CHAPTER 1

INTRODUCTION

1.1 Research Background

Concrete is an artificial stone-like material which is composed of a mixture of cement and various aggregates such as sand, gravels and stone chips with water. Concrete is an economical material and has been widely used in the construction field for its low maintenance requirement and capability of being moulded. Despite the fact that concrete has good performance in compressive strength, its tensile strength is relatively low with brittle characteristic when comparing with other building materials. Therefore, concrete need to be reinforced by other materials so that the concrete structure is able to withstand tensile forces.

Meanwhile, the application of fiber has been extensively used to improve the characteristic of construction materials. The fiber is made from either natural material or a manufactured product such as glass, steel, carbon and polymer and can be applied to concrete in the form of bars, plates, and sheets. Fiber reinforced polymeric (FRP) is one of the highly recommendable and potential reinforcement materials in construction. FRP greatly enhances ductility, toughness, tensile, and flexural strength of concrete, as well as the capability of energy absorption for structural components (Sen & Paul 2015). It can be considered as an ideal material for strengthening applications due to its high specific tensile strength and higher strength-to-weight ratio compared to the steel. In the present research, the result was shown that FRP is good in fatigue and corrosion resistance, and also high strength in the required direction (Sen & Jagannatha Reddy 2013a). Nowadays, researchers are more concerned about the application of natural fibers in the construction field due to the sustainability issues. For instance, jute, kenaf, sisal, coil and bamboo are the main natural fibers which used as the reinforced composite.

Among the natural fibers, jute fiber is one of the longest natural fiber that has high specific properties, low density, and good in mechanical strength and dimensional stability. Jute fiber in textile form is the most commonly used in plant mulching and rural road pavement construction (Aggarwal & Sharma 2011). The biodegradable property of jute fiber allows the jute products to be widely used to provide the nutrition to the soil after merging with the soil. The maximum tensile, impact and flexural strength for jute-epoxy and jute-polyester composites are 104.0 MN/m^2 and 22.0 kJ/m^2 respectively. Hence, jute fiber composite can be used as a substitute of timber, metal or masonry by moulding it into a sheet, boards, pallets and other from of shape (Mukherjee 2013). However, structural applications utilizing of jute fiber are rare due to the inapplicability of the existing production techniques. Additionally, a good theoretical knowledge and design guidelines are important to ensure jute fiber reinforced polymer composite (JFRP) are safe and cost effective.

In this study, jute fibre was considered and fabricated in the form of the mat, replacing the reinforcement bar (in the tension zone) to increase the strength and ductility of the concrete beam. Physical properties test on the fiber were conducted to evaluate the strength of the fiber in the form of mat. Structural behavior of the concrete beams was then evaluated in terms of load-deflection behavior and crack pattern of the beams.

1.2 Problem Statement

Concrete, unlike steel, is a heterogeneous material which is weak in both tension and compression. Hence, cracking and failure are easy to occur when the tensile stress is applied to the concrete structure. To address this issue, steel bars are the common material used to increase the tensile strength of a concrete structure. However, the steel bar is prone to corrosion and cutting waste of the steel bar will bring negative impact to the environment. In order to solve this problem, many types of researches have been conducted on the application of fiber reinforced polymer (FRP) composites to reinforce the concrete structure.

Natural fiber using jute fiber was suitable to replace the steel bar in reinforcing the concrete structure due to its mechanical properties and the concept of sustainable building material. To date, most of the FRP researches are focusing on the FRP in the

form of sheet or plate while the study of FRP in the form of the mat is very limit. By using jute fiber mat (JFM) as the reinforcement, it can reduce the environmental impact and promote the conservation of non-renewable resources.

1.3 Research Objective

The objectives of this study are as follows:

(i) To determine the mechanical properties of jute fiber mat through tensile test and flexural test

(ii) To obtain the optimum fiber volume ratio

(iii) To determine the behaviour of the concrete beam that reinforced by the jute fiber mat (JFM) in term of the load-deflection curve and cracks pattern under three-point loading test.

1.4 Research Scope

This research was focused on the behaviour of the concrete beams reinforced by jute fiber mat. A total of six concrete beams with the dimension of 100 mm x 100 mm and length of 500 mm was deployed to investigate the influence of jute fiber mat to the flexural strength of the concrete beam. A three-point load test was conducted to analyse the performance of the beam and to determine the strengthen effect of the jute fiber mat. The ultimate load and failure patterns of the concrete beam specimens were reported.

Jute fiber was treated with 5% (w/v) sodium hydroxide, NaOH to increase the interfacial bonding effect between the fiber and epoxy. After the alkaline treatment, the single fiber tensile test was then be conducted with the standard, ASTM C1557 to evaluate the tensile strength and Young's modulus of the jute fiber. Jute fiber was coated with the epoxy and hardener, and then woven into mat form of 20 mm spacing. The mixing was carried out in a ratio of 2 parts of Epoxy DER 331 and 1 part of jointmine hardener. Lastly, the optimum volume ratio of fiber to epoxy was determined from the test result of the fiber mat tensile test and flexural test.