Study and Development of Process Material Fiber Board from Sugar Cane Leaf in Applied Product Design for Sugar Cane from Agriculturist Thai

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Abstract. This research has objectives as this following: 1) to study the properties and quantities of the leave-buds and the leaves of sugar cane 2) to develop the transformation process of the leave-buds and the leaves of sugar cane as the materials replacing of wood 3) to test the replacing material standard from using the leave-buds and the new transformed leaves of sugar cane 4) To take satisfaction assessment to manufactured process and the transformation steps of the leave-buds and the leaves of sugar cane as the materials replacing of the wood. According to above details, it was found as this following: 1) for the peeling of tissues on the leave-buds and the leaves of sugar cane, it has applied with the caustic soda, water and salt by boiling with fire in 100 Celsius. Similarly, for the leave-buds it can boil with fire for totals 40 minutes while the leave stalks of sugar cane should be boiled for totals 60 minutes. 2) for the sheet forming , it has applied the Isocyanate Resins with 7 percent and tissues from materials replacing of wood with 93 percent by using the sheet of sugar cane replacing of wood with the size of 45 cm X 120 cm as using the hot rolling process in 130 Celsius and pressure for 180 kilograms per square meter. 3) for the test result with Japanese standard of JIS A 5908-1994, it had the specific gravity of 0.74 and the property of moistness quantity with 9.75 percent that have been in the benchmark level and in the modulus of rupture or MOR standard, it had the result with level of 6.53 and in modulus of elasticity or MOE standard, it had the result with level of 327.76 MPa that haven't been in the benchmark level. 4) for the satisfaction assessment of manufactured process and transformation steps of the leave-buds and the leaves of sugar cane, it has showed that the effectiveness of the material process replacing of wood from the leave-buds and the leaves of sugar cane was in average level of 4.14.

Introduction

The fact which Thailand is an agricultural country enriches Thailand with a large number of growth of sugar cane for internal consumption and for export, and thereby causing also a large number of refuses of the kinds of top leftovers and leaves in almost every regions of growing spaces throughout Thailand and there was discarding of sugar cane tops and leaves to waste or burn to destroy to use the space soil for growing sugar cane of next generation burning to destroy the wastes of leftovers of which has caused certain pollution to the world's atmospheres as well as to be in line of the sight of visibility alike which if there is an addition of the value to the materials of refuses from sugar cane farming then in such a case will definitely help farmers to increase an income revenue on one hand, according to the Department of Agriculture's Report being with finding that materials of refuses from sugar cane farming was as much as 53 million tons a year.[1]

As a result of the problems of farmers burning to destroy sugar cane tops and leaves in order to harvest the produces at the period before the new growing season as preparation of growing spaces which affects environmental surrounding and also burning soil spaces severely, as well as degenerating soil minerals causing pollution increasing carbon monoxide world heat or to the extent of causing greenhouse effects causing world's polar ice melting and the most important thing is that affecting insects that help to control and eliminate plant pests to be destroyed causing plague outspread of a variety of plant pests with the results of the research being with findings of problems such as shortage of real wood for building of various wood products and environmental surrounding problems because of burning to destroy farming leftover materials which effects the world's atmosphere directly, and from such mentioned problems were processed as a concept in producing agricultural leftover refuses of farming spaces for application to yield optimum interest without impact on environmental surroundings as well as to make publicity and transfer of the process to the locality or farmers for making promotion, whereby each province in the Northeast should be promoted at the time of general meeting of sugar cane farmers (which normally farmers will burn up sugar cane leaves for convenience of harvesting and for decrease of harvesting labor cost which the effects as a result of the burning including such as rapid soil degeneration, abundance of dead destroyed soil bacteria causing growing sugar cane of next generations being with less productivity, if farmers could use sugar cane tops and leaves to increase value on one hand by the process of independent molding using plastic this is of the opinion that this could be promoted for farmers to adjust their attitude from burning into cutting for harvesting instead.[2]

The Objectives of the Research

2.1 To study the properties and volume of sugar cane tops and leaves in Thailand capable of passing production process as wood replacement material product in place of housing residence and housing fitting out works.

2.2 To develop production process and steps in converting sugar cane tops and leaves as wood replacement material product in place of housing residence and housing fitting out works.

2.3 To test replacement material standard newly developed from sugar cane tops and leaves.

2.4 To assess satisfactory level of production process and steps on conversion of sugar cane tops and leaves as wood replacement material product.

