CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Concrete is a non-homogenous solid matrix of materials that is the most widely used man made material on the earth (Lamborg, 2001). In its simplest form, concrete is made up of four basic components which is cement, water, fine aggregate and coarse aggregate, whereas the density of normal weight concrete is approximately 25 kN/m\(^3\) (2500 kg/m\(^3\)). A hydration reaction between cement and water creates a hardening paste that binds the aggregates with strength of the resulting concrete found to be predominantly governed by its water-to-cement ratio. Using a small water-to-cement ratio, reinforced concrete with high compressive strength of 100MPa can be produced for commercial use (ACI Committee 363, 2006).

Although concrete can develop high compressive strengths, plain concrete is unsuitable for structural applications due to a low tensile capacity, in the order of 10 per cent of its compressive strength. In order to enhance the tensile capacity of plain concrete, steel reinforcing bars are then introduced to form a composite system, called reinforced concrete, where the tensile forces are resisted by steel and the compressive forces are resisted by concrete. Concrete and steel acting in tandem and it's becomes an excellent construction material with many advantages over other structural media (ACI Committee 213, 2006).

Since, the reinforced concrete is able to resist compression force and tension force at the same time, therefore reinforced concrete is used to construct various type of structural member such as beam, column, slab, wall, and foundation. Reinforced
Concrete beam are important element that used as horizontal members transferring the load from the floor slab above them to the vertical members below them.

The most common reinforced concrete beams come in the form of solid rectangular shapes and the beams can be classified as narrow beam or wide beam according to their geometry of cross-section as shown in Figure 1.1. A reinforced concrete beam is classified as narrow beam when its width, $b_w$ to height, $h$ ratio smaller than 2.0 and while classified as wide beam when its width, $b_w$ to height, $h$ ratio equal or larger than 2.0. There are some benefits in using wide reinforced concrete beams within the construction industry. One of the benefit of wide reinforced concrete beam is it can be act transition beam between substructure and super structure which could transfer large amount of load to column. Therefore, the selection of the geometries of beam is constrained by both structural and architectural requirements. (Alluqmani, A.E & Haldane, 2011)

![Figure 1.1: Classified of reinforced concrete members according to their geometry.](image)

Source: (Alluqmani, A.E & Haldane, 2011)

The cross-section shape of the reinforced concrete beam, which shows the main tensile reinforcing bar, and shear reinforcement bar can have an effect on the beam design for flexure and shear capacity (Grant, 2003). In rectangular slender beams, either shallow and deep beams, or narrow and wide beams, the shear and ultimate flexure stresses increase when the member width, $b_w$ to effective depth, $d$ ratio increases. In
addition any increase in beam width, \( b_w \) has the effect of increasing both the flexure and shear strengths of beams (Alluqmani, 2010).

Reinforced concrete beam is a flexural member designed within the ultimate limit state which allowing the beam for a certain local damage to occur, by assuming steel bars carry all the tensile forces. The limit of damages in a cross-sectional design process is governed by the ultimate compressive strain of concrete. This will avoid crushing of reinforced concrete when yielding of reinforcement bars occurs. The occurrence of deflection in reinforced concrete beam is a rather expected phenomenon for fairly high loads. However in cases where no pre-stressing is applied, the deflection is estimated to form even for a small portion of the ultimate load.

Deflection in concrete is accompanied by overall stiffness reduction, cracking, lack of homogeneity of the cross-section, and it is also aesthetically undesired. Furthermore, large deflection will cause cracking and contribute to the permeability of structural member increase, which under severe environmental conditions could enhance corrosion of reinforcement, spalling of the concrete cover and local bond deterioration at the interface between the constitutive materials.

Therefore, in recent years, there have been significant improvements were made in properties of concrete and modification of reinforcement. In comparing both categories of improvements, reinforcement modification dominates in the strengthening process of reinforced concrete beam to minimize the deflection when it reaches the ultimate limit state.

1.2 BACKGROUND OF STUDY

For several decades, the strengthening and rehabilitation of reinforced concrete structures are becoming increasingly important in construction. Especially, the horizontal member, reinforced concrete beam requires a high level of attention where it is undergoes major deflection which leads to cracking when reach its ultimate limit state. This is due to its low flexural capacity which influence by the steel reinforcement in tension zone.