BEHAVIOUR OF CONFINED HIGH STRENGTH CONCRETE COLUMN SUBJECTED TO CONCENTRIC AND ECCENTRIC LOADS

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To my beloved mother and father

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ABSTRACT

In common practice, columns are subjected to a combination of an axial load and a bending moment in different direction. The only axially loaded columns are rarely occurred. However, most of the studies have concentrated on column which subjected to concentric load rather than eccentric load. In this study, the behaviour of confined high strength concrete columns under concentric and eccentric compression load was investigated. Twenty four high strength concrete short column specimens which internally reinforced with steel were cast in rectangular (140x140 mm) shape with 600 mm in height. The design of concretes compressive strength was 60 MPa. The specimens was categorised into three groups, which are control column, two layer metal straps columns and four layer metal straps columns. From each of the categories, the columns were tested with 25 mm and 50 mm eccentric load. The strength and the ductility of column are increased by external confinement. For concentric loaded column with two layers and four layers metal strap, the ultimate strength has increased 21% and 31%, respectively. Meanwhile, for the columns with eccentricity 25 mm that confined with two layers and four layers metal strap, the ultimate strength has increased with 17% and 21%, respectively.

ABSTRAK

Umumnya tiang adalah anggota struktur yang menanggung gabungan beban paksi dan momen lentur dalam arah yang berbeza. Tiang yang hanya menanggung beban paksi sahaja adalah jarang berlaku. Walau bagaimanapun, kebanyakan kajian hanya menumpukan pada tiang yang tertakluk kepada beban mampatan paksi sepusat dan bukannya beban sipi. Dalam kajian ini, sifat tiang konkrit kekuatan tinggi yang dikenakan beban mampatan paksi sepusat dan beban sipi telah diuji. Dua puluh empat tiang kekuatan konkrit tinggi bertetulang keluli berkeratan rentas segi empat tepat (140x140 mm) dan 600 mm tinggi telah disediakan. Konkrit kekuatan mampatan rekabentuk 60 MPa digunakan. Spesimen-spesimen telah dikategorikan kepada tiga kumpulan iaitu, tiang kawalan, tiang yang dililit dengan two lapisan jalur besi dan tiang yang dililit dengan empat lapisan jalur besi. Daripada setiap kategori, tiang-tiang tersebut telah diuji dengan beban pada kesipian 25 mm dan 50 mm. Kekuatan dan kemuluran tiang telah dipertingkatkan dengan menggunakan kurungan sisi luaran. Untuk tiang yang dikenakan beban paksi sepusat yang dililit dengan dua lapisan dan empat lapisan jalur besi, kekuatan muktamad tiang telah meningkat masing-masing sebanyak 21% dan 31%. Sementara itu, bagi tiang yang menanggung beban sipi 25 mm, dililit dengan dua lapisan dan empat lapisan jalur besi, kekuatan muktamad telah meningkat masing-masing sebanyak 17% dan 21%.

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CHAPTER 1

INTRODUCTION

1.1 Background of study

Recently, high strength concrete (HSC) has gained its popularity due to its greater compressive strength compared to normal strength concrete. With the development of concrete technology, the application of high strength members has showed its advantages in terms of high strength, economy, and durability (Helland, 1995).

A common application of high strength concrete was found in columns which were subjected to large compressive forces. The use of high strength concrete allows a significant reduction in column sizes which would increases the floor area, leading to economic advantages. Nowadays the costs of rehabilitaion and replacing the constructions are very high and there is need in reducing the cost through new technology of high strength concrete.

However, there are some drawback from high strength concrete column application. The ultimate compressive strength of the column increased as the concrete strength increased, while reduce its ductility relatively. Besides, due to the brittleness of high strength concrete element, some engineers are hesitating to apply the high strength concrete in their design. The collapse of the high strength concrete member was also identified as more explosive and unpredictable compares to the

normal strength concrete (Hadi and Li, 2003). Nevertheless those problems can be solved by increasing the ductility of the concrete member.

In past decades, external reinforcement has been focused as one of the confinement method which was proven by previous studies as an effective method to enhance the structural properties of HSC (Hadi and Li, 2003; Foster and Attard, 2001). Most importantly reduced the effect of its brittle behaviour and allowing the column to attain maximum load carrying capacity. These higher strengths are achieved as a result of the lateral pressures, which applied by the external reinforcement to the extreme fibres of the concrete column. The confinement prevents the lateral expansion of the specimen under axial load, improving the column's stiffness. As a result, the high strength concrete column is able to carry higher loads than if it were unreinforced (Hadi and Li, 2003).

In practice, concrete column loaded by concentric load are rarely occur. Even the column only carry axial load, the bending effect always exist. This may due to the unintentional load eccentricities or error in construction. The stress concentrations caused by the eccentric loading further reduce the strength and ductility of high strength concrete. Therefore the studies of concrete column subjected to eccentric load are essential for practical application.

1.2 Problem statement

The increase in brittleness with the increase of strength of concrete is one of the major concern in using the high strength concrete (Mansur et al., 1999). In recent years, external reinforcement has been focused as one of the effective method of confinement which has been proved by previous studies to enhance the structural properties of high strength concrete (Li and Hadi, 2003). Among the various types of external reinforcements, it was found that metal strapping method requires lower cost and easier handling/preparation, which do not required specific skilled labour. Therefore, the studies of high strength concrete column with metal-straps

confinement could be essential for future practical use and definitely would contribute to the enhancement of composite material knowledge.

1.3 Research significance

In practice, concrete column loaded by concentric load are rarely occur. Thus, the performance of high strength concrete column under eccentric load is the key concern in this research. This paper describes a new method to increase the deformability of eccentric loaded high strength concrete column. Besides, the behavior of high strength concrete column with external lateral confinement was defined clearly before it can be used in construction.

1.4 Scope of study

This study focuses on the compressive strength and ductility of short column (HSC) under concentric and eccentric load. The investigated parameters are confinement volumetric ratio and eccentricity magnitude of the applied load.

1.5 Objectives

The objectives of this study are as follows:

I. To obtain the relationship of high strength concrete column deformability with volumetric ratio of confinement subjected to concentric and eccentric loads.
II. To study the effect of eccentricity magnitude of the column towards the load capacity and deformation
III. To compare the experimental results with the results of previous studies.

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