PROPERTIES COMPARISON OF GUADUA AND MOSO BAMBOO ORIENTED STRAND BOARD WITH ASPEN STRANDS IN THE CORE

by

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Abstract

Bamboo (*Poaceael/Graminaceae*) has great potential for use in improving the properties of wood-based strand composite building materials. In previous work it has been shown that replacement of aspen surface strands with Moso bamboo (*Phyllostachys pubescens* Mazel) strands significantly improves the strength and water resistance of oriented strand board (OSB) of the same density made from Aspen. Guadua (*Guadua andustifolia* Kunth) is one of the most commercially cultivated and used timber bamboo genera in Latin America. In this study, three experiments were designed.

Six sets of 6 three-layer OSB (737 x 737 x 11.1 mm) were made with bamboo strands in the face layers and Aspen strands in the core layer. Measured board properties included internal bond, flexural properties (modulus of rupture, MOR; and modulus of elasticity, MOE), and water resistance (% thickness swell, TS; and % water absorption, WA). The 50% Guadua -50% Aspen boards (type GM) was compared with 50% Moso -50% Aspen boards (type MM) to examine the effects of bamboo species. Guadua hybrid OSB had a weaker IB strength and a higher MOE in the parallel direction. No other significant difference was found.

To examine the effect of reducing board density down to an acceptable level, three board types were compared. 1) 50% Moso - 50% Aspen boards (type MM) with target density of 760 kg/m^3, 2) 25% Moso - 75% Aspen boards (type ML1) with target density of 720 kg/m^3, and 3) 25% Moso - 75% Aspen boards (type ML2) with lower target density of 628 kg/m^3. The lowest density group had the lowest mechanical properties and water resistance ability but met the Canadian Standards Association (CSA) standards for industrial OSB.

Another two board types were designed to examine the effect of the nodes on Guadua OSB products' properties. 50% Guadua Node – 50% Aspen boards (type GN) showed weaker IB strength and weaker flexural properties than 50% Guadua Internode – 50% Aspen boards (type GI).

Preface

A version of section 4.2 has been published. Zhang, K., K. Semple, and G. Smith (2015). Tailoring the addition of Moso strands to enhance the properties of OSB but reducing board density. Proceedings of the 58th International Convention of Society of Wood Society and Technology June 7-12, 2015. 788:197-205. With Kate Semple's help on making the boards, I conducted all the testing and wrote all of the manuscript under the supervision of Greg Smith.

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List of Abbreviations

ANOVA – Analysis of Variance

ASTM – American Society of Testing Materials

COV – Coefficient of Variance

CSA – Canadian Standards Association

GLG – Glued Laminated Guadua bamboo

IB – Internal Bonding

MC – Moisture Content

MOE – Modulus of Elasticity

MOR – Modulus of Rupture

PF – Phenol Formaldehyde

TS – Thickness Swelling

WA – Water Absorption

Glossary

Bamboo Fibre refers to a distinct family of primary processed bamboo elements. Bamboo fibre usually refer to single bamboo fibre cells or an aggregation of multiple fibre cells (Liu et al., 2016). Many species of bamboo produce fibres similar in size to wood fibres and vascular wood-cells.

Bamboo Strand is a short sliver of bamboo. The thickness ranges from 0.5 mm to 0.8 mm and lit is longer than it is wide. In the case that bamboo strands are used to make Oriented Strand Board, the strands range from about 10 to 50 mm in width and 100 to 120 mm in length.

Billet is the short section cut from the culm. Mostly, the culm could be cut to four billets depending on the length of the culm.

Culm, sometimes used alternately with ‘pole’ or ‘stem’, refers to the stem of the bamboo plant. The bamboo culm is further processed into smaller elements for engineered bamboo products.

Halves, also known as Half-Split Culm or Half-Round Bamboo, refers to the largest form of a thick section of culm. Nodes are removed from these units using hand tools.

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Chapter 1: Introduction

1.1 Background

Bamboo (*Poaceae*/*Graminaceae)* is a fast growing giant grass that can be tougher than wood owing to its unique microscopic structure and chemical composition (X. Li, 2004). As a renewable woody biomass plant, bamboo is used to replace wood in construction and other fields in several countries across Asia, Africa and Latin America where bamboo grows natively (Liese, 1998; Peng et al., 2010). This Master's study is part of the Structural Bamboo Products (SBP) project funded by the G8 Multilateral Research Initiative sponsored by the United Nations and administered by NSERC. The SBP project aims to develop green construction materials as an alternative to the energy-intensive nature and unsustainability of conventional construction materials such as steel and concrete.

Many composite products are made of bamboo such as laminated bamboo flooring, bamboo plywood-like panels, and bamboo scrimber. However the individual manufactures are small scale and very labour intensive. The processing has low product recovery from the culm, and uses more adhesive than comparable wood composites. Bamboo processing enterprises are economically marginal due to rising competition for culm supplies and cost of labour (Semple, 2015a). According to Mr. Li (Li, 2013), who is the plant manager of Chengfeng Bamboo Industry Co. Ltd in Anji, China, the recovery from bamboo culm to laminated bamboo lumber was about 60% to 70%. Most waste is bamboo inner and outer wall layers. No record was found for a worldwide average recoveries for industrialized bamboo products. A V-grooving method was studied in the lab with a recoveries around 77% in Malaysia (Bakar et al., 2013). This method took the advantage of the cylindrical shape of bamboo culm and made the outer circumference of the cylinder the same with the inner circumference by removing parts of the outer side in a series of V-shaped grooves.

1.2 Rationale

Although both the physical and mechanical properties of bamboo OSB could meet CSA industry-level standards (Lee et al.1996), the density of bamboo composites is often too high to be a practical direct substitute for commodity OSB manufactured from wood. The great concentration of vascular bundles in the culm wall makes the bamboo dense and strong (Ghavami 2005). The strength of bamboo depends largely on the number of the vascular bundles (Lo et al. 2008). The density of the bamboo fibres is 800 kg/m^3 making it very difficult to nail conventionally (Li & Shen, 2011).

Moso is one of the most common bamboo species used as building materials and has, for decades, produced good quality, strand-based composites (Lee, Bai, & Peralta, 1996). However, the best known commercially cultivated genus in Latin America is Guadua. Among 38 known Guadua species, *Guadua andustifolia* Kunth, a sympodial bamboo, is the typically species used for timber products (Schroder, 2014). But there is no literature on strand based composites made from Guadua specie.

There are a few studies on Guadua composites products. Correal and Ramirez (2010) from Columbia found optimal adhesive spread rates of 300 g/m^2 for glued laminated Guadua bamboo among six different rates based on glue line tests. Archila et al. (2015) formed a novel composite flat sheet material using Guadua fibre and a set range of polymers such as thermoset polymers, natural latex, polystyrene and polyurethane. They called their product “plastiguadua” and assessed its physical and mechanical properties. The work reported here will attempt to fill the knowledge gap in the literature on Guadua strand based composites.

Nodes are generally the rings that appears on a bamboo pole with varying distances from one another (Mahdavi et al., 2012) and are indicated by the arrows in Figure 1. The opposite is an internode, which represents the material between nodes. The mechanical properties of the culm in the node region are lower than the culm material between nodes (Lee et al., 1996; Sulastiningsih & Nurwati, 2009). Idris et al. (1994) reported the MOR of *G. apus* was 502.3 kg/cm^2 for parts with nodes and 1240.3 kg/cm^2 for internodes; and the compression strength of *G. apus* was 505.3 and 521.3 kg/cm^2 for parts with nodes and internodes respectively. Previous studies of Smola and Zhang found that nodes significantly reduced the bending strength of hybrid Moso-Aspen OSB (Smola, 2013; Zhang, 2013). However, there is no study on how nodes affect the strength of Guadua strands based composites products.

