# EXPERIMENTAL STUDY OF REINFORCED CONCRETE COLUMNS WITH EMBEDDED PIPE

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# ABSTRACT

An experimental study was carried out to investigate the effect of positioning rain water down pipes inside reinforced concrete short braced columns in buildings. Thirty three columns in eleven sets, having various sizes and reinforcements were constructed and tested. The PVC or steel pipes were positioned at the centre of cross-section of each of them. The installation of the strain gauges on the models was carried out before the testing of the models. As an alternative solution, PVC drain pipes were replaced by steel pipes in reinforced concrete columns. The ultimate strength of the columns obtained from the present investigation is compared with the design strengths recommended by the British code of practice (BS 8110) and the American code of practice (ACI). The columns showed significant reduction in their load carrying capacities and the safety factors obtained were much less than the nominal value usually recommended by various codes of practice. Also the study showed that by using steel pipes instead of PVC drain pipes, the load carrying capacity of the columns can be enhanced near 10 percent.

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# INTRODUCTION

## 1.1 Background

A column is the vertical structural member supporting axial compressive loads, with or with-out moments. Columns support vertical loads from the floors and roof and transmit these loads to the foundations. Failure of a column in a critical location can cause the progressive collapse of the adjoining floors and the ultimate total collapse of the entire structure.

In the construction of modern multistory buildings, pipes are positioned vertically inside the reinforced concrete columns to accommodate the essential services such as drainage of roof top rain water, electric wiring from floor to floor etc. The pipes are placed inside the columns, based on pretext to maintain the aesthetic of the buildings. The practice of embedding rain water down pipes inside reinforced concrete columns is followed particularly in those multistory buildings which have flat roofs and glass front views. The diameters of pipes vary, depending on the amount of drained water.

Tropical countries such as Malaysia is having rainfall throughout the year, which require an effective and appropriate drainage system for rain water, and has to be considered in the construction of all building projects having flat roofs. Therefore, the practice of positioning Poly Vinyl Chloride (PVC) pipes inside reinforced concrete (RC) columns has become quite common nowadays. The water from the roof tops of multistory buildings is drained through these pipes and discharged at ground level (Figure 1.1).

However, this method of drainage could cause serious damage to the safety of the structure. And as a result, positioning drain pipe inside the columns may reduce the effective cross-section area of it significantly and cause huge reduction in the load carrying capacities of columns. A literature study on the problems shows that no rational information and guidelines in codes of practice of ACI 318 (American), and BS8110 (British Standard) on this problem are available.

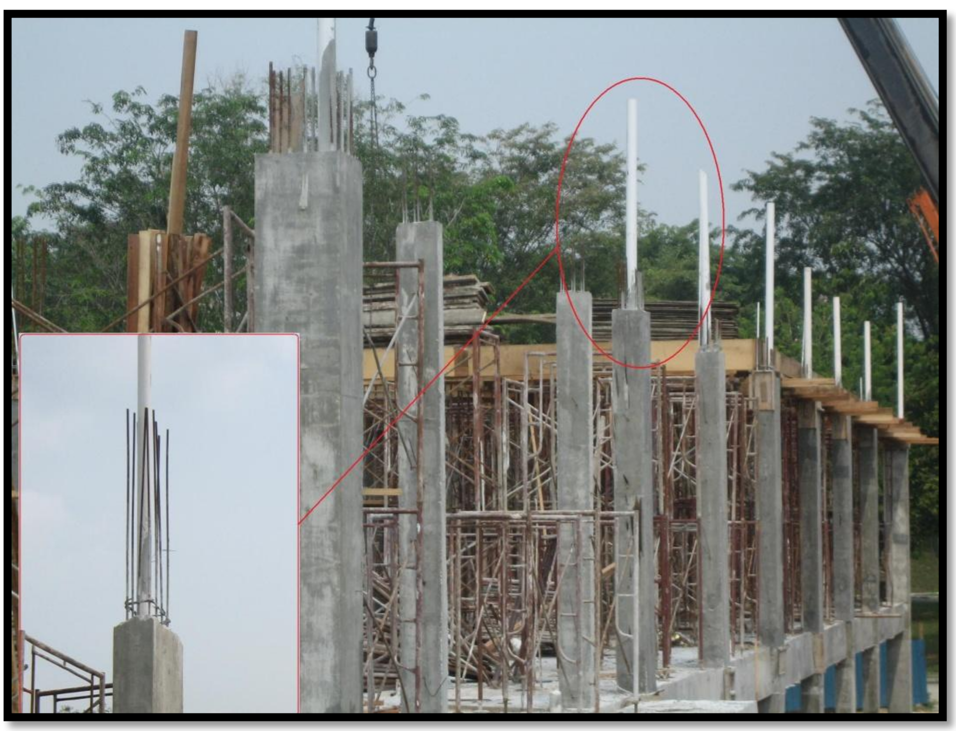

**Figure 1.1: Rain Water Pipe Is Positioned Inside Columns**

A thorough literature survey on these types of columns indicates that, no significant investigations have been carried out to study the actual reduction in load carrying capacity of these types of columns. Most of the previous works in this regard have been limited to the studies of the effect of constant axial load and eccentric load on the behavior of rectangular and circular hollow reinforced concrete columns. [2-6]

