TISTR

Thailand Institute of Scientific and Technological Research

Environment Ecology and Energy Department

196 Phahonyothin Rd., Chatuchak, Bangkok 10900, Thailand

Composite Construction Material from Fibrous Biomasses

Wirachai Soontornrangson Romanee Wungdheethum Chansa Jirasuwan Satta Wattanatham Pichai Wongharn

Two studies namely, feasibility study for producing energy saving construction materials from fibrous biomass and marketing surveys for acceptant on energy saving construction materials from fibrous biomass of potential buyers, are conducting parallelly. Feasibility study for producing energy saving construction materials from fibrous biomass is focusing on productions of brick/block and wall/ceiling board from fibrous biomass. Certain amount of Portland cement, sand and water with 1.5, 3.0, 4.5, 5.5 and 8.5 percentages of pre-prepared fibers from Vetiver, sisal, Rice straw, and Wood pulp are used to produce energy saving brick or block. Results obtained indicated that brick/block produced with rice straw has the lowest average thermal conductivity following by brick/block made from sisal, Vetiver and Wood pulp respectively. Thermal conductivity of bricks/blocks made from all fibrous biomass was lower than the average thermal conductivity of commercial construction materials. Compressive strength of all bricks/blocks produced in the experiment was lower than the compressive strength of weight loaded and non-weight loaded brick/block given by Thai Industrial Standard Institute (TISI). 0.5:1, 1:1, 1.5:1 and 2:1 weight ratios of gypsum cement to pre-prepared fibers from Vetiver, Rice straw and Wood pulp including certain amount of water were formulas of materials used to produce wall/ceiling board. The average thermal conductivity of wall/ceiling board was similar to those of wall/ceiling boards available in the market. Results obtained from 3-points bending tests showed that bending strength of wall/ceiling boards produced by the study was lower than those of commercial wall/ceiling boards. Marketing surveys for acceptant on energy saving construction material from fibrous biomass of 200 potential buyers via pre-prepared questionnaires were found that 58 % of potential buyers willing to buy such energy saving construction materials and 30% of such potential buyers were attracted by the electrical energy saving potential.

Introduction

Vetiver was introduced and recommended by His Majesty the King Bhumibhol to be used as soil/water conservation plant for Thailand since the early 1990s. Millions of vetiver seedling were produced and distributed to be planted throughout the country's arid areas. The majority of vetiver planted in Thailand were wasted as some may consider as weed or useless grass. However, certain amount of fully grown vetiver leaves were cut and used for making local handicraft e.g. handbag, purse, hat. Despite vetiver is abundant and free its wide spread growing pattern could cause high labor collection and transportation costs. In addition, vetiver's pre-treatment and treatment processes could cause only minor impact to the environment. Thus, it is rated as high potential fibrous biomass to be used for producing composite construction material.

