Bamboo Training and Development Centre in Mbeya, Tanzania... ...the Experience of an Architecture Student

> Index of contents:

1.) Introduction and Background
2.) Raw Material: Cut, Seasoning, Preservation and Dry
3.) Construction of Bamboo Drying Shed
4.) Furniture Manufacture
5.) Technical Research
> Basics of the project:

- Grant by Polytechnic University of Madrid (UPM)
- ‘Final Projects in Cooperation for Development’
- Funding by Madrid Regional Government
- MoU: UPM (Spain) and ARU (Tanzania)
> Main agents involved:

1. Polytechnic University of Madrid (UPM)
> Main agents involved:

1. Polytechnic University of Madrid (UPM)
2. Technical School of Architecture (ETSAM)
Main agents involved:

1.- Polytechnic University of Madrid (UPM)
2.- Technical School of Architecture (ETSAM)
3.- Mbeya Bamboo Women Group (MBWG)
> Main agents involved:

1. Polytechnic University of Madrid (UPM)
2. Technical School of Architecture (ETSAM)
3. Mbeya Bamboo Women Group (MBWG)
4. Ardhi University (ARU)

- Introduction and Background -
AFRICA

1. Introduction and Background
AFRICA

Introduction and Background
AFRICA - Introduction and Background
Introduction and Background

Mbeya

Uyole

1. Tanzania

Mbeya Uyole

AFRICA

Tanzania

Dar-es-Salaam

AFRICA

- Introduction and Background -
IX World Bamboo Congress – Merksplas, Belgium. April 13th, 2012
Jaime Espinosa – UPM – Bamboo Training and Development Centre – Mbeya, Tanzania

1. Introduction and Background
Introduction and Background

- MBWG & Jaime Espinosa

Goal:
To produce bamboo furniture prototypes.

Activities:
- Preservation process
- Build up drying shed
- Furniture prototypes

www.bambooafrika.com
Species: *Arundinaria alpina*  
(African mountain bamboo)

- Raw Material: Cut, Seasoning, Preservation and Drying -
2. "How to cut bamboo for building and furniture" (in swahili)

a.) Cut:
- Mature specimens, over 1st or 2nd knot


3. Ulikila manzi angalia kutoka kwa tunda kwa sababu, sahara hatuachuka mali kwa mvua. Hivyo ilia saa.


5. Subiri waki tatu kwa sababu utumvule ni mlimu hivyo unavuta wadudhi. Baada yake waki tatu hawezi kufahamu hivyo wakula hawani utumvule.
b.) Seasoning:
- 3 weeks in the forest, leaning on its own stem
c.) Preservation:
   c1.- Washing bamboo stems
c.) Preservation:
c2.- Open up every cell between 2 knots
c.) Preservation:
c3.- Immersion in borax + boric acid solution

- During 5 days, 4% concentration
Raw Material: Cut, Seasoning, Preservation and Drying

- d.) Drying - 20 days
3. Construction of Bamboo Drying Shed

a.) Capacity building

a1.- Explanations

a2.- Practice
3. Construction of Bamboo Drying Shed

b.) Principles of design
- Limited length of bamboos
- Prefabricated elements
- Basic tools available:
  - Hand saw
  - Hammer
  - Span
  - Splitter
  - Electric drill and drill bits
IX-World Bamboo Congress – Merksplas, Belgium. April 13th, 2012
Jaime Espinosa – UPM – Bamboo Training and Development Centre - Mbeya, Tanzania

3. Construction of Bamboo Drying Shed

c.) Foundations

- Precast reinforced concrete
- Plastic buckets as shuttering
- Reinforcement: 2 feet-length corrugated steel bar
d.) Prefabricated elements
d1.- Vertical frames
3.

- Construction of Bamboo Drying Shed -

d.) Prefabricated elements
d2. - Roof trusses
3.

Construction of Bamboo Drying Shed
4. Furniture Manufacture

a.) Principles of design:
- Limited length of bamboos
- Modular frames
- Easy making

b.) Production phases:
- Cut bamboo pieces
- Frames and joinery
- Bamboo mat covering
- Finishing with linseed oil
4.

- Furniture Manufacture -

Single armchair
- Sitting room set
  - Single armchair
  - Triple armchair
  - Low table

- Furniture Manufacture -
- Dinning room set

> Standard chair

> Dinning table

- Furniture Manufacture -
4. **Furniture Manufacture**

> School desk
5.

