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**DIVISION: 06—WOOD AND PLASTICS**

**Section: 06110—Wood Framing**

**REPORT HOLDER:**

ESR-1636

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**EVALUATION SUBJECT:**

STRUCTURAL BAMBOO POLES

**ADDITIONAL LISTEE:**

BAMBOO HARDWOOD INC.  
THOI HOA VILLAGE  
BEN CAT DISTRICT  
DINH DUANG PROVINCE  
VIETNAM

1    **1.0    EVALUATION SCOPE**

2           **Compliance with the following codes:**

- 3           ■       2003 *International Building Code*<sup>®</sup> (IBC)
- 4           ■       2003 *International Residential Code*<sup>®</sup> (IRC)
- 5           ■       1997 *Uniform Building Code*<sup>™</sup> (UBC)

6           **Properties evaluated:**

7           Structural

8    **2.0    USES**

9           The structural bamboo poles are used as structural elements in wall, roof and floor

10 trusses (panels) or as individual compression and/or tension members, in Type V  
11 non-fire-resistance rated residential and commercial construction. The commercial  
12 construction is limited to one story and a maximum floor area of 2000 square feet  
13 (180 m<sup>2</sup>).

### 14 **3.0 DESCRIPTION**

15 The structural bamboo poles covered in this report are from Quang Ngi, Vietnam,  
16 and are of the Tre Gai (*bambusa stenostachya*) species. The bamboo poles are  
17 typically 2<sup>3</sup>/<sub>4</sub> inches (70 mm) and 3<sup>1</sup>/<sub>4</sub> inches (82 mm) in diameter and 10 feet (3048  
18 mm) to 14 feet (4267 mm) in length, depending on building the type. The structural  
19 bamboo poles have a nominal density of 42 pcf (673 kg/m<sup>3</sup>) and are preservativesly  
20 treated with a borate solution.

### 21 **4.0 DESIGN AND INSTALLATION**

#### 22 **4.1 General:**

23 Design and construction practices shall take the following into account:

- 24 ■ A design shall be provided for lateral bracing to resist wind and seismic  
25 forces.
- 26 ■ The structural performance shall be assessed by calculating the action  
27 effects using a linear material model (elastic behavior).
- 28 ■ The effect of shrinkage shall be taken into account in the design of individual  
29 structural members, and in the design of the structure as a whole.
- 30 ■ The effects of long-term loading (creep) need to be considered in the design  
31 of individual structural members, and in the design of the structure as a

32 whole. Long-term flexural creep in bamboo in bending may be assumed to be  
33 3 to 4 percent of the immediate elastic deformation.

#### 34 **4.2 Design Considerations:**

35 **4.2.1 Allowable Design Stresses:** Design stresses shall not exceed the values  
36 noted in Table 1. No adjustment for duration of load shall be made, except for  
37 permanent load and wind load conditions, as addressed in this section.

38 For a permanent load condition (more than 10 years), all stresses, except for MOE,  
39 shall be reduced by 25 percent. For a wind loading condition, the allowable design  
40 stresses, except for MOE, are permitted to be increased by 20 percent.

41 **4.2.2 Bamboo Poles (Elements):** The design of individual elements shall consider  
42 the following:

43 **4.2.2.1** The element retains its elastic behavior, until failure (plastic behavior is  
44 considered to be not significant).

45 **4.2.2.2** The elements are analyzed as variable-thickness, hollow-tube  
46 structures.

47 **4.2.2.3** The elements are analyzed as not perfectly straight members.

48 **4.2.2.4** The elements are analyzed as tapered members.

49 **4.2.2.5** Design is conducted in accordance with the following:

50 a. Conventional structural analysis methods are used, with definitions of the  
51 initial curvature, the diameter and the wall thickness.



74           **4.2.2.7**       Design of bamboo poles acting as columns shall be based on one of  
75           the following:

76           a.       Results of compression buckling tests on full-size specimens.

