

Comparative Study on Solid Unconfined Cylinder and Soild Cylinder with Outer PVC Confinement

Mohammad Aiman Khan¹, Md.Tabish Izhar², Mohammad Hashim Siddiqui³

^{1, 2, 3} Department of Civil Engineering
^{1, 2, 3} Integral University, Lucknow, (U.P) India

Abstract- In this paper an experimental study is presented to investigate the effectiveness of PVC tube for confinement of concrete cylinders. PVC confinement depends upon several parameter, concrete strength, volume and orientation, PVC pipes thickness, slenderness ratio. Total 36 cylinder are casted in which, 18 cylinder are unconfined solid cylinder and 18 are solid cylinder with pvc confinement. PVC tubes of concrete diameter 100mm and 90 mm with effective length are 400mm, 500mm and 600 mm were casted and PVC tube thickness are 3mm. The concrete has been designed using IS CODE: 10262-2009 M20 grade of concrete. The cylinder were tested for axial loading in the UTM of capacity 1000KN. One of the main advantage in the interaction between PVC tube and concrete is local buckling PVC tube delayed by restraint of concrete and strength of concrete is increased by the confining effect of PVC tube. It is found that compressive strength in solid cylinder with outer pvc confinement increases 5% to 6% with compare to solid unconfined cylinder. and column load capacity and the compressive strength decreases with increase in slenderness ratio. Specifically PVC confined cylinder strength is more compare to unconfined solid the study shows greather potentiality of PVC tubes can be used in economical building.

Keywords- Compressive Strength, PVC tube, M20 grade of concrete, Cylinder

I. INTRODUCTION

For more than 50 years, PVC has been very Successful throughout the world. Today this versatile material is one of the most important plastic material recognized internationally and proven on the market. PVC product are often cost effective in terms of purchasing and maintenance. Pvc is normal impact, high corrosion resistant poly vinyl chloride because of its exceptional corrosion resistance it is ideally suited for where maximum chemical resistance is necessary. Its high strength to weight ratio, cost efficiency, ease of fabrication and economical balance make it the material of choice. It can be used in self supporting construction up to 1400F (depending on chemistry). PVC combines tensile strength and stiffness for the toughest application for resistant to most acids and alkali solution. This material is popular because of the wide range of properties

that can be obtained depending upon the additives that are mixed with it. all this relatively in expansive price .

Pvc is extensively used in building industries as a low maintenance material. If structural concrete filled tube (CFT) columns can be developed from pvc tubes, which is locally available, it would be a great achievement for the local infrastructure. Therefore the main purpose of this study is to determine the feasibility of using pvc in CFT and to enhance the strength and durability and ductility of the material.



Fig-1 Different size of PVC pipes

1.1 CONCRETE FILLED PVC TUBES USES.

- 1-enhance strength and ductility due to confinement.
- 2-this gives aesthetical appearance to the structure.
- 3-low workable concrete can be used effectively.
- 4-Rapid construction.

In this time concrete column are using in everywhere but one of the deficiency of concrete column is lack of lateral confinement and low energy absorption capacity. Researchers are working on the techniques by which such problems can be minimized during construction stage. Strength, ductility and energy absorption capacity can be enhanced by providing external confinement by employing pvc tubes. These pvc tubes can be used as foamwork during construction and their after a part of column.

Since use of pvc for confinement of concrete is relatively new and economical work and theoretical work available in this area is very limited.

II. LITERATURE REVIEW

Pramod Kumar Gupta.[1] concluded that a new kind of composite column which is obtained by fully un plasticized poly-vinyl chloride(upvc)tube with concrete and it found that upvc tubes improves their compressive strength and ductility and failure pattern of all the specimen are shear type failure and the predicted capacities of column using different modes are within $\pm 6\%$ of experimental capacities. upvc tubes can be effectively used for confinement of the concrete column and to enhance their load capacity ,ductility as well as energy absorbing capacity.

