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MODES OF FAILURE AND MICROSCOPIC FAILURES OF BETONG BAMBOO STRIPS LOADED IN SHEAR, BENDING, TENSION AND COMPRESSION

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ABSTRACT

Bamboo is an important building material and its potential should be fully utilized. Information on failure properties under load is essential for bamboo to be used as structural materials. In this study, the classification of failure modes, differences of strength properties between failure modes and microscopic failures of Betong bamboo strips were investigated. Specimens were loaded in shear parallel to grain, bending, tension parallel to grain and compression parallel to grain. Specimens were taken from internodes and node parts in bottom, middle and top portions of bamboo culms. From the classification, different failure modes occurred in different portions and parts. In shear, Mode I (Even Splitting) occurred in internodes of all portions and Mode II (Uneven Splitting) in nodes of all portions. In bending, Mode I (Splintering) and Mode II (Simple Tension) occurred in internodes of bottom and middle portions, Mode III (Compression) in internodes of middle and top portions while Mode IV (Brash Tension) and Mode V (Brittle Shear Tension) in nodes of all portions. In tension, Mode I (Splitting) occurred in internodes of all portions, Mode II (Brittle Splintering) in nodes of all portions and Mode III (Grip Splitting) in internodes of top portion. In compression, Mode I (Middle Crushing) occurred in both internodes and nodes of all portions. Strength properties such as Maximum Stress (σ_{mi}), Stress at Proportional Limit (σ_{pl}) and Modulus of Elasticity (E) values between failure modes for all tests were different. Strength properties of failure modes in the same portion and part were not significantly different. Strength properties of failure modes between different portions were significantly different. Similarly, strength properties between failure modes in different parts for all tests were significantly different. From the microscopic observation, the failures occurred in both parenchyma and vascular bundles regions for all classified failure modes from all tests, except for Mode I (Even Splitting) from shear as well as Mode I (radial splitting only) and Mode III (Grip Splitting) from tension test. These modes exhibited failure in parenchyma only, without any failure in vascular bundles regions. Generally, anatomical behaviour had influenced the different modes of failure and microscopic failures of Betong bamboo strips loaded in shear, bending, tension and compression.

CHAPTER 1

INTRODUCTION

1.1 Introduction

Bamboo is an important raw material and probably the most useful raw material, especially in its modern applications and uses. Its great potential and versatility can be developed to overcome the problems of timber resources, environmental degradation and inadequate raw materials supply.

The importance of bamboo has been acknowledged at the earliest epoch and it has been used traditionally in many tropical countries for housing materials, bridges, baskets, handicraft items, fishing rods, paper making, foods, and other uses (Farrelly, 1984; Wong, 1995a). Bamboos are frequently used in structural applications with lack of understanding of their characteristics. Therefore, improving the understanding of its properties could further develop the uses of bamboo. Today, more researchers are aware of the potential of bamboo in supporting the demand of raw material. Multiple uses of bamboo could be achieved by transforming it into high quality products. At present, many achievements and new findings were obtained successfully through research on bamboo applications (Abd. Latif and Abd. Razak, 2001; Liese, 1990). These findings are very useful in promoting the potentials of bamboo as an alternative raw material, especially in structural applications.

1.2 Justifications

Information on failure and strength behavior of bamboo under extreme mechanical loading conditions is essential for structural material. Information on basic mechanical and strength properties of bamboo was widely documented. However, their strength properties in relation to failure modes are very limited. Relationship between failure modes and strength properties should be studied in order to enhance the confidence of