CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

The installation of the building services is needed in every building and these services play an important role for the structures so that the system can be maintained from time to time. In order to ease the installation of the services, concrete beam with opening is provided so that the services such as conduits, PVC pipes and other more, can pass through easily. These concrete beams usually will be used for high-rise building, where the pipe will be having difficult on installation, so concrete beam with opening will be able to ease the installation. It also helps to ease the maintenance of the building service as there will be avoid drilling through the hole of the beam in order to fix the water pipe that passes through the concrete beam.

However, concrete beam with opening will be experiencing reduction of the shear strength. Mansur (1998) suggested that the strengthening method of the opening was by reinforcing with the diagonal bar which also known as web reinforcement. Amiri and Reza (2011) conducted the opening effect on behavior of concrete beams without additional reinforcement in opening with the opening of circular and square shape, while Saksena (2013) simulated the effect of the circular opening on the behavior of concrete beam without additional reinforcement in opening region. As well as, Majeed (2011) had conducted experimental and numerical study of the effects of creating openings in existing RC beams and strengthening with CFRP. Chin (2013) also simulated reinforced concrete beams with openings by strengthening with CFRP laminates. In this study, it aimed to
conduct simulation on the behavior of the reinforced concrete with opening by using ANSYS 12 computer program to check out the strength of the beam with and without the CFRP laminates in 3 dimensional.

1.2 PROBLEM STATEMENT

Based on the literature that had been conducted regarding the behavior of RC with openings, there were still many issues that can be discussed. RC beam with opening will be experiencing the reduction of strength. This mainly due to the square opening, the sharp edges of the opening undergoes more stress. It also reduced the stiffness of the opening due to the decrease in volume of RC beam. The shear cracks tend to form around the region of the openings and allowable deflection of RC beam decreases. Thus, strengthened method was required to provide in order to regain the strength of the RC beam with openings.

1.3 OBJECTIVE

The main objective of this research is to understand the behavior of the reinforced concrete beam with opening via ANSYS 12: The sub-objectives are as follows:

- To determine the behavior of RC beams with opening on un-strengthened and strengthened CFRP laminates in term of load-deflection, crack pattern, stress and strain distribution and failure mode.
- To determine the effects of square opening and location at 0d, 0.5d and d from the support
- To study the effective strengthening configuration of CFRP laminates in RC beams with openings
- To compare the result obtained in three dimensional with the experimental results from the literature.
1.4 **SCOPE OF WORK**

The scope of the research was to simulate simply supported reinforced concrete beam in three dimensional with square openings loaded with four point bending by using ANSYS 12 software. The beam was tested to failure under four-point loading so that the result will be able to obtain. Through software, load-deflection curve, stress, strain and the crack pattern was able to obtain. The test perimeter of the research was analyzed by using the cross sectional of 120 mm x 300 mm and length of 2000 mm for all beams. Furthermore, the effective length for the beams was 1800 mm and the effective depth will be at 280 mm. As for the reinforcement steel bar, it will be installed with 2H10 at top and 2H12 at bottom for all seven beams. The shear link will be using H6 with 300 mm center to center. The opening will be identical dimension of 210 mm x 210 mm square shape for other six concrete beams and there is one control beam which is without any opening. The location of the opening will be 140 mm, 280 mm and 420 mm from the support. Each location of opening will be tested with and without CFRP laminates. While, the compressive strength of the concrete was 35 MPa with the Poisson ratio of 0.2 and young modulus, E is $3 \times 10^9$.

1.5 **SIGNIFICANT OF RESEARCH**

This research can be provided with an understanding on the behavior of RC beam with openings and the strengthening method on RC beam with openings was determined. Through this research, M&E engineers will be able to know the installation through the concrete beam avoiding the critical location for the beam when opening is required. Since ANSYS is promising software on modeling the concrete beam with opening. It also enable to strengthen the RC beam with CFRP laminates during analysis in ANSYS. The geometrical model on CFRP configuration was able to done easily through ANSYS. At the same time, engineer able to make reasonable decision at the same time shorten the procedure to test out the detailed analysis of beam with opening and strengthen method.