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# Strength Evaluation of Reinforced Concrete Columns Eccentrically Concealed with CPVC and HDPE Rain Water Pipes

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**Abstract -** *Water plays a significant role in our lives since it is a precious natural resource. Over the past few years, there has been an increase in water shortages in several parts of the country. Ideal measures should be taken to reduce the high rate of water loss, one such measure is Rainwater Harvesting. Rain water harvesting is nothing but the collection and storage of rain water which runs off from roof tops, parks, roads, open grounds, etc. This water run off can be either stored or recharged into the ground water. In case of buildings, the conveyance system that is required to carry the water harvested from the catchment i.e the terrace area of the building is done through a series of pipes. These pipelines running through building facades are difficult to maintain and over a period of time they cause damage to the elevation of the building. Though rain water harvesting is a solution for a bigger problem of water scarcity and cannot be done away with, the damage to the elevation of any building structure due to these pipelines needs to be solved. One of the solution to this is to conceal the pipes inside structural columns, however the strength of columns is effected by reinforcing ratios and cross sectional area which is reduced if pipes are placed in these columns, In this paper, strength evaluation of reinforced concrete columns eccentrically concealed with CVPC pipe and HDPE pipe with a concrete grade of M30 is done to compare its compressive strength and load carrying capability. The results concluded that column with CPVC pipe has a superior compressive strength and load carrying capability as compared to column with HDPE pipe.*

***Key Words*: *Eccentrically Concealed column, CVPC pipe, HDPE pipe***

## 1. INTRODUCTION

Water is a precious, essential and an abiotic component of the ecosystem. Today we all are heading toward the scarcity of water and this is mainly because of the lack of water conservation and pollution of water bodies.

Rain water harvesting is one measure through which wastage of runoff water from rooftops can be saved but the conveyance system which is used to transport the harvested water from the catchment to the recharge zone is required to be placed all over building walls and this plumbing work on the surface of building is not very desirable and all the key players related to civil industry i.e architects, designers, developers, engineers would prefer to avoid it as due to weather conditions the deterioration of such plumbing works is very rapid and thereby it badly affects the elevational view of the building.

To solve this problem, these pipes can be concealed within the structural members itself. In this paper, study is done on effect of CPVC Pipe and HDPE pipe when positioned eccentrically in a cross section of a column. Chlorinated polyvinyl chloride (CPVC) is a thermoplastic made by chlorinating polyvinyl chloride (PVC) resin. It is more flexible and has a higher compressive strength than PVC. It can also resist temperatures that are higher than conventional PVC. HDPE pipe is a flexible plastic pipe that is used to transport fluids and gases. HDPE (high-density polyethylene) is a thermoplastic with a high level of impermeability and a strong molecular bond, making it ideal for high-pressure pipelines.

## 2. METHODOLOGY

The main objective of this study is to evaluate the load carrying capacity and compressive strength of a square reinforced short column with CPVC and HDPE pipes positioned eccentrically on the cross section of the column and compare it with a column that does not contain any pipe.

## 3. MIX DESIGN FOR M30

Initiation Mix design of M-30 of concrete with 20mm maximum size aggregate with medium workability based on IS 10262-2009 and IS 456-2000 was done and the ratio obtained as mentioned in table 1 with a W/C ratio of 0.45.

**Table -1:** Mix design proportioning

| Mix design | | |
|---|---|---|
| Cement | Fine aggregate | Coarse aggregate |
| 1 | 1.89 | 3.37 |

## 4. CUBE TESTING

The cubes were cast on-site and tested on UTM as shown in Figure 1. The cubes were kept in the curing tank for 28 days after the formwork was removed, following result were obtained and mix design was found to be satisfactory, results are shown in table 2

**Table -2:** Trial Mix results of concrete cube of grade M30

| Trial Mix results | | | | | | |
|---|---|---|---|---|---|---|
| Cube No | Date of casting | Date of testing | Load [KN] | Area [mm²] | Compressive Strength [N/mm²] | Average Compressive Strength [N/mm²] |
| 1. | 21/2/22 | 21/3/22 | 791.5 | 22500 | 35.1 | 34.24 |
| 2. | | | 756.7 | 22500 | 33.6 | |
| 3. | | | 765.8 | 22500 | 34.3 | |

**Fig -1**: Cube Testing

## 5. SPECIFICATION OF COLUMNS

Three Short Columns of cross section 200 mm X 200 mm and length of 950 mm were designed, one was without any placement of pipe, other one with a placement of CPVC pipe of diameter 50 mm and last one with a placement of HDPE pipe of diameter 50 mm. The pipes were positioned eccentrically to the cross-section. The design Specification of the columns are as shown in table 3 and casting of columns is shown in figure 2 and 3.

**Table -3:** Specification of columns

| Specification of columns | | | | |
|---|---|---|---|---|
| Column specimen | Dimension of column(mm) | Pipe diameter and type | Vertical reinforcement | Lateral ties |
| C1 | 200 x 200 x 950 | CPVC 50mm Ø | 4 Nos of 12 mm Ø | 8 mm Ø @ 150 mm c/c |
| C2 | 200 x 200 x 950 | HDPE 50mm Ø | 4 Nos of 12 mm Ø | 8 mm Ø @ 150 mm c/c |
| C3 | 200 x 200 x 950 | - | 4 Nos of 12 mm Ø | 8 mm Ø @ 150 mm c/c |

**Fig -2**: Column formwork

**Fig -3**: Column casting with CPVC and HDPE pipe

## 6. CONCLUSIONS

The test results are shown in table 4 and testing procedure is shown in figure 4, 5 and 6. The analysis reveals that inserting an HDPE drain pipe inside the column considerably affects the column's weight carrying capacity. When compared to a column concealed with HDPE pipe, a column with CPVC drain pipe and a solid column has higher compressive strength and load carrying capacity. CPVC Pipe can be used as an alternative to PVC Pipe for concealing in a column as a rainwater drain pipe. It can be concluded that column with CPVC pipe has a superior compressive strength and load carrying capability as compared to column with HDPE pipe.

**Table -4:** Compressive Strength comparision

| **Compressive Strength comparision** | | | |
|---|---|---|---|
| | Cracks Formation [KN] | Sustained Compressive Load [KN] | Failed a Compressive Load [KN] |
| Column with no pipe | 500 | 666 | 670 |
| Column with CPCV pipe | 183 | 914 | 915 |
| Column with HDPE pipe | 175 | 598 | 591 |

**Fig -4**: Testing on column without pipe


**Fig -5**: Testing on column with CPVC pipe

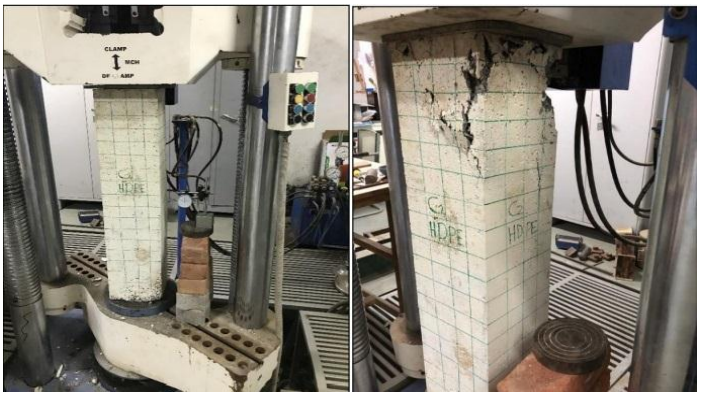

**Fig -6**: Testing on column with HDPE pipe

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