib Soliman and Mostafa Osman, (2015) 'Behavior of Confined Columns under Different Techniques', Vol 9, No1.
4. Donald R. Kramer, Douglas L. Sarkkinen and Stephen P. Schneider (2004), 'The design and construction of concrete-filled steel tube column frames', vol 3, Pp 252.
5. Eramma,H. Madhukar, N.J. (2015) 'Experimental investigation on PVC encased columns ', Volume 04, Issue 09.
6. Eramma,H. and Usha, C.M (2014) 'Experimental study on concrete filled, Unplasticised Poly vinyl chloride (UPVC) tubes', vol 02, Issue 07.
7. Gathimba Naftary, K. Oyawa Walter, O. Mang'uriu Geoffrey, N. (2012) 'Compressive Strength Characteristics of Concrete-Filled Plastic Tubes Short Columns', Volume 3, Issue 9.
8. Ganesh Babu, O. Rajasekar, K. Sakthieswaran, N. Shiny Brintha,G. (2016) 'Study about the Behaviour of Concrete Filled Tubular Column with GFRP Wrapping', vol 4, Issue V.
9. Gopinath, R. Rajalakshmi, R. Thilagavathi, V. and Ramya, U. (2014) 'Experimental Study on Confined Concrete with Steel Fiber', Vol. 3 Issue 3.
10. Hua Zhao and Muhammad N. S Hadi, (2011) 'Experimental Study of High-Strength Concrete Columns Confined with Different Types of Mesh under Eccentric and Concentric Loads', Vol 4, Pp 545-548.