From previous study is investigated that, column constructed with embedded PVC drain pipes, not only have reduced load carrying capacities also could be very dangerous to the safety of the entire building structure and could reduce its useful life as well. Some of the problems caused by the practice of embedding drain pipes inside the columns are:

i. Compressive strength of the column is reduced, because placing a pipe inside the column, decreases it effective cross-sectional area.
ii. Reduction of cross-sectional area of the column will also affect its shear capacity.
iii. There is a chance of formation of honeycombs around the drain pipe.
iv. Leakage from the joint lapping part of the pipe can cause corrosion of reinforcement.
v. Load carrying capacity of the columns is further reduced, if the pipe is not positioned vertically and centrally.
vi. Significant loss in the strength of the columns at ground level, where elbow part is used to discharge rainwater.

In present study an experimental research has been carried out to investigate the load carrying capacity of rectangular and square reinforced concrete short columns (models) having PVC or steel drain pipes positioned inside them. The hysteric performance of the columns is evaluated using various cross-sections with different amount of reinforcement. Figure 1.2 shows a typical column with pipe positioned at the center of column cross-section. The cross section dimensions of the column are represented by *h* and *b*, where its height is *l*.

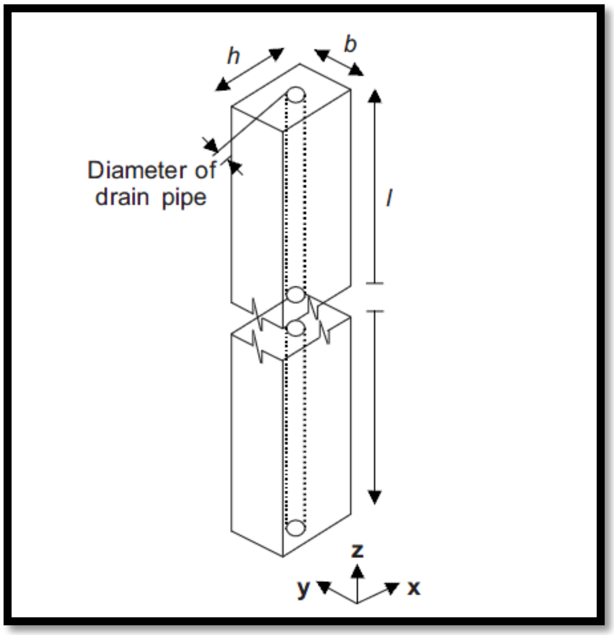


**Figure 1.2: Typical Columns with Embedded Pipe**

## 1.2 Problem Statement

The practice of positioning Poly Vinyl Chloride (PVC) pipes inside reinforced concrete (RC) columns to drain the rain water common nowadays However, this method of drainage could cause serious damage to the safety of the structure.

To the best of the knowledge of the authors, no significant investigations have been carried out to study the load carrying capacity of these types of columns. Most of the previous works in this regard have been limited to the studies of the effects of constant axial load and eccentric load on the behavior of rectangular and circular hollow reinforced concrete columns.

The major parameter will be focused in this study to investigate the load carrying capacity of rectangular and square reinforced concrete short columns (models) having PVC or steel pipes as a replacement for PVC pipe.

## 1.3 Objective of Study

The objective of this study is to investigate load carrying capacity of rectangular and square reinforced concrete short braced column having pipe inside them. Objectives of study are:

i. To investigate the load carrying capacity of rectangular and square reinforced concrete short columns (models) having PVC or steel pipes with different diameter inside them.
ii. To investigate load carrying capacity of column with various Steel pipe diameters as the replacement of PVC pipe.
iii. To compare the experimental result with the recommended design strengths of the codes of practice (BS8110-97 and ACI318-05).

## 1.4 Scope of the Study

It is impossible to study every parameter that will influence the behavior of columns with embedded pipe in experimental study. Therefore, this study focuses on the rectangular and square short braced axially loaded column with embedded pipe which have 1.5 hour fire resistance. The scope of work includes:

i. Review of the design assessment and construction of braced short columns based on the codes of practice of BS8110 (British) and ACI-318 (American).
ii. Casting of the half scale short columns as the control model with different cross-section areas and steel contents.
iii. Casting the half scale short columns with embedded PVC pipes.
iv. Constructing of the half scale short columns with embedded steel pipes.
v. Models instrumentation and alignment.
vi. Testing of the models under axial compressive load and analyzing the results.
vii. Comparison of the load carrying capacity of the models with the design strengths calculated based on the equations provided by the codes of practice.

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