CHAPTER 1

INTRODUCTION

1.1 General

High rise building is commonly known as ‘tall building’ which mean it has multi-story that need the used of elevator to reach at the particular level of the building. In Malaysia, the rapid economic growth that results in the increasing demand for business and residential areas has limited land to accommodate the huge number of citizens. Therefore, this has creating a new challenge for the engineers to search for numerous ways to produce a safe ‘tall building’.

Application of steel frame in the construction of high rise building is an effective way to achieve structural stability. Steel frame is a construction technique from the combination of steel columns and I-beams. The combinations of the two elements form a rectangular grid which gives support to the floors, roof and walls of the high rise building. Normally, the type of steel used is mild steel that is very strong and thus make the steel frame has a lot benefits to the high rise building. Steel frame has high flexibility such that it is able to bend without crack. Thus, it is good in resist dynamic force. Besides, steel exhibits characteristics which are plasticity and ductility or other means it will not crack suddenly when huge force is applied on it. In addition, steel frame has faster time of erection as it can be built fast during construction. Therefore, the time and cost for a particular construction project can be reduced.

The movement of air in the atmosphere is more commonly known as wind. The motion of air for wind is in horizontal and it gives weights or loads upon the high rise building. Air flows from high to low pressure, thus wind speed is increasing with the height of a building. Therefore, it is more dangerous to resist high wind speed for tall, long span and slender structures.
For a high rise building that carry lateral loads from wind, braced frame is used to resist the wind loads. It is very often to apply brace frame in high rise construction as it is simple and economical in construction. It is found that brace frame is able to reduce horizontal displacement or other mean to reduce the lateral drift of high rise building effectively as it resists torsion act on a building. There are various types of bracing such as X-bracing, K-bracing, V-bracing, diagonal bracing and so on. However, X-bracing was used throughout the research. X-bracing or well-known as cross-bracing applies two diagonal steel which crossing each other. X-bracing not only can be applied in one bay but multiple bays. Thus, there are various arrangements and positions can be applied to locate the bracing at high rise building in order to achieve high lateral stiffness, this increasing the stability of building.

1.2 Problem Statement

Wind has caused to structural failures in the past 150 years and most of the building failures caused by wind happened while the erection of steel frame (McCormac & Csernak, 2012). One of the great examples can be considered is the Union Carbide Building in Toronto, Canada (1958). The structure mentioned collapsed because of the steel frame of the building swayed due to wind speed that reached 90km/h at about 6.20pm (Bradburn, 2011). It was found out that the bracing provided was no longer enough to give support against the high speed of the winds (Bradburn, 2011). From all those information, it is important to realise that wind loading and bracing are important factors to consider when designing a high rise building. There are a lot of studies have been carried out over the years regarding to the issues of lateral drift on high rise structure. Design of high rise structure that subjected to wind loading is a difficult task that face by engineers today as the wind speed varies from time to time. In addition, the layouts of bracing need to be studied well so that optimal bracing layout can be applied to the high rise building. Building is about to face severe damages such as broken glass and local component failures if too much lateral drift imposes by wind load (Zhang et al., 2014). Thus, it is very important to choose and locate the bracing type correctly in a steel frame structure for different storeys of high rise building to resist wind load successfully. However, time consume is long if the analysis is carried out by experimented method. In order to shorten the time of experiment, ANSYS software is used as the analysis tool which can also give accurate results.
1.3 Objectives

The objectives of this research are stated as follow:

i. To determine the effect of varying the position of x-bracing to the drift index.

ii. To determine the effect of different storey steel frame building to the lateral drift.

iii. To determine the effect of joint connection which is pin connection only, and the combination of pin and fixed connection to the drift index.

1.4 Scope of Study

The scope of study for this research was to run the analysis for high rise steel frame with different x-bracing locations and arrangements for 28-storey by utilization of Eurocode 3, ANSYS 12.0. There were a few arrangements involved in this study which were centre bay bracing with single, double and triple floor bracing, pattern bracing and exterior bracing. After that, the optimum layout of bracing was chosen then applied to 24, 20 and 16-storey building to observe and study the lateral drift through simulation. It was followed by changing pin connection from optimum location and arrangement of bracing for 28-storey to the pin-moment connection in order to observe which type of connection provides the best stability to the high rise building. The plan of the building was shown in Figure 1.1, the information need for the modelling of steel frame was shown in Figure 1.2, and the layouts of x-bracing for 28-storey high rise building was illustrated in Figure 1.3, 1.4, 1.5 and 1.6.

X-bracing was the most common bracing used in steel frame construction due to it was good in compression and tension. In order to obtain comparable results of lateral drift, the size of column for each storey for every type of high rise building was decided such that bottom half of total storey for the structure used the same size of column (UC 356x406x634mm), then top half of total storey for the storey was divided by two again so that divided bottom part used the same size of column (UC 356x406x467mm) and top part used column size which was UC 356x406x393mm. Besides, the layouts for the bracing was also decided such that centre bay bracing with single floor bracing at top,