The Scope of the Research

3.1 Research Objective 1 "To study the properties and volume of sugar cane tops and leaves in Thailand capable of passing production process as wood replacement material product in place of housing residence and housing fitting out works"

3.1.1 Population were sugar cane farmers in the area of Nakhon Ratchasima Province.

3.1.2 Sampling groups were sugar cane farmers in the areas of Nakhon Ratchasima Province, Buriram Province, Surin Province and Ubol Ratchathani Provinces total of 12 provinces (specific random sampling groups : farmers with growing space of more than 30 Rais upwards)

3.1.3 Studying of data 1) Primary Data. Its were collected and samplings of leftover scraps remaining in sugar cane farms such as sugar cane tops, leaves from actual locations in various sources for production to study of the properties on various aspects such as physical appearance for consideration of leftover scraps in farming space which are of suitable potentiality for mold compression. 2) Secondary Data. To collect data from the study and collect data from documentary references from various places, sources such as the National Library, various libraries for references on the part of various articles.

3.1.4 Research Instrument was Participatory Observation Questionnaire Form. The Questionnaire Form has the structure using qualitative analysis based on analytical criteria following research framework and percentage analysis.

3.2 Research Objective 2. “To develop production process and steps in converting sugar cane tops and leaves as wood replacement material product in place of housing residence and housing fitting out works”

3.2.1 The population were qualified persons on wood replacement material development in university educational institutions.

3.2.2 The sampling group was group of qualified persons on wood replacement material development in the university level of 3 persons (specific random sampling group)

3.2.3 The research instrument was a Rating Scale Questionnaire Form fixing selection rating scale of 5 levels using the mean and standard deviation values.

3.3 Research Objective 3. “To test replacement material standard newly developed from sugar cane tops and leaves by using the test by comparison with Japan Particle Board Industrial Standard (JIS A 5908 – 1994) for wood replacement material produced from scraps left over from farming use in the North Eastern region.

3.4 Research Objective 4. “To assess satisfactory level of production process and steps on conversion of sugar cane tops and leaves as wood replacement material product”.

3.4.1 The population were provincial farming group of 19 Northeastern Provinces of 19 persons.

3.4.2 The sampling group was provincial farming group of 13 provinces using specific random sampling for representation of population group comprising of provinces of Buriram, Surin, Si Sa Ket, Nakhon Ratchasima, Chaiyaphum, Amnat Charoen, Yasothon, Kalasin, Mahasarakham, Roi-Et, Nongbua Lumphu, Nakhon Phanom, Ubon Ratchathani (specific random sampling group)

3.4.3 The research instrument was a Rating Scale Questionnaire Form fixing selection rating scale of 5 levels using the mean and standard deviation values.

The Result of the Research

4.1 The Result of Research Study Objective No. 1 was with finding that farming groups growing sugar cane in the areas of provinces of Nakhon Ratchasima, Buriram, Surain and Ubon Ratchathani were farmers growing sugar cane for sugar industrial factories each with sugar cane growing space of 13-50 Rais, with growing duration of approximately 10-15 years, growing during April of every years and lasting another 1 year for harvesting, productivity of approximately 15 tons / 1 Rai, with method of harvesting of 1) Removal of sugar cane leaves to remain only the stem and afterwards falling the stems to the ground and cutting off the top the method of harvesting is not complicated but there is a problem of cutting of sugar cane leaves will itch and the second method of 2) burning sugar cane before harvesting instead buying price of harvesting of burning type of which will be cheaper to non-burning harvesting method of Baht 20.- / ton which is considered as the method of harvesting which affects environmental surrounding and causing air and environmental surrounding condition pollution which currently the public office sector has banned permission to burn sugar cane for harvesting.[3]

Fig. 1 North Eastern region sugar cane farming group agriculturists

Annual sugar cane volume during the year 2007 – 2014 was considered as having increased annually due to the expansion of sugar industry and alternative energy by comparison of productivity grosses of the year 2007 of 42,2009,977 tons and the year 2015 of 65,780,210 tons considered as having increased up to 35.84% in the period of 5 years, this is, therefore, the kind of economic plant which has potentiality of extension of growing space greatly and the trend of generation of leftover scraps in the growing space and burning to destroy more. It can be concluded that the utilization of farming leftover scraps of sugar cane the parts of the tops and leaves were the most leftover parts abundantly and are not used leaving to be discarded therefore the growing areas will be with a large number of leftover refuse. It is of the opinion that if making sugar cane tops and leaves to be of value or of the price it would be fine if the developed to be easily produced and not too complicated because the tops and leaves must be left to waste anyhow.