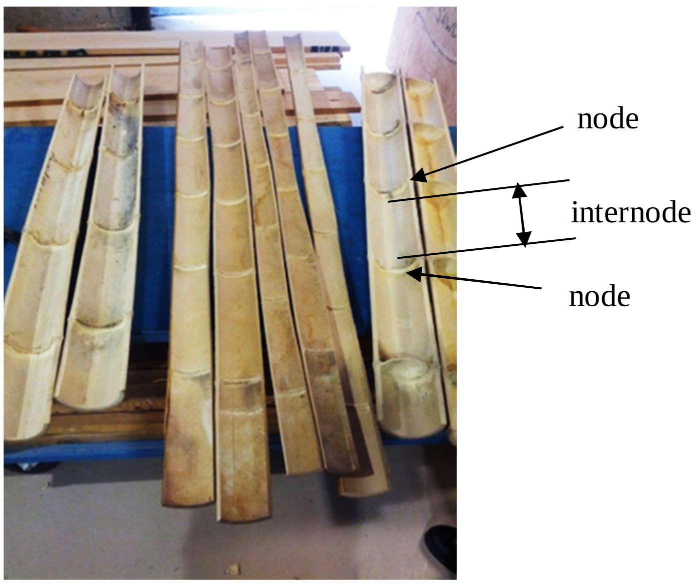


Figure 1. Nodes on Moso Bamboo

1.3 Hypotheses

Based on the literature review and previous studies (Semple et al., 2015a; Semple et al., 2015b), several questions need to be addressed. First, since Guadua has denser vascular bundles than Moso, it is expected that Guadua OSB products will have higher strength properties than Moso OSB for similar final density of products. What is the difference in properties between boards made from these two species? Second, we want to reduce the density while still retaining acceptable mechanical properties. How much would the strength be affected by reducing the density? Could we meet the requirements based on CSA standard for both the density and the quality? Third, it was found that nodes have negative effect on the bending strength of Moso OSB (P. K. Zhang, 2013). The node anatomy of each species is very different and it is not clear if the presence of nodes in Guadua will reduce board properties.

The hypotheses are as follows. First, Guadua is stronger than Moso based on similar final density of products. Second, the properties will be affected by the reduced density but still meet the requirements of CSA standard. Third, the presence of node will reduce the board properties.

1.4 Approach

Guadua and Moso were compared under the same manufacture condition. In previous work Aspen strands are mixed with bamboo elements to improve the compaction of the mat in the core (Semple et al., 2015b; Zhang, 2013). Thus the boards in this research used Aspen as core material.

In our previous work (Semple et al. 2015b) mixed Moso bamboo (*Phyllostachys pubescens* Mazel) and Aspen (*Populus tremuloides* Michx.) wood strands together to produce a 3-layer

Moso surfaces/Aspen core OSB with a density around 740 kg/m^3. Based on Structural Board Association design information (SBA, 1998) and TECO publication Design Capacities for OSB (TECO, 2008), the normal density is around 640 kg/m^3.

1.5 Structure of Thesis

The thesis consists of the following chapters:

Chapter 1. Introduction: this chapter introduced basic information on bamboo and discusses the motivation of this master project.

Chapter 2. Literature Review: this chapter summarized the body of previous work on bamboo and bamboo composites.

Chapter 3. Materials and Method: this chapter described the raw materials (bamboo, aspen strands, and resin). The manufacture process of hybrid three layer OSB was covered in detail in this chapter.

Chapter 4. Results and Discussion: this chapter displayed the test results and discussed what could be concluded from the results. The discussion part answered the questions and examined the hypothesis stated in Chapter 1.

Chapter 5. Comments and Future Work: this chapter gave a brief conclusion and list several possible directions for further research.

Chapter 2: Literature Review

2.1 Bamboo

Bamboo has been used in construction structures for centuries, especially in South Asia and South America. The high strength and tubular form of varying diameters make bamboo different from conventional, rectangular wood materials. The hollow cylindroid form of a culm makes bamboo an optimal material in an engineering sense. Its tubular structure provides good structural stiffness per unit weight with bending strength ranging from 10.3 to 27.6 GPa (Lee et al., 1994) while its nodes behave as bulkheads and prevent buckling of the stem under compression (Amada & Lakes, 1997).

Bamboo grows faster than any other plant. Most species can reach their full height within 2-4 months while requiring about 3-8 years to reach maturity (Lee et al., 1996; Liese, 1987). Certain species grow and reach heights of 4.8 m to 28 m tall depends on species (Lewis et al., 2007) at a rate as high as 3 cm/h (Guinness World Records, 2015). With the optimized distribution of fibers and bio-matrices in resisting environmental loads in nature, bamboo is regarded as one of the most sophisticated natural materials (Low et al., 2006).

In the modern world, two forms of bamboo have been cultivated: woody bamboos and herbaceous bamboos (Kelchner & Group, 2013). Different species which range in size from delicate culms smaller than a few millimeters in diameter and centimeters in height to massive culms up to 36 cm in diameter. Figure 2 shows *Phyllostachys* sp., one kind of lignified woody bamboo. Woody bamboos are referred as lignified bamboos, while herbaceous bamboos are non-lignified. Some species of herbaceous bamboos are used in China as an indoor ornamental plants.

The specie shown in Figure 3 is *Arthrostylidium sarmentosum*, a kind of herbaceous bamboo. With limited vegetative branching, herbaceous bamboos are clump-forming or stoloniferous (Calderón & Soderstrom, 1980).

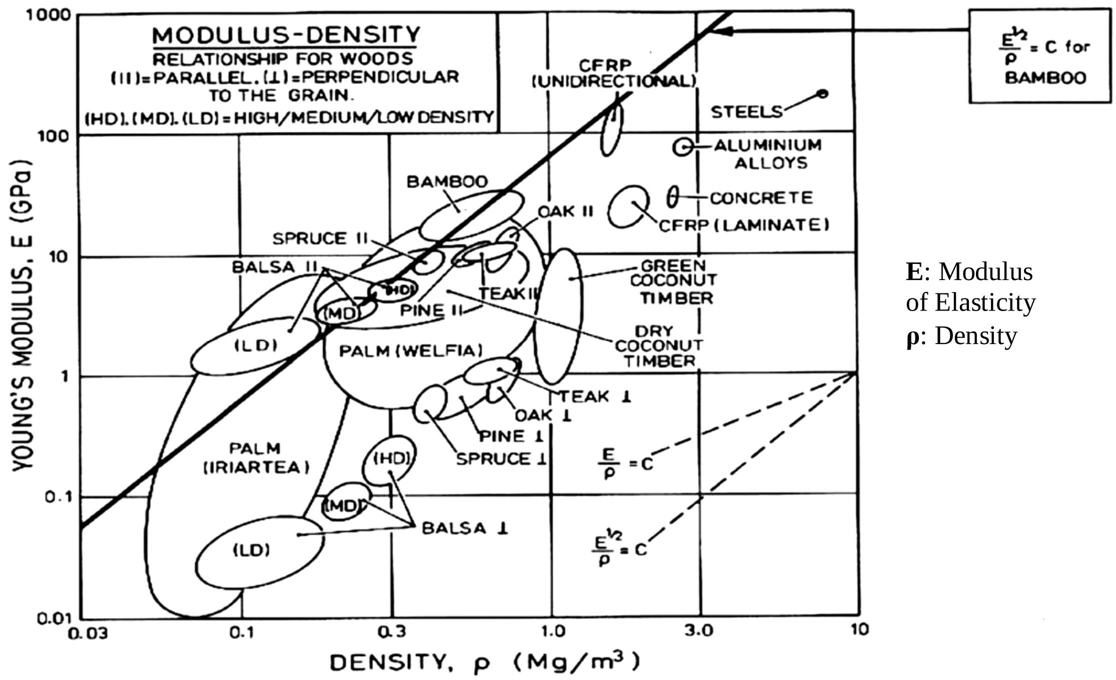
Figure 2. *Phyllostachys* sp. (Clark, 2006) **Figure 3. *Arthrostylidium sarmentosum***(Clark, 2006)
Retrieved January 11, 2016 from http://www.eeob.iastate.edu/research/bamboo/bamboo.html . Used with permission from the photographer Dr. Clark. (See Appendix D for the permission).

