PRODUCTION AND PROPERTIES OF ‘BULUH SEMANTAN’
(Gigantochloa scortechinii Gamble) HARDBOARD COMPARED TO
COMMERCIALY PRODUCED PINE HARDBOARD

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MASTER OF SCIENCE
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(Gigantochloa scortechinii Gamble) HARDBOARD COMPARED TO
COMMERCIAL PRODUCED PINE HARDBOARD

By

SABIHA SALIM

Thesis Submitted to the School of Graduates Studies,
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of Master of Science

September 2007
Specially dedicated to:

My mother

NORIMAH BT MD DALI

&

My father

SALIM B HARUN

Love is the only rationale act...
Bamboo, a fast-growing plant with great versatility is being manufactured into various products of wood composites. In Malaysia, Buluh Semantan (G. scortechinii Gamble) is the most commercially utilised bamboo species and currently, fast being studied on its anatomical, physical and mechanical properties for contribution towards expanding the bamboo industry. Another potential product utilising bamboo fibre is hardboard, due to its long fibres produced good fibre bonding and strong hardboard. A study was conducted to determine the potential of utilizing bamboo (Gigantochloa scortechinii) for hardboard production. The objective of this study were to prepare and evaluate the bamboo fibre after undergone pre-treatment processes prior to refiner mechanical pulping (RMP), to determine the optimum pre-treatment process
for fibre production, and to evaluate the mechanical and physical properties of hardboard from bamboo compared to those of commercial hardboard from pine. Bamboo chips were either treated by soaking in 2% (w/v) sodium hydroxide (NaOH) solution at 60°C for 4, 6 and 8 h or by steaming at 170°C at 5.95 kg cm⁻² pressure for 3 h to soften them. The results showed that chips pre-treated with NaOH yielded higher fibre recovery (77.2%) compared to those of steamed (50.7%). Fibre recovered from NaOH pre-treatment produced more unbroken fibres than those of steam. Fibre after undergone steam pre-treatment produced darker fibres compared to those of NaOH treated. Thus, from these measurements of fibre recovery and morphology, fibre from NaOH pre-treated produced better fibre quality than those of steam-treated. It was also found that soaking in 2% NaOH for 6 h was the most optimum treatment condition for the bamboo fibre. Thirty 3-mm hardboards (density, 1000 kg m⁻³) prepared from the pre-treated fibres of bamboo, with and without resin and additives were then fabricated. Phenol formaldehyde (PF) resin at two concentration levels, i.e., 1% and 2% (based on oven dry weight of board), wax emulsion at 1% and 2% (based on oven dry weight of board), and alum (Al₂(SO₄)₃) at 0.25% (based on oven dry weight of board) were added selectively to enhance the properties of the boards. Boards were hot pressed at 180°C for 20 min and tempered in a forced circulation oven at 160°C for 6 h. Physical and mechanical properties of the boards were evaluated in accordance with Japanese Industrial Standard for Fibreboard (JIS A 5305-2003). Properties of commercial hardboard made from
pine of the same thickness were also tested for comparison purposes. The results showed that all bamboo hardboards produced from NaOH pre-treated fibres showed higher Modulus of Rupture (MOR) and Modulus of Elasticity (MOE) values compared to the commercial hardboard. NaOH pre-treated board with 2% PF resin+1% wax and 2% PF resin+2% wax had the highest bending strength values (MOR values) but poor in dimensional stability compared to the commercial hardboard. Bamboo hardboards without resin and additives produced from steam-treated fibres showed lower MOR and IB values compared to those produced from NaOH pre-treated fibres. The bamboo hardboards without resin and additives showed lower MOR and Internal Bond (IB) values compared to those with resin and additives. Increasing PF resin and wax levels of concentration from 1% to 2% had increased the strength and stiffness properties of bamboo hardboards; namely the MOR, MOE and IB and was significant at p<0.01. The Internal Bond (IB) value showed the highest for hardboard with 2% PF resin+2% wax though was lower than the commercial hardboard (1.64 and 1.92, respectively). Bamboo hardboard was superior in terms of bending strength when compared to the commercially produced hardboard. Meanwhile for dimensional stability, bamboo hardboards showed poorer resistant to water absorption (WA) than the commercial and the value did not meet the JIS Standard specified.
Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PEMBUATAN DAN PENILAIAN SIFAT PANEL GENTIAN BERKETUMPATAN TINGGI DIPERBUAT DARIPADA BULUH SEMANTAN (Gigantochloa scortechinii Gamble) DIBANDINGKAN DENGAN PANEL KOMERSIAL DARIPADA PINE