4.2 The Result of Research Study Objective No.2.3 Phases of Wood Replacement Development Process.

4.2.1 Material Membrane Peeling Process was with finding that the raw material external physical appearances were different causing the period for boiling to peel off membrane under the control of temperature control variable of boiling at 100° Celsius i.e. on the part of raw materials having no hard part stalk separated as follows :

- 1) The parts of tops and leaves. Using the size of 1-2 cm.'s mixed with 10 grams of salt and mixed with caustic soda scales of 20 grams boiled in 5 liters of water, boiled for 30 mins. At 100 ° Celsius.
- 2) The hard part of leaf stem. Using the size of 1-2 cm.'s mixed with 10 grams of salt and mixed with caustic soda scales of 20 grams boiled in 5 liters of water, boiled for 50 mins. at 100 ° Celsius.
- 3) The hard and thick parts of the beginning of leaf stem. Using the size of 1-2 cm.'s mixed with 10 grams of salt and mixed with caustic soda scales of 20 grams boiled in 5 liters of water, boiled for 60 mins. at 100° Celsius.

Fig. 2 The Process of Boiling for Peeling off Wood Replacement Membrane Material from Sugar Cane Tops.

4.2.2 Coloring Process of Wood Replacement Material was tested using 2 techniques of

1) Chemical breaching, dyeing. Chemical breaching, dyeing is boiling to eliminate dirt using caustic soda mixing with pure water and salt by separating boiling with raw materials of top parts and main material for 50 minutes, then wash to clean with pure water to wash out chemical corroding the surface or oil out. Afterwards take to dry and after drying when the wool or raw material is dry boil in pure water mixed with salt and desired dyeing color and leave for 5 minutes, take derived material scraps or wood membrane to dye by boiling on fire and leave for approximately 40 minutes, after having observed that dyeing is good and thorough take the dyed agricultural materials scraps to wash with pure water and then dry awaiting for entering compression process.[4]

2) Dyeing with Natural Substance. Dyeing with natural substance is the application of process of breaching and dyeing with such as turmeric, eucalyptus leaves, butterfly pea flower, screw pine leaves, mangosteen shell etc. in the coloring, dyeing process of wood replacement material. This test was therefore made by boiling to eliminate dirt by taking guava and eucalyptus leaves mixed with pure water and salt, put on fire approximately 60-80 minutes. Notice the shells of the materials that an appearance of yellow membrane is seen then take down to clean with pure water and take to dry, after

drying the wool or material proceed to boil with pure water mixed with salt and plant giving natural color (butterfly pea flower, turmeric, okra, screw pine leaves etc.) and peeled off wood membrane, put on fire and leave for approximately 60 minutes. After noticing that dyeing is good and thorough take the dyed material scraps to spread and dry. Afterwards await to enter into compression process next. Based on the testing results of the two methods of general coloring it's found that worthiness or the cost on the production of wood replacement material membrane with chemical was more cost-effective for trade or industrial system more than using natural materials on the complete production process.[5]

Fig. 3 Wood Replacement Membrane Derived from Peeling Off and Color Dyeing Process.

4.2.3 Wood Replacement Membrane Mold Compression. The wood replacement membrane mold compression from wood membrane from the process of method of peeling off sugar cane tops, leaves in this research tested the sheet type molding of membrane scraps deriving from using bonding a varieties of methods taking into consideration production suitability on mass production and not too expensive production cost as well as beauty appearing on wood replacement material sheets with the extent of membrane preparation of 7 kg's with iso-cyanate glue of 7%, smooth sheet of 45 cm x 120 cm and using compression process with thermal compression unit at heat level of 130° Celsius being with finding that there was relatively little contraction and with strength of wood replacement material higher than using other bonding materials very much. Therefore, the result of the test was with the opinion that the production processing using 5% iso-cyanate glue for bonding using pressure and heating to help made the strength the highest capable of taking loading weight at work better and derived color was beautiful and was still tolerable against water seepage moderately.

Fig. 4 Wood Replacement Material Membrane derived from Peeling Off & Coloring, Dyeing

1) Finding Relating Problematic Conditions : Reduction of pollution from farmers burning to destroy leftover scraps from sugar cane growing for sugar industry causing air pollution and also affecting the world's atmospheres in the phenomena of "Black carbon" causing temporary greenhouse effect phenomenon. The reduction of pollution as a result of farmers burning leftover scraps from growing sugar cane for sugar industry causing air pollution and causing the phenomenon of "Black Carbon" affecting temporary greenhouse effect rendering heat transfer from earth out to world's layers of atmospheres during the period of months of January – April every years out-of-question.[6]

2) Processing and Creation of Primary Stage Concept : This was inspired from the nature of sugar cane plant during growing period of breeding through conceptual designing thinking process.