In 2006, a detailed quantitative lifecycle assessment of the environmental, economic and practical performance of bamboo, van der Lugt et al. found that bamboo structures have a lower environmental impact than other more commonly used building materials, such as steel, timber, or concrete. Three years later, Nath et al. (2009) report that common bamboos of northeast India (represented by 67% *Bambusa cacharensis*, 18% *Bambusa vulgaris* and 15% *Bambusa balcooa*) sequestered 61 tons of above ground carbon per hectare per life span (average 2 years age), compared to 54 tons per hectare above ground carbon stocks for tropical forests and 25 tons per hectare above ground carbon stocks for temperate forests during the latter part of 20th century (Gorte, 2009). Bamboo has a better rate of carbon sequestration than tropical forests, boreal forests, and temperate forests.

To be suitable for processing into similar kinds of engineered composites as small wood logs, culms of sufficient diameter, up to 150 mm, are required (Semple et al., 2015a). Among bamboo species, Moso and Guadua are both temperate woody bamboos are known as giant timber bamboo as they have diameters of 130 mm or more. The thickness of the culm wall ranges from 4 to 12mm. The wall thickness of a culm is directly proportional with the outer culm diameter (Lo et al., 2004).

Similar to wood, bamboo exhibits significant anisotropy in strength. It is more than ten times stronger in tension in the longitudinal direction than in the transverse direction (Amada & Lakes, 1997). The microstructure, strength and density of nodes may affect the properties of OSB product made from bamboo. One of the differences between bamboo and wood is the outer and inner layers which cover the bamboo culm. The composites of the culm outer layer or epidermis of bamboo contains silica. Li et al. (2004) have found the ash content of bamboo is primarily silica, calcium, and potassium. Among those, silica content is the highest in the epidermis, lower in the nodes and absent in the internodes (Li, 2004). Silica content dulls normal steel blades very fast (Shaddy, 2008). It is hard to treat bamboo with preservatives because of the hard epidermis and the inner wax layer covering the bamboo culm prevents penetration (Lee et al., 2001; Liese, 1998). While an oil-bath treatment has proved to be successful in preventing fungal attack, this treatment severely weakens the material (Leithoff & Peek, 2001). The wax and silica contained in the inner and outer culm layers affect the wetting characteristics of the surface by making it difficult to bond (Lee et al., 1998). These layers can be removed by planing or sanding but this results in significant loss at material.

To study the structural advantage of bamboo culms over other engineering materials in terms of Young's modulus, also known as elastic modulus, E, and density, ρ, Wegst et al. (1993) developed a material selection method. The results were summarized as shown in Figure 4. To make the comparison clear, they used a line whose equation was C (a constant) = $E^{1/2}/\rho$ to compare the properties of bamboo with other materials. Stiffer and lighter materials fall above the line, while more flexible and heavier materials fall below the line. The ovals in the figure represents the range of the available data for a particular given material. The figure shows that only timber from palm-trees and balsas have comparable specific stiffness to bamboo, i.e. similar high MOE but low density; whereas conventional building materials, such as aluminum, concrete, and steel, have lower specific stiffness.



E: Modulus of Elasticity
ρ: Density

Figure 4. Relationship of modulus-density for materials (Wegst et al., 1993)
Retrieved November 15, 2103 from Elsevier. Used with permission from Elsevier.

2.1.1 Moso Bamboo

Of the over one thousand species of bamboo (Austin et al, 1972), Moso (*Phyllostachys pubescens* Mazel) is one of the few commercially used species. Bamboo can be differentiated under two categories as sympodial and monopodial (Birkeland, 2002), shown in the Figures 5 and 6. As a monopodial bamboo (intermittently spaced stems from an interconnected below-ground rhizome), Moso has been used in China for a wide range of products. China has over 5 million hectare of Moso bamboo, or 70% of China's natural and commercial bamboo forests, amounting to over 20% of total world bamboo resources (Jiang, 2002; Peng et al., 2010). Since Moso is easy to plant, grows straight and rapidly, and has a thick wall (Fu, 2007b), it is widely cultivated and utilized.

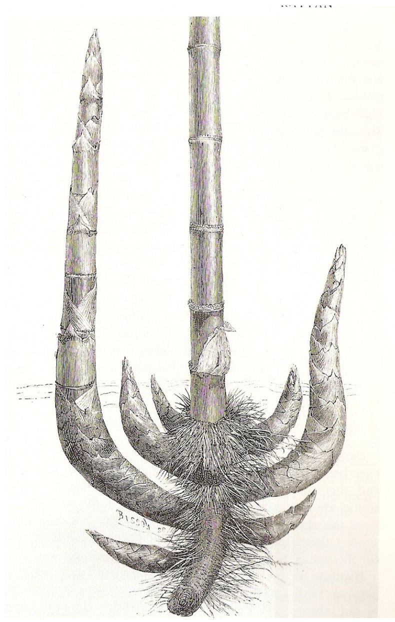


Figure 5. Sympodial Bamboo (Rivière & Rivière, 1878)
Retrieved June 28, 2016 from Biodiversity Heritage Library (BHL). Used with permission from BHL.

Figure 6. Monopodial Bamboo (Rivière & Rivière, 1878)
Retrieved June 28, 2016 from Biodiversity Heritage Library (BHL). Used with permission from BHL.

2.1.2 Guadua Bamboo

Some countries in South America such as Colombia have been using Guadua plastered with mud or cement mortar in housing construction for centuries (Paudel & Lobovikov, 2003). Other simple building products made from Guadua include crushed bamboo mats (also called "esterilla" in Spanish), which is a single or multilayer plywood-like panel made from flattened, thin-walled culms cut from the upper stem (Semple et al., 2015c). Mats made from crushed Guadua bamboo are shown in Figure 7.

Colombia has made significant progress in developing engineered, glue-laminated guadua bamboo (GLG), of which the mechanical properties are better than most conventional laminated wood or bamboo species (Correal et al., 2014). Even when compared to those of the highest quality structural tropical wood products in Colombia, GLG shows equivalent performance (Voermans, 2006). It has excellent structural properties for dwellings in earthquake zones including a high shear and fastener tear resistance-to-weight ratio, high energy absorption capacity and, flexibility (Juan F Correal & Varela, 2012). Since consumers are looking for alternatives with similar appearance, density and properties to tropical timber, Guadua timber is becoming popular. Guadua stems can reach 30 m in height, 20 cm in diameter, and similar to Moso, culms are harvested around 5 years of age.