Technical Research

National Housing and Building Research Agency

Headquarters at Mwenge (Dar-es-Salaam)
Specimens taken from treated bamboo in Mbeya
36 samples, from 18 different bamboo stems
### Characterization of the specimens

#### Technical Research

<table>
<thead>
<tr>
<th>Wall thickness (mm)</th>
<th>Ext. Ø (mm)</th>
<th>Int. Ø (mm)</th>
<th>Ext. Area (mm²)</th>
<th>Int. Area (mm²)</th>
<th>Height (mm)</th>
<th>Volume (mm³)</th>
<th>Compr. Effect. A (mm²)</th>
<th>Shear Effect. A (mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>9.00</td>
<td>70.00</td>
<td>52.00</td>
<td>3,848.45</td>
<td>2,123.72</td>
<td>90.00</td>
<td>346,360.52</td>
<td>1,724.73</td>
</tr>
<tr>
<td>2.</td>
<td>7.00</td>
<td>50.00</td>
<td>36.00</td>
<td>1,963.50</td>
<td>1,017.88</td>
<td>90.00</td>
<td>176,714.55</td>
<td>945.62</td>
</tr>
<tr>
<td>3.</td>
<td>6.00</td>
<td>56.00</td>
<td>44.00</td>
<td>2,463.01</td>
<td>1,520.53</td>
<td>90.00</td>
<td>221,670.73</td>
<td>942.48</td>
</tr>
<tr>
<td>4.</td>
<td>6.00</td>
<td>53.00</td>
<td>41.00</td>
<td>2,206.18</td>
<td>1,320.25</td>
<td>90.00</td>
<td>198,556.47</td>
<td>885.93</td>
</tr>
<tr>
<td>5.</td>
<td>11.00</td>
<td>58.00</td>
<td>36.00</td>
<td>2,642.08</td>
<td>1,017.88</td>
<td>90.00</td>
<td>237,787.10</td>
<td>1,624.20</td>
</tr>
<tr>
<td>6.</td>
<td>9.00</td>
<td>56.00</td>
<td>38.00</td>
<td>2,463.01</td>
<td>1,134.11</td>
<td>90.00</td>
<td>221,670.73</td>
<td>1,328.89</td>
</tr>
<tr>
<td>7.</td>
<td>7.00</td>
<td>56.00</td>
<td>42.00</td>
<td>2,463.01</td>
<td>1,385.44</td>
<td>90.00</td>
<td>221,670.73</td>
<td>1,077.57</td>
</tr>
<tr>
<td>8.</td>
<td>6.00</td>
<td>49.00</td>
<td>37.00</td>
<td>1,885.74</td>
<td>1,075.21</td>
<td>90.00</td>
<td>169,716.65</td>
<td>810.53</td>
</tr>
<tr>
<td>9.</td>
<td>6.00</td>
<td>58.00</td>
<td>46.00</td>
<td>2,642.08</td>
<td>1,661.90</td>
<td>90.00</td>
<td>237,787.10</td>
<td>980.18</td>
</tr>
<tr>
<td>10.</td>
<td>5.00</td>
<td>52.00</td>
<td>42.00</td>
<td>2,123.72</td>
<td>1,385.44</td>
<td>90.00</td>
<td>191,134.46</td>
<td>738.27</td>
</tr>
<tr>
<td>11.</td>
<td>5.00</td>
<td>55.00</td>
<td>45.00</td>
<td>2,375.83</td>
<td>1,590.43</td>
<td>90.00</td>
<td>213,824.61</td>
<td>785.40</td>
</tr>
<tr>
<td>12.</td>
<td>6.00</td>
<td>50.00</td>
<td>38.00</td>
<td>1,963.50</td>
<td>1,134.11</td>
<td>90.00</td>
<td>176,714.55</td>
<td>829.38</td>
</tr>
<tr>
<td>13.</td>
<td>6.00</td>
<td>55.00</td>
<td>43.00</td>
<td>2,375.83</td>
<td>1,452.20</td>
<td>90.00</td>
<td>213,824.61</td>
<td>923.63</td>
</tr>
<tr>
<td>14.</td>
<td>5.00</td>
<td>57.00</td>
<td>47.00</td>
<td>2,551.76</td>
<td>1,734.94</td>
<td>90.00</td>
<td>229,658.23</td>
<td>816.81</td>
</tr>
<tr>
<td>15.</td>
<td>6.00</td>
<td>53.00</td>
<td>41.00</td>
<td>2,206.18</td>
<td>1,320.25</td>
<td>90.00</td>
<td>198,556.47</td>
<td>885.93</td>
</tr>
<tr>
<td>16.</td>
<td>6.00</td>
<td>55.00</td>
<td>43.00</td>
<td>2,375.83</td>
<td>1,452.20</td>
<td>90.00</td>
<td>213,824.61</td>
<td>923.63</td>
</tr>
<tr>
<td>17.</td>
<td>8.00</td>
<td>73.00</td>
<td>57.00</td>
<td>4,185.39</td>
<td>2,551.76</td>
<td>90.00</td>
<td>376,684.73</td>
<td>1,633.63</td>
</tr>
<tr>
<td>18.</td>
<td>7.00</td>
<td>49.00</td>
<td>35.00</td>
<td>1,885.74</td>
<td>962.11</td>
<td>90.00</td>
<td>169,716.65</td>
<td>923.63</td>
</tr>
</tbody>
</table>