Mr.Abhale R.B et al.[2] concluded that the test showed local buckling and pvc tube delayed by restraint of concrete and strength of concrete is increased by the confining effect of pvc. the improvement in strength depend on the concrete strength and geometrical properties of the tubes. as the length increases the ultimate axial strength of column decreases. the experimental result is about 1.19% greater than theoretical result.

Gathimba Naftary K et al.[3] concluded that plastic pipes are effective in confining concrete ,as evidenced by the increased compressive stress. the enhancement in strength due to confinement of circular columns is substantial and depending upon the level of confinement ,strength is increased any where from 1.18 to 3.65 times unconfined strength values. low strength concrete tends to be more ductile suggesting the potential of an earthquake resistant composite column system. the tube thickness also affect the confinement effect of plastic tube .and this research recommends that further research should be conducted with varying tube thickness to establish the actual contribution it makes in column confinement.

Mostafa Osman et al.[4] studied the behavior of confined column under different techniques. the techniques of confined RC column are mortar strengthening, steel rings strengthening ,FRP strengthening and the technique of confined plane concrete column used pvc tubes showed that the strengthening results improve behavior of column and can used in construction. and also tested confined PC column with pvc tube results shown that the confined PC with pvc tubes can be used in economical building .confinement increases the column load ductility and enhanced energy absorption capacity.

Mostafa Fakharifar et al.[5] concluded that the use of such confined concrete filled tube(CCFT) system ,incorporating FRP sheets and polymer plastic tubes ,can dramatically increases the amount of energy absorbed and decrease the brittle failure. typically observed in the case of confined or poorly confined concrete member. CCFT specimens more significantly increased both ductility and

strength of the composite columns. The CCFT system revealed different behaviors than the CFT system.the total strength capacity of all CCFT specimens experienced an increase in strength by over 50%.

Amir Mirmiran et al.[6] concluded that square sections are shown to be less effective in confining concrete than the circular counter parts. length effect in short column of upto 5:1 is shown to be similar to ACI provisions for tied columns .10% eccentricity and 20% strength reduction in pure compression .mechanical shear connectors can enhance the load –carrying capacity of the column by providing an effective load distribution mechanism.

Ata El-Kareim shoeib soliman [7] concluded that utilizing plastic tube for confinement significantly influence the failure mechanism of concrete column .the influence of column slenderness ratio on their axial load ,axial stress and radial strains is also investigated. Stiffness of the tested long confined concrete columns as specimens increases as slenderness ratio decreases .slenderness ratio affects the mode of failure.

Amir Z.Fam and Sami[8] concluded that strength and ductility of beams are greatly improved by filling the tubes with concrete and higher strength to weight ratio are achieved by providing a voided concrete core GFRP shells provide significant concrete confinement in short columns. Which improve strength and ductility central voids in columns reduce the confinement effectiveness and it still can be improved if the void is maintained using an inner GFRP shell.filament wound are superior to pultruded tube in bending and confinement and also investigate that GFRP tubes are more efficient than steel tube.

III. EXPERIMENTATION

The main objectives of the experimental programme are. 1.Compare soild unconfined cylinder to soild cylinder with outer pvc confinement

The investigation was carried out on concrete cylinder on internal diameter 100 mm,90mm with 3 mm thick of pvc tube for finding compressive strength in 400mm,500mm,600mm height of cylinder.

Material properties on performing the experimental studies. laboratory following material were used.

- 1. Cement:** Cement are broadly used as a binder material in construction.ppc (Portland pozzolana cement)brand name mycem cement was used in the entire experimental work.