Oleh

SABIHA SALIM

September 2007

Pengerusi : Professor Madya Zaidon Ashaari, PhD
Fakulti : Perhutanan

Buluh merupakan tanaman spesis cepat tumbuh dan serbaguna yang digunakan untuk pembuatan pelbagai produk kayu gubah. Di Malaysia, Buluh Semantan (G. scortechinii Gamble) adalah spesies komersial yang popular digunakan dan pelbagai kajian dijalankan tentang sifat-sifat anatomi, fizikal dan mekanikal dalam membantu menaikkan industri buluh. Antara produk yang berpotensi untuk diperbuat daripada buluh ialah papan gentian berketumpatan tinggi, memandangkan gentian buluh adalah panjang dan berupaya menghasilkan produk tersebut yang kuat terutamanya dari segi kekuatan ikatan gentian. Penyelidikan ini dijalankan untuk mengkaji potensi penggunaan buluh tropika (Gigantochloa scortechinii) untuk penghasilan kayu...
gentian berketumpatan tinggi. Objektif kajian ini adalah menganalisa kesan pra-rawatan sodium hidroksida (NaOH) dan pengewapan ke atas sifat gentian sebelum dipulpa menggunakan kaedah Pempulpaan mekanikal (RMP). Seterusnya, untuk menentukan pra-rawatan gentian yang optima, justeru itu mencirikan sifat-sifat mekanikal dan fizikal yang terhasil daripada gentian yang terawat. Cip-cip kayu terlebih dahulu dirawat dengan merendam di dalam larutan sodium hidroksida berkep ekatan 2% (berat/isipadu) pada suhu tetap 60°C selama 4, 6 dan 8 jam atau mengewap/ menstim pada suhu 170°C dan tekanan 5.95 kgcm⁻² selama 3 jam untuk melembutkan cip-cip tersebut. Kedua-dua pra-rawatan ke atas cip-cip menggunakan stim dan NaOH mempengaruhi sifat morfologi gentian dan warna pulpa yang terhasil. Gentian terhasil dari rawatan dengan NaOH memberikan hasil gentian yang banyak, dengan 77.2% berbanding stim; hanya 50.7%. Gentian yang telah dirawat dengan NaOH menghasilkan lebih banyak gentian yang tidak patah daripada gentian yang dirawat dengan stim. Gentian yang dirawat dengan stim menghasilkan gentian yang berwarna gelap manakala gentian dirawat dengan NaOH menghasilkan gentian yang berwarna cerah. Daripada pengiraan pulangan gentian yang terhasil dan pengukuran morfologi gentian, gentian terawat dengan NaOH menghasilkan gentian yang lebih berkualiti berbanding gentian terawat dengan stim. Selain itu, didapati bahawa rawatan optimum untuk melembutkan cip buluh sebelum proses pemulpaan adalah dengan merendam cip buluh dalam 2% NaOH pada suhu 60°C dengan masa rendaman
selama 6 jam. Tiga puluh keping papan gentian berketumpatan tinggi (1000 kgm⁻³) dihasilkan dengan ketebalan 3-mm diperbuat daripada batang buluh. Panel tersebut dihasilkan menggunakan perekat dan juga tanpa perekat dan aditif lain, kemudian perbandingan dibuat dengan panel komersil daripada pain dengan mengambilkira ketebalan panel yang sama. Perekat fenol formaldehid (PF) dengan dua kepekatan; 1% dan 2% (berasaskan berat kering oven panel), pengemulsi lilin pada 1% dan 2% kepekatan (berasaskan berat kering oven panel), dan 0.25% alum (Al₂(SO₄)₃) (berasaskan berat kering oven panel) ditambahkan mengikut kepekatan tertentu kepada panel daripada buluh *G. scortechinii* manakala panel daripada bahan lignoselulosa yang lain hanya ditambahkan dengan perekat PF berkepekatan 2% dan pengemulsi lilin 1% serta alum. Panel diberikan tekanan panas pada suhu 180°C selama 20 minit dan kemudian dipanaskan dalam oven pada suhu 160°C selama 6 jam. Semua sifat mekanikal dan fizikal panel yang dihasilkan diuji mengikut ketetapan piawaian papan gentian ‘Japanese Industrial Standard for Fibreboard’ (JIS A5305-2003). Sifat panel komersil daripada kayu pain dengan ketebalan yang sama juga diuji untuk perbandingan. Keputusan kajian menunjukkan semua panel gentian berketumpatan tinggi diperbuat daripada buluh menggunakan pra-rawatan dengan NaOH menunjukkan nilai rintangan terhadap kepecahan (MOR) dan kekenyalan (MOE) yang lebih tinggi berbanding panel komersil. Panel terawat dengan NaOH menggunakan 2% resin PF+1% pengemulsi lilin, dan 2% resin PF+2% pengemulsi lilin memberikan nilai ketahanan terhadap
kepecahan yang tertinggi (nilai MOR) tetapi lemah terhadap rintangan terhadap air dan kelembapan (nilai WA) berbanding panel komersil. Panel yang diperbuat menggunakan gentian buluh yang terawat dengan stim, tanpa resin dan bahan tambah lain menghasilkan panel dengan ketahanan terhadap kepecahan (MOR) dan kekuatan ikatan dalaman (IB) yang lebih rendah berbanding panel yang diperbuat menggunakan gentian terawat dengan NaOH. Panel yang diperbuat tanpa resin dan bahan tambah menunjukkan kekuatan (MOR) dan ikatan dalaman (IB) yang lebih rendah berbanding panel yang diperbuat menggunakan resin dan bahan tambah. Dengan pertambahan kepekatan resin PF dan pengemulsi lilin daripada 1% ke 2%, kekuatan dan kekerasan panel tersebut turut bertambah; iaitu nilai MOR, MOE dan IB adalah bererti pada p<0.01. Nilai kekuatan ikatan dalaman (IB) tertinggi terhasil daripada panel buluh yang diperbuat menggunakan 2% resin PF +2% pengemulsi lilin. Panel gentian berketumpatan tinggi yang diperbuat daripada buluh memberikan kekuatan yang superior. Manakala untuk kestabilan dimensi atau kadar resapan (WA), panel gentian berketumpatan tinggi daripada buluh adalah tidak tahan terhadap lembapan berbanding panel komersil dan nilai kadar resapan (WA) tidak mencapai piawaian yang ditetapkan oleh JIS A 5305-2003.
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…May Allah bless us always…
I certify that an Examination Committee met on 7th September 2007 to conduct the final examination of Sabiha bt. Salim on her Master of Science thesis entitled “Production and Properties Evaluation of Buluh Semantan (Gigantochloa scortechinii Gamble) Hardboard compared to Commercially Produced Pine Hardboard” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The committee recommends that the candidate be awarded the relevant degree. Member of the Examination Committee are as follows:

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Date: 22 January 2008
DECLARATION

I hereby 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 or concurrently submitted for any other degree at UPM or other institutions.