Figure 7. Cured and dried crushed bamboo mats (Schroder, 2014)
Retrieved from March 13, 2013 from https://www.youtube.com/watch?v=RqYtEB8Lq9E Used with permission from Youtube.

Guadua has a very high storage of carbon fixed annually per hectare, with a very short growth period. Following the methodology of Riaño et al. (2002), the carbon fixation estimated for 400 clumps per hectare of Guadua *angustifolia* is 54.3 tons in total for a growth period of 2190 days (6 years). Another report edited by Gorte (2009) summarized the average carbon levels sequestered for several major biomes including Tropical Forests, Temperate Forests, Boreal Forests, Tundra, Croplands, Wetlands, Temperate Grasslands and etc. during the latter of part of 20th century (10 years). The weighted average carbon sequestered for all biomes is 34.6 tons of carbon per hectare in total for 10 years.

In countries such as Colombia and Peru, Guadua is widely used for construction either as round culms or standardized engineered products with rectangular strips. However, about 40% of the material is wasted due to natural defects or variability in dimensions (Archila et al., 2015). Researchers are interested in fully exploiting Guadua's high fibre content and high tensile strength with the aim of creating more efficient alternatives for converting raw Guadua into standardized products.

2.1.3 Differences and Comparison between Moso and Guadua

A report from Larenstein University gives a detailed comparison between Moso and Guadua (de Vos, 2010). Comparing the thickness of node plate in Figure 8 and the length of the node region in Figures 9e) and 9f) of each species, the node regions of Moso are smaller than Guadua. Also visible in Figures 9a) and 9b) is the decrease in size of the vascular bundles from the inner culm wall toward the outer wall as shown in tangential surface (de Vos, 2010). But the vascular bundles at the outer part of the culm are denser than toward the inner part (Grosser & Liese, 1971). Moso has a finer grain than Guadua because of its smaller vascular bundles. As shown in Figures 9c) and 9d), the longitudinal surface of Moso is smoother than Guadua's surface. Both species have a higher concentration of the vascular bundles near the outside of the culm wall than toward the inside, as shown in the difference between Figures 9c) and 9e), and between Figures 9d) and 9f).

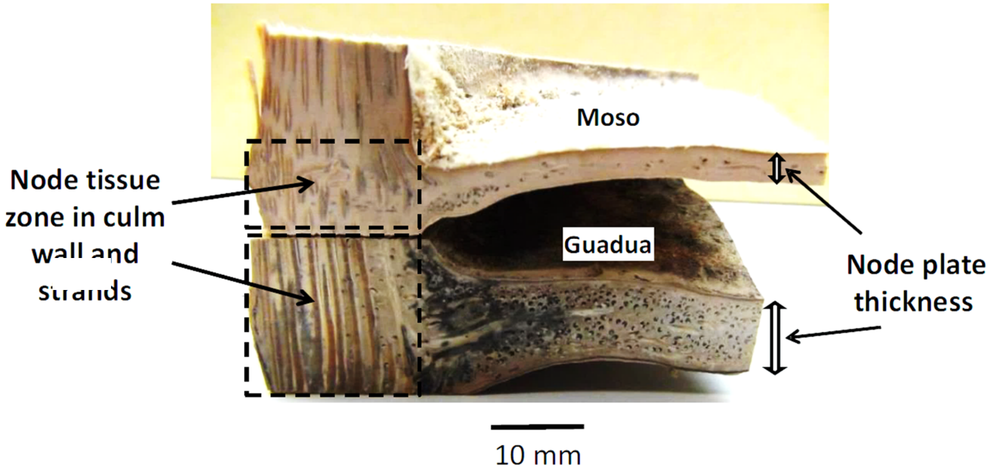


Figure 8. Appearance of the node plates of Moso and Guadua
Bottom 1 meter portion of the culm

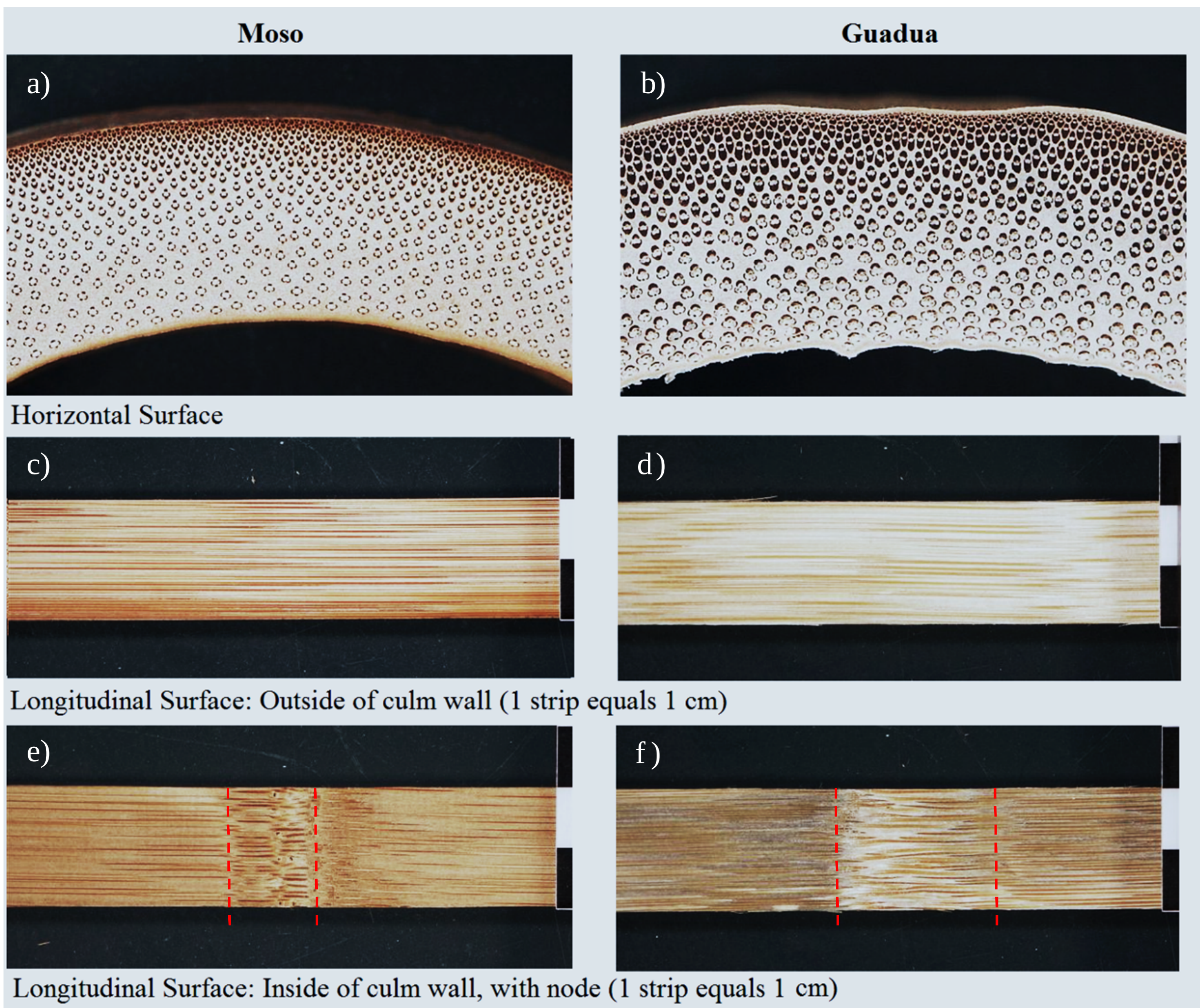


Figure 9. Comparison between Moso and Guadua culm(de Vos, 2010)
Retrieved June 15, 2015 from Wageningen UR Library. Used with permission from Wageningen UR.