2. **Fine aggregate:** River sand were used as a fine aggregate .aggregate used in this study those sand which passes through 4.75 sieve and retained on 60 micron sieve with the grading zone of fine aggregate was zone 2 as per IS code.
3. **Coarse aggregate:** Crushed rocks were used as coarse aggregate of maximum 20 mm confirming to IS 383 - 1970 was used.. Locally available coarse aggregate having maximum size 20 mm and 10 mm used in the experiment.
4. **PVC Pipes:** Pvc is replacing traditional building material such as wood, metal, concrete and clay in many applications. Versatiliting cost effectiveness and excellent record of use mean .it is most important polymer for the construction sector .pvc is one of the most important polymer for the construction sector.pvc is one of the most popular plastic used in building and construction .pvc'abrasion resistance ,light weight good mechanical strength and toughness are advantages for its use in building and construction application .pvc can be cut very easily shaped welded easily in a variety of styles .pvc is very durable resistant to weathering ,chemical rotting corrosion ,shock and abrasion .it is therefore preffered choice for many different long life and outdoor products. it is estimated that more than 75%of pvc pipes will have a life time in excess of 40 years with potential in service life of 100years.pvc is cost effective and non toxic.it is safe material product will burn when exposes to fire .pvc however are self extinguishing ie. if the ignition source is with drawn they will stop burning because of its high chlorine content pvc products have fire safety characteristics ,which are quite favourable .pvc can also be used as a protective layer against mechanical damage cause by the several environmental.



Fig-2PVC pipes of different tube



Fig-3 Concrete filled PVC L/D ratio.

Service life of pvc tube is longer than 50 years and with the mechanical properties supporting of core concrete.

Pvc can serve longer as a protective layer of the concrete structure.

The different properties are given in the table no-1

Physical Property	Value
Relative density	1.42-1.48
water absorption	0.12%
Coefficient of friction	0.4
Mechanical properties	Value
ultimate tensile strength	27.5-52 Mpa
elongation at break	50-80%
elastic tensile modulus	3.0-3.3Gpa
elastic flexural modulus	2.7-3.0Gpa
Bulk modulus	4.7 Gpa
poisson's ratio (increase with time load)	0.4
Electrical & thermal properties	Value
Surface resistivity	1013-1014Ω
Surface resistivity	1013-1014Ω
Thermal conductivity	0.16W/[M.K]
Fire performances	Value
Flammability (oxygen index)	45%
Service life	>50 years

5. **Water:**Normal clean tap water free from suspended particles Normal tap water is used for both mixing (M20 propotions) and curing of concrete cylinder.

Specimen Instrumentation and testing:

A total of 36 concrete cylinder were casted in which 18 were solid unconfined cylinder whose length are 400mm, 500mm and 600 mm with different diameter 100mm,90 mm. Thickness of tubes were 3mm in soild unconfined cylinder.18 soild cylinder with outer pvc confinement length are same as unconfined cylinder and outer dia 100 mm,90 mm. thickness are also same 3 mm for every cylinder slenderness ratio is evaluated. all the cylinder are casted in M20 mix propotions by IS code. Pvc tube was fix on one side by plastic cover and taped it which was then used as a mould for casting cylinder. the outer plastic casing was then removed after 24 hours. they were then marked and cured for 28 days of prior testing.

Compressive strength test. Compressive strength is the capacity of a material to with stand loads tending to size. it can be measured by plotting applied force against a

deformation in testing machine. some material fracture at their compressive strength limit others deform irreversibly, so a given amount of deformation may be considered as the limit for compressive load. Compressive strength is the key value of design of structures.



Fig-4 Testing of confined cylinder (UTM)

This test is carried out by a placing of a cylinder on vertically between the loading surface of ultimate testing machine.and load applied until the failure..the Experimental setup for compressive strength along the vertical.average of three value was taken as a representative of batchthe testing of utm test.

The compressive strength specimen can be determine by the following test

$$F_c = P/A$$

F_c =compressive strength N/mm^2
 P =load applied at failure KN
 A =loaded area of cylinder mm^2

The column were tested using an incremental loading procedure .only compressive strength data is presented in this paper the applied load was kept constant for each load stage to allow for measurements and observations.

IV. RESULTS AND DISCUSSIONS

4.1 Failure behavior. all cylinder average in during the loading process. few types of failure of the pvc tube.



Fig-5 Different types of failure mode

1. Bursting of pvc tube also show towards the end of loading process.
2. Plastic tube was preceded by flow of resin show the white patches at higher stress sections.
3. Shear failue of the tube.
4. Cylinder tube crushing under compression named bulging.bulging was observed to occur bottom, top or mid height.