**Humidity content:** 8-10%
### Compression Strength (N) vs. Effective Area (mm²) vs. Stress (N/mm²) vs. Total Area (mm²) vs. Stress (N/mm²)

<table>
<thead>
<tr>
<th></th>
<th>Compression Strength (N)</th>
<th>Effective Area (mm²)</th>
<th>Stress (N/mm²)</th>
<th>Total Area (mm²)</th>
<th>Stress (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>80,000.00</td>
<td>1,724.73</td>
<td>46.38</td>
<td>3,848.45</td>
<td>20.79</td>
</tr>
<tr>
<td>2.</td>
<td>50,000.00</td>
<td>945.62</td>
<td>52.88</td>
<td>1,963.50</td>
<td>25.46</td>
</tr>
<tr>
<td>3.</td>
<td>55,000.00</td>
<td>942.48</td>
<td>58.36</td>
<td>2,463.01</td>
<td>22.33</td>
</tr>
<tr>
<td>4.</td>
<td>60,000.00</td>
<td>885.93</td>
<td>67.73</td>
<td>2,206.18</td>
<td>27.20</td>
</tr>
<tr>
<td>5.</td>
<td>80,000.00</td>
<td>1,624.20</td>
<td>49.26</td>
<td>2,642.08</td>
<td>30.28</td>
</tr>
<tr>
<td>6.</td>
<td>75,000.00</td>
<td>1,328.89</td>
<td>56.44</td>
<td>2,463.01</td>
<td>30.45</td>
</tr>
<tr>
<td>7.</td>
<td>50,000.00</td>
<td>1,077.57</td>
<td>46.40</td>
<td>2,463.01</td>
<td>20.30</td>
</tr>
<tr>
<td>8.</td>
<td>65,000.00</td>
<td>810.53</td>
<td>80.19</td>
<td>1,885.74</td>
<td>34.47</td>
</tr>
<tr>
<td>9.</td>
<td>50,000.00</td>
<td>980.18</td>
<td>51.01</td>
<td>2,642.08</td>
<td>18.92</td>
</tr>
<tr>
<td>10.</td>
<td>45,000.00</td>
<td>738.27</td>
<td>60.95</td>
<td>2,123.72</td>
<td>21.19</td>
</tr>
<tr>
<td>11.</td>
<td>60,000.00</td>
<td>785.40</td>
<td>76.39</td>
<td>2,375.83</td>
<td>25.25</td>
</tr>
<tr>
<td>12.</td>
<td>45,000.00</td>
<td>829.38</td>
<td>54.26</td>
<td>1,963.50</td>
<td>22.92</td>
</tr>
<tr>
<td>13.</td>
<td>40,000.00</td>
<td>923.63</td>
<td>43.31</td>
<td>2,375.83</td>
<td>16.84</td>
</tr>
<tr>
<td>14.</td>
<td>60,000.00</td>
<td>816.81</td>
<td>73.46</td>
<td>2,551.76</td>
<td>23.51</td>
</tr>
<tr>
<td>15.</td>
<td>55,000.00</td>
<td>885.93</td>
<td>62.08</td>
<td>2,206.18</td>
<td>24.93</td>
</tr>
<tr>
<td>16.</td>
<td>40,000.00</td>
<td>923.63</td>
<td>43.31</td>
<td>2,375.83</td>
<td>16.84</td>
</tr>
<tr>
<td>17.</td>
<td>100,000.00</td>
<td>1,633.63</td>
<td>61.21</td>
<td>4,185.39</td>
<td>23.89</td>
</tr>
<tr>
<td>18.</td>
<td>55,000.00</td>
<td>923.63</td>
<td>59.55</td>
<td>1,885.74</td>
<td>29.17</td>
</tr>
</tbody>
</table>

