UNIVERSITI PUTRA MALAYSIA

INTEGRATED APPROACH TO PREDICT THE PERFORMANCE OF NONLINEAR FORM OF KENAF HYBRID COMPOSITE FOR CONSTRUCTION APPLICATION

GOLNAR KIANI

IPTPH 2012 5

INTEGRATED APPROACH TO PREDICT THE PERFORMANCE OF NONLINEAR FORM OF KENAF HYBRID COMPOSITE FOR CONSTRUCTION APPLICATION

By

GOLNAR KIANI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

August 2012

DEDICATION

To my parents

&

My beloved husband

whose great love and care supported me all through the way

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

INTEGRATED APPROACH TO PREDICT THE PERFORMANCE OF NONLINEAR FORM OF KENAF HYBRID COMPOSITE FOR CONSTRUCTION APPLICATIONS

By

GOLNAR KIANI

August 2012

Chairman: Professor Rahinah Ibrahim, PhD

Institute: Tropical Forestry and Forest Products

The construction industry is not adapted for producing modern nonlinear dynamic forms of building designs. Prearranged machines and molding systems draw a lot of limitations to architects while designing. On the other hand, complex structural forms for these styles with their time consuming erecting and obscure nature prevent the designers to get involved in this challenge. Hence, it appears that the development in the building industry does not coincide with the architectural style of today.

In order to overcome this inconsistency, this study aimed to define the criteria in the path of adopting the latest advanced system of other industries by means of rapid manufacturing and overcome one of the difficulties to achieve this goal. As this advanced system is not based on molding employment and is directly translating the design into production parts, the complexity of previous process will be automatically removed. This study firstly involved the defining of adoptable process stages and evaluating its criteria to be adopted into the construction industry. Secondly, the material specification and composition for the system and process as the chosen key-aspect was investigated. The investigation procedure was based on the latest literature review, experimental procedure and Ansys composite analysis. The selected

fibre for the composition was Kenaf bast fiber. Lastly, defining the material workability as the load bearing component for the buildings using the advanced system of rapid manufacturing concept; which is extensively used in other industries to produce end products rather than prototyping called after Selective Laser Sintering, was investigated. This latest part utilized virtual simulation once more.

The output of this system is a dramatic change for the current construction industry with its latest development. This system is called Rapid Manufacturing and is able to generate any complex form by fusing or sintering powdered bio-composite layer by layer governed by computer numerical control, until they reach the intended form and dimensions of designed prefab building components; consuming Kenaf based composite material.

This effort successfully contributes to a new idea of enabling the use of the RM system into the construction industry simultaneously with its material needs announcement. Evaluating the system and material specifications through actual experiments are suggested for further study.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi syarat untuk ijazah Doktor Falsafah

PENDEKATAN BERSEPADU UNTUK RAMALKAN PRESTASI BORANG BUKAN LINEAR DARIPADA KENAF HIBRID KOMPOSIT BAGI PERMOHONAN PEMBINAAN

Oleh

GOLNAR KIANI

Ogos 2012

Pengerusi : Profesor. Rahinah Ibrahim, PhD
Fakulti : Institut Perhutanan Tropika dan Produk Hutan

Industri pembinaan bukan diadaptasi untuk menghasilkan rekabentuk bangunan yang nonlinear dynamic yang terkini. Mesin acuan dan mesin pembuatan yang telah sedia ada menyebabkan rekabentuk yang dihasilkan oleh jurutera bangunan terbatas. Dengan kata lain struktur yang kompleks dan masa yang terhad adalah member kekangan kepada jurubina untuk menyahut cabaran ini. Ianya seolah-olah perkembangan industri bangunan tidak sejajar dengan gaya senibina yang dipraktikkan hari ini.