It is to investigated that no attached to the concrete is tube.and smmoth interface is develop. main conclusion is that no bond is developed between concrete and pvc tube.

4.2 Effect of varying slenderness ratio on load and compressive strength-as the diameter increases and also the load capacity result of decreases compressive strength. decreases in strength with increased diameter due to increased area and then increased in axial load carrying capacity of the cylinder. however the load carrying capacity and the compressive strength both decreases with increase slenderness ratio.

Table 4.1-Solid unconfined cylinder

S.N O	Length(L)mm	Concrete Inner diameter(D)mm	Concrete Slendemes ratio L/D	Average load (KN)	Compressive strength N/mm^2
1	400	100	4	217.16	27.65
2	400	90	4.44	186.60	29.35
3	500	100	5	208.21	26.53
4	500	90	5.55	152.90	27.06
5	600	100	6	197.06	25.16
6	600	90	6.67	162.08	25.59

The stiffness of cylinder increases with the decrease in slenderness ratio.

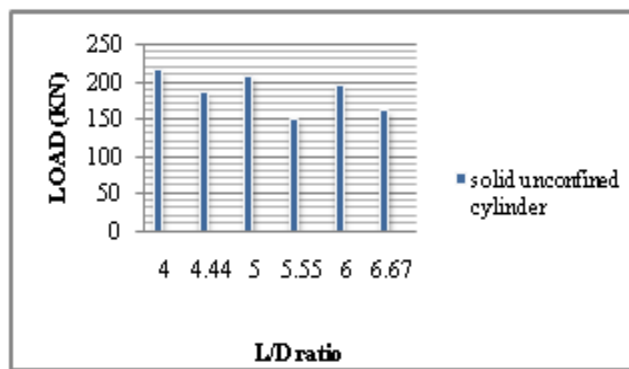


Fig-6

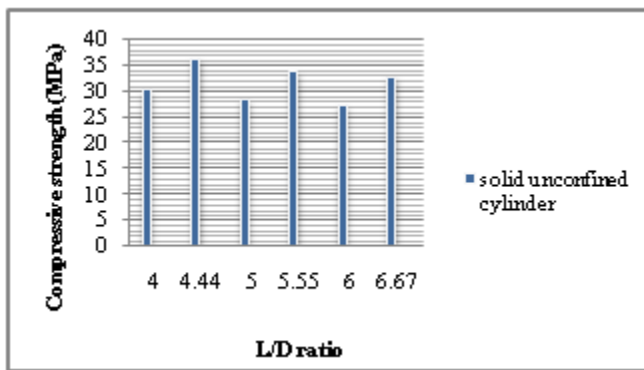


Fig-7

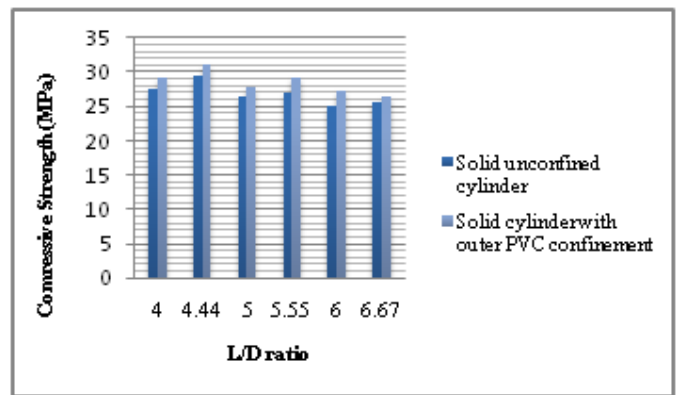


Fig-10

Table 4.2-Solid cylinder with outer PVC confinement

S. N O	Length(L) mm	Concrete outer diameter(D) mm	Tube thickness(mm)	Concrete Slenderness ratio L/D	Average load (KN)	Compressive strength N/mm ²
1	400	100	3	4	229.29	29.26
2	400	90	3	4.44	196.23	30.98
3	500	100	3	5	219.56	27.93
4	500	90	3	5.55	185.43	29.12
5	600	100	3	6	213.50	27.23
6	600	90	3	6.67	169.16	26.53