____________________
SABIHA SALIM

Date: 7th November 2007
TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEDICATION</td>
<td>ii</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>iii</td>
</tr>
<tr>
<td>ABSTRAK</td>
<td>vi</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>x</td>
</tr>
<tr>
<td>APPROVAL</td>
<td>xi</td>
</tr>
<tr>
<td>DECLARATION</td>
<td>xiii</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>xviii</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>xx</td>
</tr>
<tr>
<td>LIST OF ABBREVIATIONS</td>
<td>xxiv</td>
</tr>
</tbody>
</table>

CHAPTER

1 INTRODUCTION
1.1 Background of the Study 1
1.2 Statement of Problem 5
1.3 Objectives 6

2 LITERATURE REVIEW
2.1 Bamboo, a Natural Forest Resource in Malaysia 7
2.2 Uses of Bamboo 8
2.3 Area of bamboo Distribution in Malaysia 10
2.4 Properties of Bamboo 13
   2.4.1 Physical and Mechanical Properties 13
   2.4.2 Chemical Properties 15
   2.4.3 Anatomical properties 18
2.5 Gigantochloa scortechinii 22
2.6 Hardboard 23
   2.6.1 Hardboard Application and Uses 24
   2.6.2 Hardboard Fabrication 25
   2.6.3 Research on Hardboard 28
   2.6.4 The Differences of Wet-processed Hardboard Compared to Paper 29
2.7 Manufacturing Process 31
   2.7.1 Fibre Pre-treatment 31
   2.7.2 Refiner Mechanical Pulping (RMP) 36
      2.7.2.1 Effect of Mechanical treatment on Hardboard Properties 37
2.7.3 Wet Forming Process 37
2.7.4 Press Cycle 39

2.8 Adhesive Bond in Composites 41
2.8.1 Phenol formaldehyde (PF) resin and wax emulsion 42
2.8.2 Alum (Al₂(SO₄)₃) 44

2.9 Bamboo among the Non-Wood Fibre Plant of the World 44
2.9.1 Alternative Fibre for Wood-Based Composites 46
2.9.2 Bamboo-based Composites 48
2.9.3 Current Research on Bamboo-Based Composites in Malaysia 48

2.10 Some Common Species of Fibre Utilized for Wood-Based Composites 49
2.10.1 Pine and other Softwoods 49

2.11 New direction for research and development on Bamboo Hardboard 50

3 MATERIALS AND METHODS

3.1 Materials 52
3.1.1 Bamboo 52
3.1.2 Chemicals 54

3.2 Experimental Design 55

3.3 Bamboo Hardboard Production 56
3.3.1 Fibre Preparation 58
3.3.2 Mat Forming 66

3.4 Evaluation of Fibre Quality of Pre-treated Bamboo 69
3.4.1 Fibre Recovery after undergone Mechanical Refining 69
3.4.2 Colour Changes of Pre-treated Fibres 70
3.4.3 Measurements of Fibre Morphology 70
3.4.4 Determination of Lignin Content in Fibres 72

3.5 Evaluation of Bamboo Hardboard 73
3.5.1 Spring back of Boards 74
3.5.2 Evaluation of Colour of Boards 77
3.5.3 Determination of Board Density 77
3.5.4 Determination of Board Moisture Content 78
3.5.5 Mechanical Properties 78
3.5.5.1 Static Bending Flatwise Direction 78
3.5.5.2 Internal Bond 80
3.5.5.3 Impact Resistance Test 81
3.5.5.4 Scratch Resistance Test 83
4 RESULTS AND DISCUSSION

4.1 Fibre Quality of Pre-Treated G. scortechinii Fibres
   4.1.1 Effect of Pre-treatments on Fibre Recovery, Morphology and Lignin Content of G. scortechinii
      4.1.1.1 Fibre Recovery
      4.1.1.2 Fibre Morphology
      4.1.1.3 Fibre Lignin Content
   4.1.2 Effect of Refining on Fibre Recovery and Morphology of pre-treated G. scortechinii

4.1.3 Summary of Results on Fibre Quality of Pre-treated G. scortechinii

4.2 Properties of Hardboard Fabricated from Buluh Semantan (G. scortechinii)
   4.2.1 Properties of Hardboard in Relation to Density
   4.2.2 Effect of Pre-treatment
      4.2.2.1 Bending Strength
      4.2.2.2 Internal Bond
      4.2.2.3 Impact and Scratch Resistance
      4.2.2.4 Springback
      4.2.2.5 Water Absorption/Thickness Swelling
   4.2.3 Effect of Resin and Wax
      4.2.3.1 Bending Strength
      4.2.3.2 Internal Bond
      4.2.3.3 Springback
      4.2.3.4 Water Absorption/Thickness Swelling

