CHAPTER 1

INTRODUCTION

1.1 General

The constructions of high-rise buildings are becoming more prominent nowadays due to the scarcity of land, increasing demand for business and residential space and desire for aesthetics in urban settings. Since the beams at the lower part of the tall buildings will carry huge load compared to the beam of the normal buildings. So, deep beams are useful to solve the massive loading issue at the beams of the lower part of the high rise buildings (Chin & Doh, 2015)

The deep beam having a depth comparable to its span and is a type of non-flexural member. Strut and tie model (STM) is used to design the deep beam which based on the truss analogy. The tension members in a truss are tie which subjected to tension; struts are the members which being compressed, while the intersection between strut and tie is node. According the ACI 318, deep beam is defined that member with the clear span equal to or less than 4 times the overall member depth. A simply supported beam will be considered as a deep beam when the ratio of its effective span to its depth is less than 2. However, a continuous beam is classified as a deep beam if the ratio of the effective span to its overall depth is less than 2.5.

The main function of the deep beam is performed massive load transfer from the top to the bottom of the building. The role of deep beam becomes more significant especially for the high rise buildings with carpark or basement because it able to transfer the load and provide more space by replacing the columns used. Other than that, replacement of columns by deep beams can achieve aesthetical values (Nishitha et al., 2015) without compromising the load bearing transfer of the structure.

In the construction of modern buildings, all the vessels, pipes, and passageway access for the services such as water supply, sewage, air-conditioning and electricity are needed to be considered before the construction is started. While the huge size of the deep beam will become an obstruction for the installation of these utilities. So, penetration of beam had to be done by providing a transverse opening at the deep beam.

1.2 Problem Statement

Previously, the used of the deep beams are normal in large scale structure, for instance, high rise building, foundation and offshore structure to support massive loadings. Meanwhile, the installation of beam's opening is necessary for accessibility purposes and to make a conduit for the ventilation system, network system and utility pipes. Usually, these vessels are installed underneath the beam soffit, passed through the transverse openings and covered by suspended ceiling to improve the architectural effect. However, the opening in the beam will bring negative effects to the beam behaviour such as to the strength of the beam. This will also lead to excessive cracking and deflection (Chin & Doh, 2015). This is because the opening will interrupt the load transfer and reduce the strength and serviceability (Chin et al., 2014).

Therefore, the analysis of the RC deep beam with opening at various location and different reinforcement arrangement had to be studied. So, the optimum opening's location and reinforcement arrangement can be determined to avoid structural failure.

1.3 Objective

The main objectives of this study are:

i. To study the effect of different location of the opening and reinforcement arrangement to the deep beam‘s failure load.

ii. To study the effect of the different location of opening and reinforcement arrangement to the deep beam‘s crack pattern.

1.4 Scope of Study

In the study, the dimensions of the deep beams were 1000mm, 550mm and 250mm. There was a total of 16 models were analysed in the study. The models of concrete deep beams were chosen and modified from the previous study by the (Campione & Minafò, 2012). The effective span length, l_e and shear span, s was constant, respectively at 600mm and 150mm. While the shear span to depth ratio was s/H = 0.27.

Only 12 models have a circular opening with 100mm diameter but model DB1 is a solid beam and model DB5, DB6, and DB7 are solid reinforced deep beam. There are 3 different locations of the opening are introduced to the 12 model of beam respectively. The models DB2, DB8, DB9, and DB10 have a mid-span opening. The interception of stress zone in between the loading and the fix supports to the opening was designed to the model DB3, DB11, DB12, and DB13 only by produced the opening in the centre of the shear span. While the models DB4, DB14, DB15 and DB15 have a circular opening located outside mid-span and shear zone.

All the models are reinforced expect models DB1, DB2, DB3 and DB4. The models DB5, DB8, DB11 and DB14 are designed with two main reinforcement of 18mm diameter (Top and Bottom), and horizontal and vertical stirrups of 8mm diameter. They are same designs of reinforcement for models DB6, DB9, DB12 and Db15 but without vertical stirrups. Lastly, the reinforcement of models DB7, DB10, DB13 and DB16 are designed with two main reinforcement of 18mm diameter (Top and Bottom), and vertical stirrups of 8mm diameter. The detail of all the models studied as shown in Figure 1.1, Figure 1.2 (Typical model details; mm) and the Table 1.1.

This study was investigated by using the software of CIVILFEM with ANSYS 12.0. The flexural behaviour was studied by conducting four points test. The loading was put on the shear spans and the steel plates were designed at end of the shear spans. In term of the boundary condition of all the deep beams, the displacement of the deep beams was set to zero and perpendicular to the plan. The properties of concrete and the reinforcements bars used for all the models of this study as shown in Table 1.2.