Our previous study showed the average oven dry density of Moso for both internode and node plates are lower than Guadua (Semple et al., 2015c, 2015d). Guadua poles have slightly greater average diameter and wall thickness with lower frequency of nodes and longer distances between nodes than Moso poles. A summary of the basic properties comparison is given in the Table 1.

Table 1. Properties of Moso and Guadua polese used to produce strands (Semple et al., 2015c, 2015d)

Property	Moso	Guadua
Internode tissue density* (kg/m^3)	446.8	533.1
Node tissue density* (kg/m^3)	531.8	601.6
Pole diameter (mm)	101.7	103.7
Internode length (cm)	23.98	30.67
Node Frequency (1/m)	3.80	3.30
Wall Thickness (mm)	10.9	12.0
Node Plate Thickness (mm)	2.77	7.38
Delivered MC (%)	11.7	13.3

*Oven-dry density

2.2 Bamboo Composites Products

Bamboo has been planted in many places to ameliorate soil erosion and replace extensive historic forest losses. Until recently, it has been used in varies ranges of industries from slat-based laminated furniture and flooring to plywood-like panels to heavily compressed beams known as ‘scrimber’ for decades. The bamboo composites manufacture technology has a high degree of biomass recovery into product (Jyoti Nath et al., 2009). Nevertheless, technologies to convert bamboo into the same kinds of modern, engineered composite building products as wood are still in the process of development (Flander & Rovers, 2009). Bamboo’s natural hollow tube shape makes it impossible to use standard connections to connect it. Researchers have long been interested in converting bamboo from an irregular tube into shapes more suitable form for structural applications (Mahdavi et al., 2012). This interest led to the development of laminated bamboo lumber (Lee et al., 1998; Nugroho & Ando, 2001; Rittironk & Elnieiri, 2008).

Preliminary investigation from Mahdavi et al. (2012) showed that in order to flatten culms and create mats for bamboo composites, hammering culms can be just as, or more effective, than pressing them. After hammering, coarse sandpaper was used to smooth the inner face of the culm. These alternatives were found very effective in removing inner and outer surface layers which contained wax and silica but were very labour intensive. This process is adaptable and available to people in developing regions where heavy machinery is not accessible (Mahdavi et al., 2012). Archila et al. (2015) developed Guadua composites to protect the products against humidity, insects attack and bio-deterioration. In their research, the high strength of bamboo fibres as reinforcement was combined with polymeric matrices, which was polyester resin, to form flat sheets. The physical and mechanical properties of these sheets assessed from that research were expected to serve as a basis for further development of the engineered bamboo products.

2.2.1 Wood OSB Products

OSB has been one of the fastest developing wood composite products due to its outstanding properties, ability to use logs unsuitable for veneering production, particularly in the USA (Benetto et al., 2009). OSB is a compressed mat made up of three layers of strands bonded together with a thermoset resin. Most commodity OSB is manufactured with aligned strands oriented parallel to the long edge of the panel in the surface layers, with a core of randomly oriented smaller strands and fines (shown in Figure 10b). For certain higher grades of board the core strands may be oriented perpendicular to the strands direction on the surface, this structure gives the board comparatively higher mechanical strength for both directions (Figure 10a). The third type of board has both non-directional surface and core (Figure 10c). That is the original waferboard product that pre-dates OSB, and now is rarely produced.

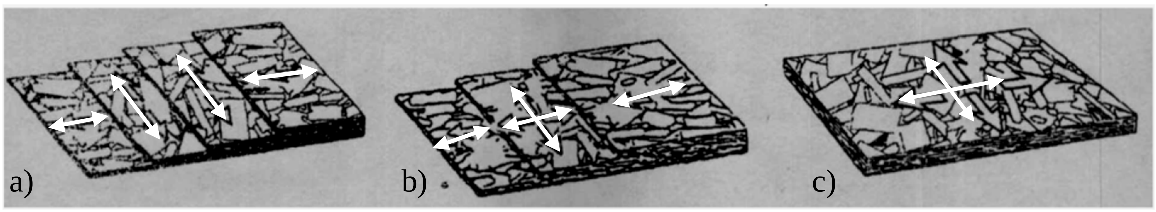


Figure 10. OSB lay up Canadian Standards Association classifications (Structural Board Association, 1998) Retrieved November, 2013 from Structural Board Association, Used with permission from OSBGuide™

2.2.2 Bamboo OSB Products

Lee et al. (1996) had shown that the manufacture of strand boards from Moso bamboo is technically feasible. Several studies have shown that Moso bamboo in particular is a potential feedstock for OSB (Fu, 2007a, 2007b; H. Zhang et al., 2006). The OSB fabrication process represents one of the best ways for automation and mass production of bamboo-based building materials. China has been developing and promoting the use of OSB as a sustainable construction material since the mid-1970's in order to reduce the demand for energy intensive traditional concrete and bricks (Hua, 2003). Yunnan Yung Lifa Forest Co Ltd. has spent a few years adapting OSB manufacture technology to bamboo and recently commenced production of commercial quality bamboo OSB for shipping container flooring (Anon, 2012; Grossenbacher, 2012).

2.2.3 Three-layer Hybrid Bamboo OSB

Because the concentration of vascular bundles in bamboo culm decreases from the outer culm wall toward the inner culm wall (Yu et al., 2008), there is a significant strength loss when the outer layer is removed as is the case for traditional bamboo products processing. Also there is lots of waste caused by removing the outer layers with up to 40% cutting waste (Archila et al., 2015; Flander & Rovers, 2009). Semple et al. (2015a) created a novel manufacturing method that uses a stranding machine for OSB to cut strands from the culms with no need to remove the outer or inner layers. Nodes were removed by hammering. With only 5% of the total culm stock chips being thrown away, recovery was about 87% (Semple et al., 2015c). In addition, a three-layer hybrid sandwich structure OSB with aspen in the core and bamboo on the surface was found to be stronger than normal uniformly mixed single layer OSB and three layers pure Aspen OSB (Semple et al., 2015b; Zhang, 2013). Thickness swell also improved by 40% compared with normal wood OSB because of the slower water absorption of the bamboo board.

There is no research that compares Guadua and Moso strands based composite products. Experiments on the effect of species on the boards' properties are required to learn the difference between Guadua and Moso. No bamboo OSB has been made with a sufficiently low density to be accepted as replacement for wood OSB. With Aspen strands in the core, the weight ratio could be adjusted to obtain the target low density. Since the nodes structure are different between Guadua and Moso, experimentation about possible node effects on Guadua OSB is required.