Material confined concrete is referred to confinement effectiveness which is f'_{cc}/f'_{co}

f'_{cc} =compressive strength confined

f'_{co} =compressive strength unconfined

- figure 6&7 shows the load and compressive strength of solid unconfined cylinder at different length 400mm,500mm,600mm With diameter of cylinder 100mm,90mm..Evaluated that compressive strength 6% increases in comparison between two different diameter 100mm,90mm in 400 mm length.1.99%for 500 mm length and 1.70 % for 600 mm length of cylinder.its shows that when diameter of cylinder decreases compressive strength increases.
- figure 8&9 shows the load and compressive strength of solid cylinder with outer pvc confinement with dia 100mm, 90mm And length 400mm, 500mm, 600mm. evaluated that compressive strength increases 6.83% when compare between two different diameter 100mm,90mm in 400 mm length,.4.2 % increase in 500 length and 2.63% increase in 600 mm length. This show that when diameter is decrease compressive strength increase also in confined cylinder with outer pvc confinement .
- In figure 10 comparison between solid unconfined cylinder to solid cylinder with pvc confinement .show that compressive strength increases 5%to 6% in solid cylinder with outer pvc confinement .it is clear that plastic pipes are effective in confining concrete.

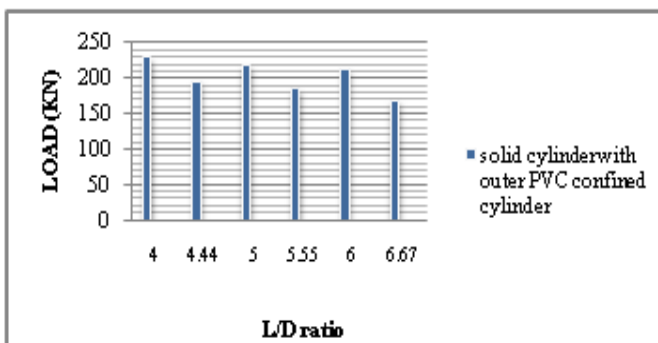


Fig-8

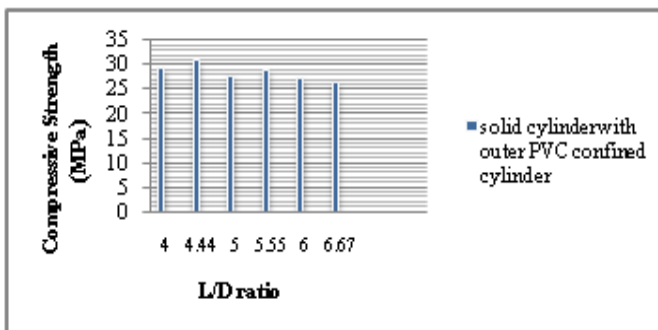


Fig-9

4.3 Comparative study on compressive strength between solid unconfined cylinder and solid cylinder with outer PVC confinement.

V. CONCLUSION

The present study focused on the structural feasibility of concrete filled plastic tube (CFPT)cylinder by studying their behavior under compressive loading .

The Following were the conclusion of this research.

1. Compressive strength of the column decreases when cylinder height increases.
 2. It was concluded that compressive strength of solid cylinder with outer pvc confinement is increases 5% to 6% compare to solid unconfined cylinder.
 3. It was concluded that compressive strength 6%,1.99%,1.70% increases in 90mm cylinder diameter and length 400mm,500mm,600mmwhen comparision with 100mm dia of cylinder in solid unconfined cylinder.
 4. 4.It was concluded that compressive strength 6.83%,4.2%,2.63% increases in 90mm dia of cylinder whose length 400mm,500mm,600mm when comparision to 100mm dia of cylinder in solid cylinder with outer pvc confinement. this shows that when diameter of cylinder increases compressive strength decreases.
 5. It was concluded that the failure of (CFPT) cylinder can occur in either of the two ways these are shear failure or by crushing.
 6. It was also concluded that the column load capacity and the compressive strength decreases with increase in slenderness ratio.
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