**Effective stress = 57.95**

**Total stress = 24.15**

---

**Compression test results**

---

**Technical Research**
### Shear Strength Test Results

<table>
<thead>
<tr>
<th>Shear Strength (N)</th>
<th>Effective Area (mm²)</th>
<th>Stress (N/mm²)</th>
<th>Total Area (mm²)</th>
<th>Stress (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 20,000.00</td>
<td>1,620.00</td>
<td>12.35</td>
<td>3,848.45</td>
<td>5.20</td>
</tr>
<tr>
<td>2. 15,000.00</td>
<td>1,260.00</td>
<td>11.90</td>
<td>2,106.18</td>
<td>7.64</td>
</tr>
<tr>
<td>3. 15,000.00</td>
<td>1,080.00</td>
<td>13.89</td>
<td>2,463.01</td>
<td>6.09</td>
</tr>
<tr>
<td>4. 5,000.00</td>
<td>1,080.00</td>
<td>4.63</td>
<td>2,642.08</td>
<td>2.78</td>
</tr>
<tr>
<td>5. 10,000.00</td>
<td>1,980.00</td>
<td>5.05</td>
<td>2,642.08</td>
<td>3.78</td>
</tr>
<tr>
<td>6. 15,000.00</td>
<td>1,620.00</td>
<td>9.26</td>
<td>2,463.01</td>
<td>6.09</td>
</tr>
<tr>
<td>7. 20,000.00</td>
<td>1,260.00</td>
<td>15.87</td>
<td>2,463.01</td>
<td>8.12</td>
</tr>
<tr>
<td>8. 15,000.00</td>
<td>1,080.00</td>
<td>13.89</td>
<td>1,885.74</td>
<td>7.95</td>
</tr>
<tr>
<td>9. 15,000.00</td>
<td>1,080.00</td>
<td>13.89</td>
<td>2,642.08</td>
<td>5.68</td>
</tr>
<tr>
<td>10. 15,000.00</td>
<td>900.00</td>
<td>16.67</td>
<td>2,123.72</td>
<td>7.06</td>
</tr>
<tr>
<td>11. 10,000.00</td>
<td>900.00</td>
<td>11.11</td>
<td>2,375.83</td>
<td>4.21</td>
</tr>
<tr>
<td>12. 10,000.00</td>
<td>1,080.00</td>
<td>9.26</td>
<td>1,963.50</td>
<td>5.09</td>
</tr>
<tr>
<td>13. 15,000.00</td>
<td>1,080.00</td>
<td>13.89</td>
<td>2,375.83</td>
<td>6.31</td>
</tr>
<tr>
<td>14. 10,000.00</td>
<td>900.00</td>
<td>11.11</td>
<td>2,551.76</td>
<td>3.92</td>
</tr>
<tr>
<td>15. 10,000.00</td>
<td>1,080.00</td>
<td>9.26</td>
<td>2,206.18</td>
<td>4.53</td>
</tr>
<tr>
<td>16. 10,000.00</td>
<td>1,080.00</td>
<td>9.26</td>
<td>2,375.83</td>
<td>4.21</td>
</tr>
<tr>
<td>17. 10,000.00</td>
<td>1,440.00</td>
<td>6.94</td>
<td>4,185.39</td>
<td>2.39</td>
</tr>
<tr>
<td>18. 20,000.00</td>
<td>1,260.00</td>
<td>15.87</td>
<td>1,885.74</td>
<td>10.61</td>
</tr>
</tbody>
</table>

Effective stress = 11.34
Total stress = 5.62

---

**- Technical Research -**
Thank you very much

j.espinosa.benito@gmail.com