Chapter 3: Materials and Methods

3.1 Culm Feedstock

For the board fabrication experiment, 20 poles of Chinese Moso culm stock in 243.8 cm lengths (Figure 11) were purchased from Canada's Bamboo World, located in Chilliwack, BC, who imports seasoned and fumigated (methyl bromide) bamboo poles from Zhejiang Province in South East China. The Moso culms had an average diameter of 101.7 mm with an average weight of 6.6 kg. All the supplied poles were harvested at four years of age. Ten Guadua poles size 579.1 cm long were acquired from Koolbamboo, Miami, FL, USA, who import seasoned, treated (Borax) culms harvested between four and six years of age from Colombia and Panama. Each Guadua pole was cut into 198.1 cm length before shipping. The average Guadua pole diameter was 103.7 mm with a MC at 13.3%. Other pole characteristics recorded were internode lengths (distance between nodes), number of nodes per meter, and the shape and thickness of the nodes were measured and compared between Moso and Guadua (see Table 1 in Chapter 2). These characteristics can vary greatly between bamboo species.

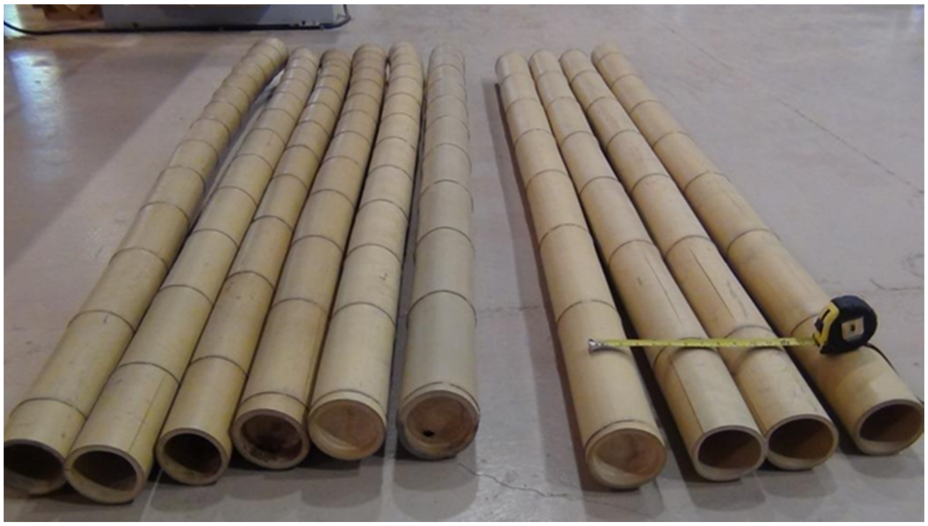


Figure 11. Moso poles purchased cut from Canada Bamboo World

All the poles were stored outside the machine lab in UBC CAWP under cover with an average temperature of 7.5 °C, and average relative humidity of 85% from March to May of the year 2014 (WeatherSpark, 2014).

To calculate the moisture content and density of the raw materials, each pole was cross-cut using the Pendulum Saw (Stromab PS 50/F) into four short billets (shown in Figure 12).

Figure 12. Short billets from Guadua poles

3.2 Culm Breakdown

After cross-cutting, the volume of small specimens cut from the culms was measured using the water displacement method. The oven dry density of the Moso culm is 745 ± 21 kg/m^3, while the oven dry density of the Guadua culm is 806.6± 17 kg/m^3. The average moisture content is 19.3 ±1.1%.

Semple and Smith (2014) found it is more effective to convert the billets into quarters rather than halves since the number of strands per culm round stranded is increased. Therefore all the bamboo culm rounds were cut into quarters lengthways using a band saw (type Meber SR-500). Because the maximum width and height of the feed box for the strander was only 130 mm, culm quarters were cut shorter to no more than 130 mm long using a chop saw (type Omega T55-300). In order to compare the effect of nodes in strands on the properties of boards, the bamboo culm quarters were cut to be either node free (internode) or to have a node near the middle (node). And for there to be roughly even numbers of node and node free rounds, there were about 17 to 19 pieces cut from each culm quarter. The internal plate of the node in Moso is very thin (about 2-3 mm in thickness) and easy to remove with a hammer. The internal plate of the node in Guadua is thicker (ranging from about 6 to 12 mm depending on height in the culm; and much thicker near the base). Node plate removal required a Dremel saw followed by sanding on a belt edge sander (Progress PMC-150) until flush with the inner wall (Figure 13).

Figure 13. Using dremel saw (left) and belt sander (right) to remove Guadua node.

3.3 Stranding

Before stranding, culm pieces needed to be pre-saturated with water to ease slicing and minimize damage to strands and knives during stranding. The technique was developed (Semple et al., 2014) to simulate the moisture conditions and stranding of fresh green cut culm stock. The laboratory disk strander (CAE 6/36 single-blade mounted disk) used was built by Carmanah Design and Manufacturing, Vancouver, BC. Since the effect of nodes on Moso bamboo strand boards was examined in an earlier study (Semple et al. 2015a, b), only the Guadua bamboo was converted to either node or internode pieces that were stranded separately. The Moso culms were cut into successive 130-mm-long pieces and processed together irrespective of node presence and location. The stacking and slicing configuration for the culm rounds through the radial-longitudinal plane is illustrated in Figure 14 and 15. The quarters were more efficient in terms of processing because this shape was easily fitted and securely held in place during stranding.