4.3 Comparison of Bamboo Hardboard with Commercial Pine Hardboard
   4.3.1 Bending Strength
   4.3.2 Internal Bond
   4.3.3 Impact and Scratch Resistance
   4.3.4 Springback
   4.3.5 Water Absorption/Thickness Swelling
   4.3.6 Effect of Fibre Morphology on Mechanical and Physical Properties of Hardboards

4.4 Summary of Results on The Performance of Hardboards
5 CONCLUSION AND RECOMMENDATION

5.1 Conclusion 138
5.2 Recommendations 140

REFERENCES 141
APPENDIX 153
BIODATA OF THE AUTHOR
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Bamboo Resources in some Asian Countries</td>
<td>8</td>
</tr>
<tr>
<td>2.2</td>
<td>Area planted with bamboo (in Peninsular Malaysia)</td>
<td>12</td>
</tr>
<tr>
<td>2.3</td>
<td>Some chemical composition of timber (softwood and hardwood), non-timber (bamboo and kenaf) and agricultural plant (oil palm EFB)</td>
<td>16</td>
</tr>
<tr>
<td>2.4</td>
<td>Length and width of selected agro-fibres compared to hardwood</td>
<td>21</td>
</tr>
<tr>
<td>2.5</td>
<td>Leading non-wood fibres of the world</td>
<td>46</td>
</tr>
<tr>
<td>3.1</td>
<td>Treatment combination of manufacturing 3-mm-thick hardboard made from <em>Gigantochloa scortechinii</em> fibres and commercial panels as control</td>
<td>56</td>
</tr>
<tr>
<td>3.2</td>
<td>Properties and specimen size for physical and mechanical evaluation of hardboard</td>
<td>75</td>
</tr>
<tr>
<td>4.1</td>
<td>Quantitative fibre morphology of <em>G. scortechinii</em> after undergone steam and NaOH pre-treatments</td>
<td>94</td>
</tr>
<tr>
<td>4.2</td>
<td>Colour changes of fibres and lignin content of pre-treated <em>G. scortechinii</em> when compared to pine (commercial)</td>
<td>100</td>
</tr>
<tr>
<td>4.3</td>
<td>Quantitative fibre morphology of pre-treated <em>G. scortechinii</em> fibres after refining for 1 cycle (2.5 mm plate gap) and 2 cycles (2.5 mm followed by 0.5 mm plate gap)</td>
<td>103</td>
</tr>
<tr>
<td>Section</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>---------</td>
<td>----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>4.4</td>
<td>Fibre morphology of <em>G. scortechinii</em> pre-treated using NaOH, steam, and untreated compared to pine</td>
<td>111</td>
</tr>
<tr>
<td>4.5</td>
<td>The Mechanical and Physical Properties of pre-treated <em>G.scortechinii</em> Hardboard</td>
<td>116</td>
</tr>
<tr>
<td>4.6</td>
<td>Impact resistance and scratch resistance of Bamboo Hardboards from NaOH and steam pre-treated compared to Commercial Hardboards</td>
<td>118</td>
</tr>
<tr>
<td>4.7</td>
<td>Level of significant difference for the Mechanical and Physical Properties of Hardboard from Bamboo compared to the Commercial</td>
<td>122</td>
</tr>
<tr>
<td>4.8</td>
<td>Summary of ANOVA of Mechanical and Physical Properties Value for Bamboo(^1) Compared to Commercial Hardboard</td>
<td>130</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Distribution of Bamboo in Peninsular Malaysia</td>
<td>11</td>
</tr>
<tr>
<td>2.2</td>
<td>Cross section of <em>Yushania alpina</em> bamboo culm wall middle layer;</td>
<td>19</td>
</tr>
<tr>
<td>2.3</td>
<td>An old Japanese paper mill showing all the processes of papermaking by hand</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>in operation</td>
<td></td>
</tr>
<tr>
<td>2.4</td>
<td>Typical SIS hardboard press cycle</td>
<td>40</td>
</tr>
<tr>
<td>3.1</td>
<td>Bamboo plantation at Hutan Simpan Chebar Besar, Nami, Kedah</td>
<td>52</td>
</tr>
<tr>
<td>3.2</td>
<td>Schematic diagram of harvesting bamboo culm</td>
<td>53</td>
</tr>
<tr>
<td>3.3</td>
<td>Bamboo culms ready for soaking in fresh water</td>
<td>54</td>
</tr>
<tr>
<td>3.4</td>
<td>The Experimental Design</td>
<td>55</td>
</tr>
<tr>
<td>3.5</td>
<td>The Process Flow of Fabricating Wet-process Hardboard</td>
<td>57</td>
</tr>
<tr>
<td>3.6</td>
<td>Preparation of Bamboo Fibre for Hardboard Manufacture</td>
<td>59</td>
</tr>
<tr>
<td>3.7</td>
<td>Hand splitter used to split bamboo, and bamboo splits</td>
<td>60</td>
</tr>
<tr>
<td>3.8</td>
<td>Wood planner used to remove the epidermis of bamboo splits</td>
<td>60</td>
</tr>
<tr>
<td>3.9</td>
<td>Mini Wood Chipper used to chip bamboo</td>
<td>61</td>
</tr>
</tbody>
</table>
3.10 Digesters used to steam bamboo chips