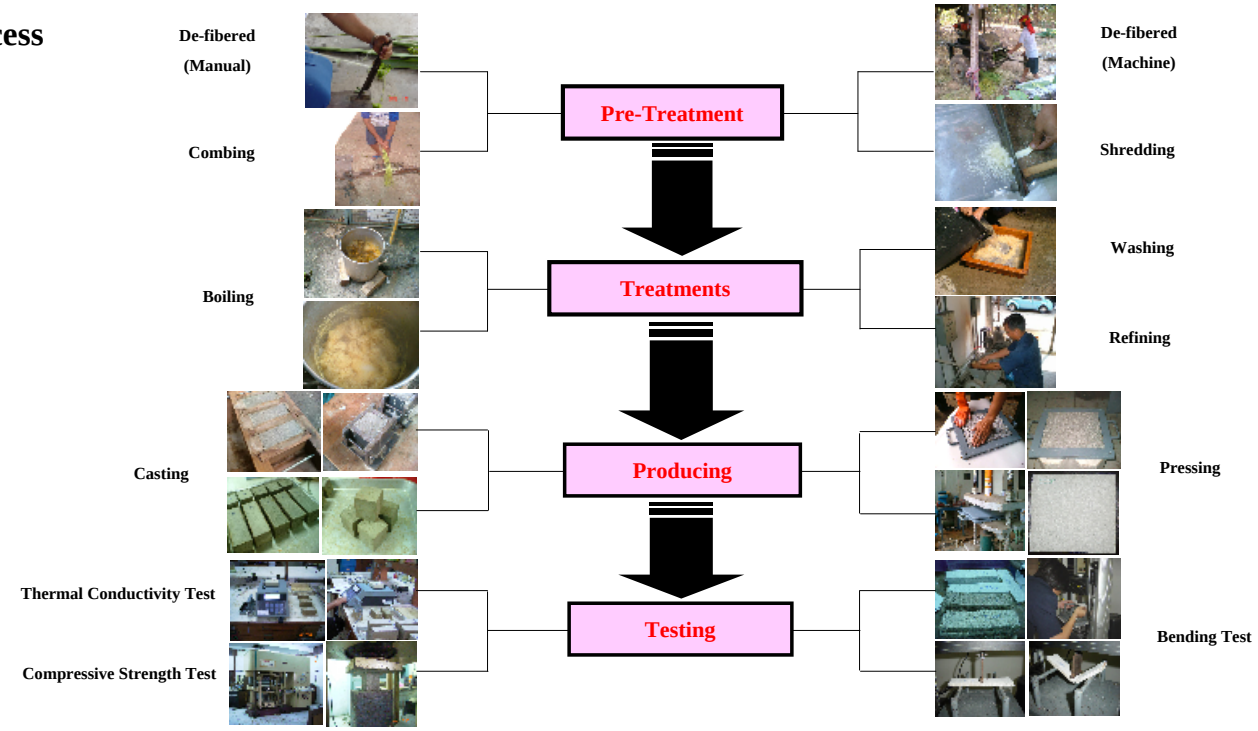
Rice straw was the most recognized agricultural waste in Thailand. Traditionally, rice straw from non-industrial rice farming was matching by the onsite demand for cattle feeding, soil conditioning and and etc. The introduction of industrial rice farming increased yields of rice and rice straw significantly. Consequently, it was estimated that more than 40 million tons of rice straw was left over from the industrial rice farming in Thailand (2000). The industrial rice farming relies on modern machinery/equipment, chemical fertilizer and soil conditioner rather than cattle force, natural fertilizer or soil conditioner, therefore rice straw is exceed the demand for onsite utilizations. In practice, huge numbers of excess rice straw left on the farm land will be incinerated before the next crop growing. Rice straw is abundant and free but bulky that could cause high labor collection and transportation costs. The use of rice straw as material for producing composite construction material required pre-treatment and treatment processes that may cause some impact to the environment, however, such impact would be less significant when compared to impact occurred from the incineration of rice straw left over on the farm land. Rice straw is also rated as high potential fibrous biomass to be used for producing composite construction material.

Kenaf mostly planted in the north eastern part of Thailand and its fiber mostly used for fabricating sack. Kenaf farmings and sack fabricating industries in Thailand tend to be declined due to the booming of plastic sack and cheaper imported kenaf sack from India and Pakistan. In addition, kenaf de-fiber process is accusing for deteriorating natural water resource, therefore it is no longer described and recommended as economy crop for Thailand and kenaf planting areas become less. Despite the decline of kenaf sack industry and small scale farming certain numbers of local kenaf sack industry are still existed. Kenaf is rated as low potential fibrous biomass to be used for producing composite construction material due to its insufficient quantity and non-environment friendly treatment process.

Sisal was brought to Thailand since before the World War II. It was introduced as economy plant for arid areas. Fiber from sisal was used to produce rope and buff. Sisal farming and relevant industry boomed in Thailand during 1970s-1980s but later it was declined due to the introduction of plastic rope and synthetic buff. Although certain numbers of sisal farms were existed the fiber production was limited and used for producing local handicraft (e.g. handbag, purse, hat and etc.) rather than industrial products. Sisal de-fiber process produces a lot of organic waste that could impact the environment. Sisal is rated as low potential fibrous biomass to be used for producing composite construction material due to its insufficient quantity and non-environment friendly treatment process.

Wood pulp was a sludge removed from wastewater treatment plant of a tissue paper company in Thailand. Total amount between 25-30 tons/day have to be removed from the wastewater treatment plant. The tissue paper company spent a lot of money for transporting large amount of sludge to the landfill sight. In fact, such a sludge is a very fine wood pulp fiber bound together by polymer and deposited in the wastewater treatment plant. Such a sludge could be mixed with other material directly without any pre-treatment or treatment required. The recovery and reuse of sludge as material for producing composite construction material conserves both environment and energy. Thus, it is rating as the highest potential fibrous biomass to be used for producing composite construction material due to its abundant quantity and environment friendly property.

Process



Specimens of products

Specimen with vetiver

Specimen with rice straw

Specimen with wood pulp