Fig. 5 Creation of First Step of Design Concept

3) Establishing additional required data factors : By the process of mold compression sheets with membrane materials of sugar cane tops and leaves through membrane peeling off and coloring, dyeing of 7 kg.'s with iso-cyanate glue of 7% with spray glue in turning mill for 10 minutes. Afterwards produce membrane which was mixed with glue to form the sheets with plywood block of the size 45 cm x 120 cm of 15 mm. thick, thermal compression at the heat level of 150° Celsius with compression of 35 kg./cm.²

4) Studying and making a collection of data according to established factors : The analysis of the properties of wood replacement material from sugar tops and leaves membrane for bonding of screw nail with average at 0.86 MPa which mixing of Iso-cyanate of 7% is considered with sufficient property for production of furniture parts.

5) Second Stage Processing and Creation of Concept : The stage of brainstorming techniques total of 60 modes afterwards to make selection of suitable modes with design analytical correlation table total of 2 modes and make evaluation by product design by qualified experts of 3 persons on the selection for production of a prototype.

6) Link Concrete to Abstract : Production of prototype of small sized relax chair product by taking the model having passed refining for production of prototype of 2 chairs and then take the prototype for evaluation of effectiveness and satisfaction assessment.

Fig. 6 Furniture Product Prototype for use in the effectiveness test.

7) Conceptual Thinking Assessment : On the part of assessment with pricing comparison from wood replacement production process with separation of pricing from the beginning of the production process until production to the market.

Table 1 Selection of design from Brainstorming Techniques total of 60 modes to remain only 1 mode

No.	Description	Mean	SD.	Meaning
Development Mode No. 1
1.Suitability with Furniture Production Process	3.50	0.55	Moderately Suitable
	2.Beauty and identity indication of Wood Replacement Material	3.33	0.52	Moderately Suitable
	Total	3.41	Moderately Suitable	
	Take compressed wood replacement sheet to apply together with steel structure sheet of 2” size, bend curve by forming and fastened with bolt and nut at the chair structure and wood replacement material newly developed by polishing surface and shining polishing at backrest area			
Development Mode No. 2
1.Suitability with Furniture Production Process	3.50	0.55	Moderately Suitable
	2.Beauty and identity indication of Wood Replacement Material	3.50	0.55	Moderately Suitable
	Total	3.50	Moderately Suitable	
	Take newly developed wood replacement material sheet coupled with chair structure made of round pipe of 1 ½ inch size by bending to make forming prior to fastening with nut and bolt at the area of chair structure and wood replacement sheet newly developed with no surface coating for presentation of surface.			

Table 2 Effectiveness Report on Wood Replacement Material (n=3)

Description of Effectiveness Assessment	Mean	Suitability
1. Production Process Assessment Criteria on Membrane Peeling Of Phase		
Average of total assessment result	4.05	Very Good
2. Production Process Assessment Criteria on Dyeing Coloring Phase		
Average of total assessment result	4.60	Very Good
3. Production Process Assessment Criteria on Taking Wood Replacement Material for Production of Furniture (Sheet) Phase		
Average of total assessment value	3.33	Moderate
Summary of average of total assessment on wood replacement material	4.00	Good

From Table 2, It's found that the first rating assessment was the assessment criteria on the production process on the coloring, dyeing phase/step being the suitability of the most level ($\bar{x}=4.60$) the second rating assessment was the assessment criteria on the production process of peeling off membrane being with suitability of the most level ($\bar{x}=4.05$) The third rating assessment was the assessment criteria on the production processing of production wood replacement material of sugar cane tops and leaves scraps as furniture being with suitability level of moderate ($\bar{x}=3.33$) In summary it's found that the overall effectiveness on the production of wood replacement material made of sugar cane tops and leaves scraps being with suitability on the process of wood replacement process at the good level with the mean at the level of 4.14.[7]

Table 3 Comparison of Costs on the Production of Wood Replacement Materials made from Tops and Leave Scraps New Mode and Old Mode

Production Process	Production Cost Price / Sheet of 120X60 size	
	Wood Replacement Material Made with Production Process Newly Developed	Wood Replacement Material Made with Production Process Previous(Old) Mode
1. Preparation of Raw Materials Step (Wood Replacement Material Membrane)	a. Membrane Peeling Process Baht 90 b. Coloring, Dyeing Process Baht 100 c. Labor Cost Baht 50 d. Raw Material Cost (Paddy Stubbles) Baht 0	a. Membrane Grinding, Digesting Baht 20 b. Raw Material Cost Baht 55
2. Thermal Compression Step (Iso-cyanate Glue)	a. Bonding Glue Cost Baht 120 b. Labor Cost Baht 10	a. Bonding Glue Cost Baht 120 b. Labor Cost Baht 10
Total Cost Price	Baht 360	Baht 195