3.11 (a) Refiner Mechanical Pulping (Andritz Sprout Bauer model); (b) the refining plate and (c) chip feeder

3.12 Beater used to beat the pulp continuously

3.13 Wet former (Niagara Type) used to form mat by wet process

3.14 Hot press machine used to press boards to targeted thickness

3.15 Microscope with Leitz DMRB Image Analyzer attached to a computer used to quantify fibre morphology

3.16 Board Properties Evaluation

3.17 Cutting design of board for testing

3.18 Static bending test

3.19 Impact tester used to test impact resistance

3.20 Scratch tester (Martens) used to test scratch resistance

3.21 Rigorous cyclic test

3.22 Thickness swelling measurement of test sample

4.1 Fibre recovery of *G. scortechini* bamboo after pretreatments and refining
4.2 (a) Damaged, (b) broken and (c) unbroken fibres, long and tapered end produced from steam pre-treatment observed using optical micrograph with 20x magnification

4.3 Swollen fibre wall after undergone NaOH pre-treatment at; (a) 4 h (note the unclean surface) and (b) 8 h (clean surface)

4.4 Fibrillation occurred to the fibre after undergone NaOH pre-treatment by chemical and mechanical reaction at (a) 4 h, (b, c and d) 6 h, and (e) 8 h

4.5 Schematic diagram of (a) original fibre, (b) partially collapsed, and (c) flattened fibre

4.6 The effect of refiner plate gap size actions on fibres

4.7 Effect of plate gap of refiner on (A) fibre length, mm (10-1), (B) fibre diameter, µm and (C) felting power of steam pre-treated and NaOH pre-treated fibre

4.8 Effect of density on strength properties of bamboo Hardboard

4.9 Impact resistance test; (a) small dent resulted in commercial test sample (b) big dent of bamboo steam pre-treated and (c) undistinguishable dent on NaOH pre-treated bamboo hardboard

4.10 Effect of Pre-treatment of Bamboo Fibre on the Springback of Hardboards

4.11 Effect of Resin and Wax Levels of Concentration on Springback of Hardboards

4.12 Water absorption and thickness swelling of hardboard after undergone cyclic water-soak test
4.13 The correlation of water absorption and thickness swelling of bamboo hardboard

4.14 Effect of fibre length and diameter on the strength and physical properties of hardboard