Figure 14. Top view of the strander feed box showing quarter cut culms

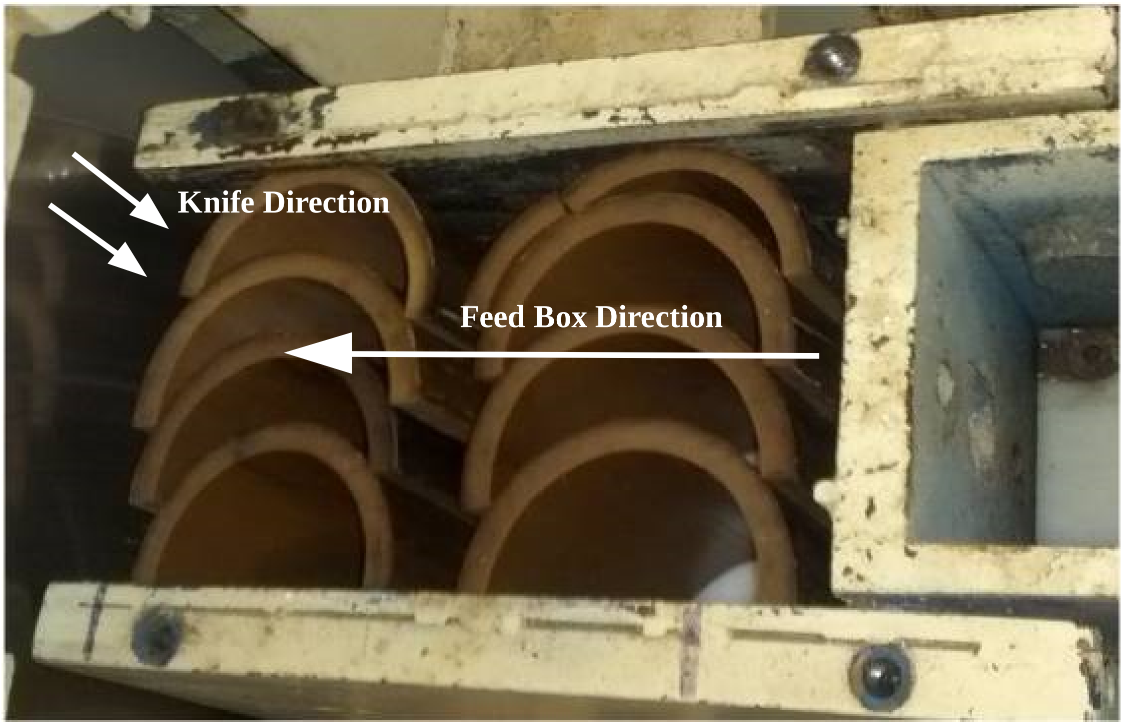


Figure 15. Top view of the strander feed box showing halve cut culms

The pre-saturation and stranding methodology was based on earlier preliminary works designed to maximize the amounts, quality and consistency of strands from Moso bamboo. (Smola 2013, Semple et al. 2014, Semple et al. 2015c, d) Disk rotational speed was set at 734 RPM, and knife projection was set at 0.675mm to give an average target strand thickness of 0.65 mm. Counter knife angle was 45° with a hydraulic piston-driven feed buffer rate of 0.37 m/min. The knife projection in conjunction with feed rate determines strand thickness. Sheet metal shims measuring 0.051 mm in thickness were inserted into the housing block to make tiny changes in the knife protrusion. A magnetic mounted dial gauge was used to measure the knife protrusion. From the preliminary stranding trials (Smola 2013, Semple et al. 2015a), slicing longitudinally through the culm wall (as shown in Figure 16) produced narrower smoother strands that did not curl, rather than stranding the culm horizontally as is normally done for wood logs. Figures 16 and 17 showed the view of disk strander with knife direction in detail. Strands were oven dried at 80°C over night and left to cool for at least 4 hours before sealing them in plastic bags. The moisture content of the dried strands was approximately 2%.

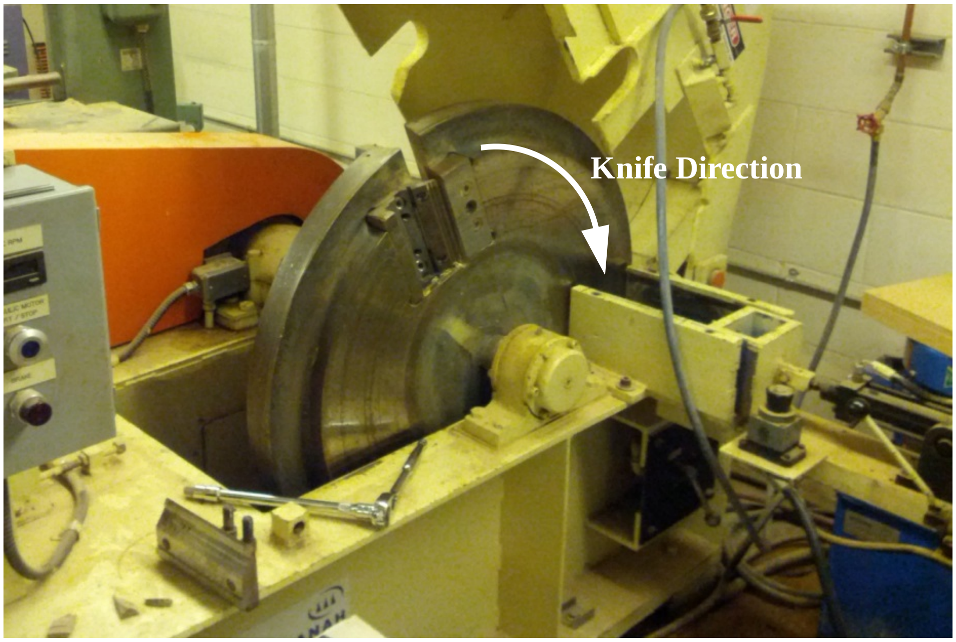


Figure 16. View of disk strander showing the knife rotation direction

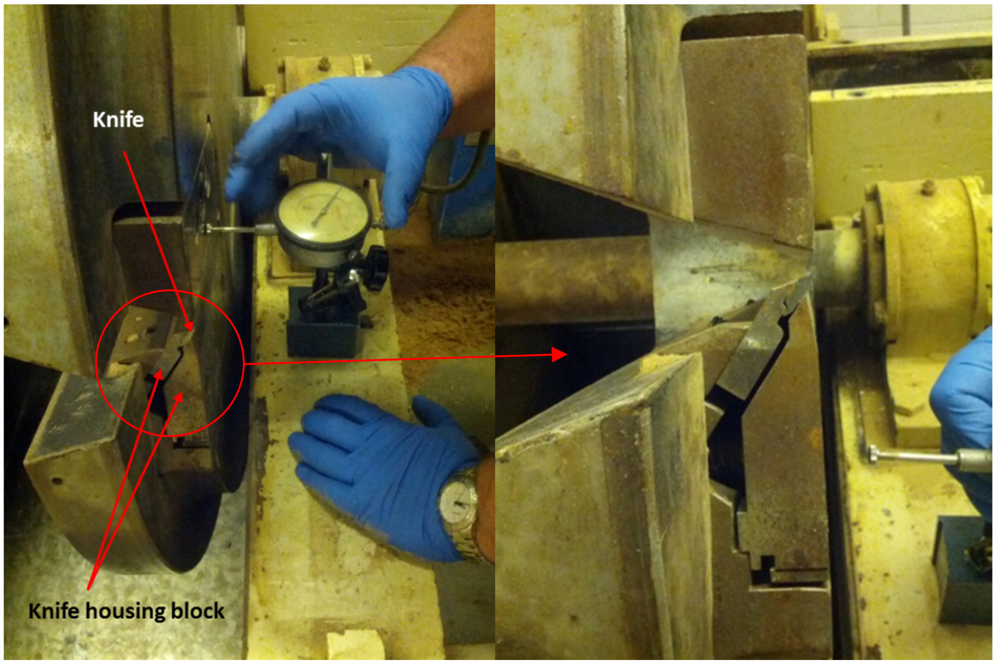


Figure 17. Stranding culm pieces vertically

3.4 Strands Screening

The Guadua strands were dried and collected separately as either node or internode, and the Moso as mixed strands. To remove the dust, fines and chips, dried strands were sifted using a motorized screening machine designed for wood strands (Figure 18). Guadua node, Guadua internode and Moso mixed strands were screened separately. The chips were hand-picked out during the screening process. Only the 14.3 mm mesh and 3.18 mm mesh screens shown in Figure 18 were used. The fines and the dust could pass through all the screens and were collected on the bottom pan. Most unbroken large strands were collected from the top of the 14.3 mm mesh screen, while medium and smaller fragments were collected from on top of the 3.18 mm mesh screen.