From Table 3, It's found that the wood replacement production cost per sheet of the new production process was higher to production cost of wood replacement production using previous (old) production process but cost reduction could be made on the production for furniture products by eliminate the coloring, dyeing process out which could be reduced the furniture production cost greatly.[8]

4.3 The Result of Research Study Objective No. 3 On the test of the material standard of the wood replacement material from sugar cane tops and leaves newly developed it's was found that the analysis of the value according to Japan JIS A 5908-1994 Standard with specific gravity value of 0.74 and in respect of moisture content property of 9.75% passing standard criteria and modulus of rupture, MOR at the level of 6.53 MPa and modulus of elasticity, MOE property at the level of 327.76 MPa not passing standard criteria. In respect of Compression Stress value at the level of 13.56 MPa and Compression Stress value at the level of 6.94 MPa and for the part of the Hardness of wood replacement material at the level of 4,545.36 N.[9]

4.4 The Result of Research Study Objective No. 4 for satisfactory assessment of production process and steps on conversion of sugar cane tops and leaves as wood replacement material.

Discussion of the Research Results

1 The process of wood replacement membrane peeling off from sugar cane tops and leaves was the process to peel off membrane from leftovers of scraps of sugar cane tops and leaves, Northeastern economic plant suitable for production for compression in sheet the derived membrane of which was with the appearance of small sized wool consistent with the concept of Northeastern Regional Strategic Group Meeting Research (2548 : 2) stating that the integration of research work for learning and response to the development of sustainable Northeastern provincial groups equilibrium and sustainably must be with capacity development of the provincial groups in the Northeast Region with research process with participation of the interested parties.

2 The results of the test of wood replacement materials sheets from sugar cane tops and leaves scraps were with specific gravity of 0.74 and moisture content property of 9.75% passing standard criteria on industrial product standard test of Japan's Particle Board (JIS A 5908 – 1994) of 7

sides/aspect comprising of 1) Density 2) Moisture Content of the Sheet 3) Water Absorption 4) Blister when saturate in the water and mechanical properties comprising of 5) bending resistance 6) internal binding 7) binding of screw nail.[10]

3 The satisfactory result of the product design from wood replacement material of sugar cane tops and leaves scraps on the production assessment of coloring, dyeing phase being with the most suitable level consistent with the concept of the product design process (Niruch Sudsung. 2000 : 29) as the design process for material development of the industrial product design which must take individual sides/aspects for consideration as follows 1) Physical proportion, 2) Geometric application 3) Refining conditions, 4) Standard Parts.

Suggestion

The act which wood replacement material sheet made from sugar cane tops and leaves being with toleration of forge force and tension less than standard was based from the color wood replacement material was with the production of previously peeled off of membrane and colored, dyed membrane and then entered into the process of thermal compression with iso-cyanate glue thereby causing membrane to be soft and with less toughness than normal, due to wood replacement membrane will lose reception of binding force and bonding of wood replacement material membrane but could be increased of the property to be strong and with reception of binding force more with the process as follows

1) Increasing iso-cyanate glue quantity being an increase of iso-cyanate glue quantity from previously 7% to be more which when the glue quantity was increased would make the property of the wood replacement material sheet be with more strength and capable of receiving the force acted on the wood replacement material more but there would be a disadvantage i.e. the production process cost would be more or increased.

2) Insertion of loading weight receiving layer at the central core of wood replacement sheet is thermal compression of sandwich type. There was an insertion of wood membrane with strength and having the nature of long sized membrane right at the middle layer core of the wood replacement sheet causing binding to be tougher because there will be binding from the middle/central core using wood membrane of long size and with strength more than normal wood membrane but being with difficulty for production due to forming sheet of layer type affecting to take more time in forming.

3) Reduction of duration on membrane peeling off time by caustic soda down will obtain wood replacement membrane with size of the membrane wool length longer than boiling with normal time, but such a reduction of membrane peeling off time will effect disadvantage on the coloring, dyeing process because coloring, dyeing will not be durable and even causing the wood replacement material derived to be with unevenly coloring, dyeing and smoothness would be less than normal boiling time but would yield the property of the wood replacement material which was strong and be able to take up more loading weight. 4) The process of compression of smooth sheet wood replacement material may be made for wood replacement material to be with smoothed, polished surface by taking colored wood replacement material membrane to be blended finely with a blender to the extent of deriving physical property like kapok wool. Afterwards take for thermal compression with normal compression and iso-cyanate glue yielding the physical property of the sheet which is smooth, clean, beautiful more than normal compression.

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