77           b.       Calculations based on the following:

78               (i)       The moment of inertia ( $I$ ) shall be determined in accordance with  
79               Section 6.6.1 of the INBAR document in Appendix A of the ICC-ES  
80               Acceptance Criteria for Structural Bamboo (AC162).

81               (ii)       The bending stresses due to initial curvature, eccentricities and  
82               induced deflection shall be taken into account.

83               (iii)       Buckling calculation shall be in accordance with the Euler equation,  
84               using a reduction of 90 percent of the moment of inertia. [The  
85               reduction to 90 percent takes into account the effect of the taper,  
86               provided the taper (defined as the ratio of the difference between the  
87               minimum and maximum outer diameters to the length) is less than  
88               1:170.]

89           **4.2.3 Connections:** Connections shall be designed to achieve structural continuity  
90           between elements.

91           Connection designs shall be based on complete full-size tests of the connector for a  
92           given load and geometry. This includes fastening elements and locations.

## 93   **5.0 CONDITIONS OF USE**

94           The structural bamboo poles described in this report comply as an alternative  
95           material and method of construction as noted in those codes specifically listed in  
96           Section 1.0 of this report, subject to the following conditions:

- 97           **5.1**    Design and analysis shall comply with the details noted in this report.
- 98           **5.2**    Calculations, drawings and required reports of connection and compression  
99                    tests, as noted in Sections 4.2 in this report, shall be furnished to the building  
100                   official, verifying that the material is used in accordance with this report. The  
101                   drawings and calculations shall be prepared by a registered design  
102                   professional where required by the statues of the jurisdiction in which the  
103                   project is to be constructed.
- 104           **5.3**    Special inspection may be required by the code official for the assembly of  
105                   the finished product at the job site, in accordance with Section 1404.6 of the  
106                   IBC.
- 107           **5.4**    The bamboo shall be limited to end-use locations at which the average  
108                   equilibrium moisture content of the material is equal to or less than 16  
109                   percent.
- 110           **5.5**    The bamboo shall be processed at Bamboo Hardwoods Inc., Thoi Hoa  
111                   Village, Ben Cat District, Dinh Duang Province, Vietnam , with inspections by  
112                   SGS Vietnam (AA-701).
- 113    **6.0    EVIDENCE SUBMITTED**
- 114           **6.1**    Descriptive details
- 115           **6.2**    Quality control manual
- 116           **6.3**    An analysis and results of tests verifying compliance with the ICC ES  
117                   Acceptance Criteria for Structural Bamboo (AC162), dated March 2000.

118 **7.0 IDENTIFICATION**

119           The structural bamboo poles shall be identified with a stamp indicating “Certified  
120           Pole,” the name of the inspection agency, the evaluation report number (ESR-1636),  
121           and the word “Borate Treated.”

122   This evaluation report is subject to re-examination in one year.

KS/ls

TABLE 1—ALLOWABLE DESIGN STRESSES

PRODUCT	BENDING STRENGTH, $F_b$ (psi)	MODULUS OF ELASTICITY, $MOE$ (psi)	COMPRESSIVE STRENGTH, $F_c$ (psi)	HORIZONTAL (LONGITUDINAL) SHEAR STRENGTH, $F_v$ (psi)	TENSILE STRENGTH, $F_t$ (psi)
Structural Bamboo Pole	2,940	$23 \times 10^6$	1,140	205	2,170

<sup>1</sup>Allowable design stresses are based on values derived from testing in accordance with AC162. Factors have been applied as noted in Sections 3.3.2 and 3.3.3 of AC162. No adjustment for duration of load shall be made, except for a permanent load condition, and as noted in Section 4.2.1 of this report. For a permanent load condition (more than 10 years), all stresses, except for MOE, shall be reduced by 25 percent.

<sup>2</sup>Allowable values are based on covered dry conditions of use, defined as those environmental conditions represented by sawn lumber with an equilibrium moisture content of less than 16 percent.

<sup>3</sup>Tensile strength noted is the result of small-scale tension tests. See Section 4.2.2 in this report for additional information.