Untuk mengatasi kekurangan ini, kajian ini bertujuan untuk mewujudkan proses aliran baru yang dipadankan dengan sistem termaju dan terkini daripada industri lain seperti automotif atau aeroangkasa dan bahan yang serasi dengannya. Disebabkan sistem ini yang bukan berdasarkan kepada acuan tetapi rekabentuk dibuat terus kepada penghasilan bahan, proses yang kompleks terdahulu tersingkir secara automatik. Kajian ini pertamanya ialah bagi menentukan peringkat proses yang dipadankan dan disahkan serta memudahkan fungsi melalui penjanaan skala model. Kedua, spesifikasi bahan dan komposisi bagi sistem dan proses dibincangkan; berdasarkan sorotan literatur terkini, prosedur eksperimen dan analisis komposit Ansys. Akhir sekali, menentukan kebolehpakaian bahan yang dipadankan ke dalam

sistem terkini dan termaju berasaskan Selective Laser Sintering dalam sorotan literatur dan penemuan simulasi. Oleh yang demikian, output sistem ini merupakan satu perubahan yang dramatik bagi industri pembinaan semasa. Sistem ini dikenali sebagai Rapid Manufacturing dan dapat menjana bentuk yang kompleks dengan menggabungkan atau lapisan pensinteran bio-komposit selapis demi selapis dengan berbantukan kawalan komputer, sehingga mencapai bentuk yang dicadangkan dan dimensi komponen bangunan yang direkabentuk; dan mengambil kira bahan yang berasaskan komposit kenaf.

Usaha yang menyumbang idea baru ini membolehkan revolusi proses yang bergelut dengan keadaan yang kompleks, cuba untuk melanjutkan sistem RM ke dalam industri pembinaan dan pada masa yang sama dengan penggunaan bahan keperluan yang telah disebutkan. Penilaian sistem dan spesifikasi bahan oleh uji kaji betul yang mendalam dicadangkan untuk kajian selanjutnya.

ACKNOWLEDGEMENTS

I would like to express my deepest appreciation to the chairman of my supervisory committee, Professor Dr. Rahinah Ibrahim for the unlimited support, assistance, advice, and compassion she devoted to me throughout my research. The honour of working under her supervision is unforgettable and inspiring.

I would also like to extend my special thanks and appreciation to my Co-supervisors Associated Prof. Dr. Khalina Abdan, Dr Farah Abdul binti Aziz and Dr. Faieza Abdul Aziz, who always devoted their time and support to help me through conducting this research.

I certify that a Thesis Examination Committee has met on 9 August 2012 to conduct the final examination of Golnar Kiani on her thesis entitled "Integrated Approach to Predict the Performance of Nonlinear form of Kenaf Hybrid Composite for Constructon Application" in accordance with the Universities and University College Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The committee recommends that the student be awarded the Doctor of Philosophy.

Members of the Thesis Examination Committee were as follows:

Paridah binti Md Tahir, PhD
Professor
Faculty of Forestry
Universiti Putra Malaysia
(Chairman)

Edi Syams bin Zainudin, PhD
Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Internal Examiner)

Mohammad Yazah bin Mat Raschid, PhD
Senior Lecturer
Faculty of Design and Architecture
Universiti Putra Malaysia
(Internal Examiner)

Mohd Fairuz Shiratuddin, PhD
Professor
Murdoch University
Australia
(External Examiner)

SEOW HENG FONG, PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 21 March 2013

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

Rahinah Ibrahim, PhD
Professor
Faculty of Art & Architectural design
Universiti Putra Malaysia
(Chairman)

Khalina Abdan, PHD
Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Member)

Farah binti Abdul aziz, PHD
Senior Lecturer
Faculty of Engineering
Universiti Putra Malaysia
(Member)

Faieza Abdul Aziz, PHD
Senior Lecturer
Faculty of Engineering
Universiti Putra Malaysia
(Member)

_____
BUJANG BIN KIM HUAT, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

DECLARATION

I declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously and is not concurrently submitted for any other degree at Universiti Putra Malaysia or at any other institution.

GOLNAR KIANI

Date: 9 August 2012

TABLE OF CONTENTS