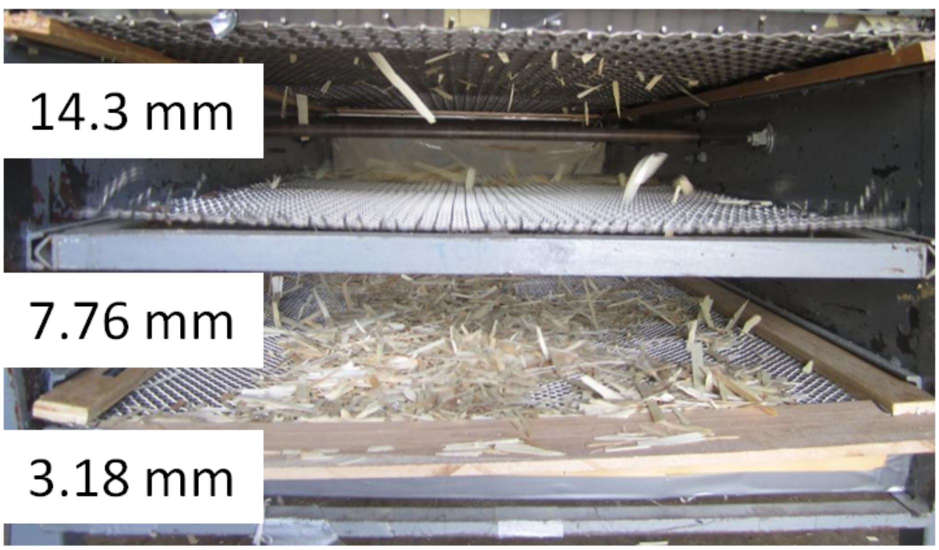


Figure 18. Screening the strands

3.5 Board Fabrication and Experiment Design

The technique of the board fabrication was based on the preliminary research (Smola, 2013;. Zhang, 2013) to produce three layers hybrid bamboo-Aspen OSB. All the process of the board fabrication were done in the Wood Composites Lab at UBC. It took two weeks to fabricate all boards and a total of 9 weeks to finish all the tests.

3.5.1 Experimental Designs

There were three different experiments designed to examine the effects of bamboo species (Guadua or Moso), the effect of reducing board density to bring bamboo boards down to the expected density of commodity OSB sheathing products, and also the effect of the presence of nodes on Guadua OSB properties.

Experiment 1: Previous work (Semple et al. 2015b) found that bamboo strands were most efficiently used in the surface layers of OSB, retaining the compressible Aspen in the core layers. Therefore for the comparison between Guadua and Moso strands in the surface layers of OSB, two types of boards were produced: 1) Guadua-Aspen 3-layer hybrid OSB, and 2) Moso-Aspen 3-layer hybrid OSB with six board replicates per type. The same weight ratio of bamboo strands and Aspen strands was used to both groups. The bamboo surface strands were a mixture of node and internode strands produced with the ratio found in cutting 8 foot long Moso feedstock poles into 130 mm-long pieces. Type 1 Guadua-Mixture (GM) were 50% Guadua bamboo strands in the surface layers and 50% Aspen strands in the core. Type 2 Moso-Mixture (MM) were 50% Moso bamboo strands in the surface layers and 50% Aspen strands in the core. Both board types were produced with a target density around 760 kg/m^3.

Experiment 2: The second experiment was aimed at retaining the mechanical properties of Moso-Aspen hybrid OSB but reducing board density. The 50%/50% MM board from Experiment 1 was used as the comparison for high density 760 kg/m³ boards. Two strategies were used to reduce board density. First the weight ratio between Moso strands in the surface and Aspen strands in the core was reduced from 50%/50% to 25%/75%. Second the overall amount of furnish used per board was reduced. Two types of 3-layer hybrid OSB were fabricated with six board replicates per type.

Moso-Medium-density (ML1) were 25% Moso bamboo strands in the surface layers and 75% Aspen strands in the core pressed to a target density around 720 kg/m³. Moso-Low-density (ML2) were 25% Moso bamboo strands in the surface layers and 75% Aspen strands in the core pressed to a target density of around 628 kg/m³. The properties of all three board types are then compared.

Experiment 3: The third experiment was to evaluate the effect of nodes in Guadua strands on Guadua bamboo hybrid OSB. Two types of 3-layer hybrid OSB were fabricated with six board replicates per type. Type 1 Guadua-Node (GN) were 50% Guadua bamboo strands with node near the middle in the surface layers and 50% Aspen strands in the core with a target density around 760 kg/m³. Type 2 Guadua-Internode (GI) were 50% Guadua bamboo internode strands in the surface layers and 50% Aspen strands in the core with a target density around 760 kg/m³.

A summary of all six types is shown in Table 2 with details. In Table 3, the factors are listed for each experiment.

Table 2. Summary of experiment design per types

	Board Type	Target Density (kg/m³)	Weight ratio of Bamboo surface - Aspen core	
Guadua/Aspen Hybrid	GM	760	50% - 50%	Mixture of node and internodes
	GN	760	50% - 50%	Strands with node
	GI	760	50% - 50%	Strands without node
Moso/Aspen Hybrid	MM	760	50% - 50%	Mixture of node and internodes
	ML1	720	25% - 75%	Higher target density
	ML2	628	25% - 75%	Lower target density

Table 3. Summary of experiment design per factors.

	Factors	Levels	Compared types	
Experiment 1	Species	Guadua	GM	Guadua Mixture
		Moso	MM	Moso Mixture
Experiment 2	Density	760 kg/m³	MM	Moso Mixture
		720 kg/m³	ML1	Moso High
		628 kg/m³	ML2	Moso Low
Experiment 3	Guadua Node	Node	GN	Guadua Node
		Internode	GI	Guadua Internode

3.5.2 Board Fabrication Design

Across the three experiments there was a total of six different board types, produced with six board replicates per type, for a total of 36. All boards were 740 mm x 740 mm, limited by the dimensions of the press platens. The target thickness was 11.1 mm (7/16th inch) which is a typical thickness of OSB sheathing. All 36 boards were fabricated under similar conditions (resin type, dosage, etc) during a continuous timeline.

From the trial experiment on uni-directional, fully oriented boards by Smola (2013), in order for the boards to consolidate correctly, mat unevenness and delamination issues were modified by making the strands in the core not oriented. In the present work, only the bamboo strands surface layers were oriented, while the aspen strands used in the core were not oriented. This produces a flatter, less voluminous mat.

3.5.3 Blending Strands with Resin

Bamboo and Aspen strands were blended separately with Cascophen RBS2345, liquid Phenol Formaldehyde (PF) resin, supplied by Momentive Specialty Chemicals Canada Inc., Edmonton, Alberta, Canada. Resin content was set to 6% of the boards mass. Given the size and density of the boards, the target initial furnish mass was 4.26 kg with 0.43 kg resin mass applied per board for type GM, GN, GI, and MM, 4.04 kg furnish with 0.41 kg resin mass for type ML1, 3.52 kg furnish with 0.36 kg resin mass for type ML2. And the amount of resin was split according to the weight ratio between bamboo strands and aspen strands.

The rotating drum blender (Figure 19a), was 183 cm in diameter by 61 cm in depth, and equipped with small flights to lift and cascade strands. The required resin was applied via a compressed air-fed (30 psi) atomizer spray nozzle connected to a paint pot (Figure 19b, c). To determine that the correct weight of resin was sprayed in, the pot was placed on a tared balance. The required amount of resin was sprayed based on monitoring the drop in weight of the tared pot, and the resin supply valve shut off once the required amount had been used.

a) b) c)

Figure 19. Blending system
a) Drum blender b) Spray paint pot c) Spray nozzle

Different types of strands (surface, core) were blended separately. Resinated strands were left in the blender and tumbled for at least five minutes to ensure the resin was evenly mixed with the strands, and after the blender was stopped the strands were left to sit for 5 min before removal to permit resin droplets to settle. Because the properties of the OSB could be affected by the humidity and temperature when pressing the boards (Zhou et al., 2009), all resinated strands were hot pressed as soon as possible after blending and mat formation. Typically, it would take 10 to 15 minutes to form the mat. Therefore the scheduling of manufacturing order of boards became important in the experiment. With six boards per type, sufficient furnish for two or three boards (depending on surface or core weight) with 10% spillage were blended per run. Table 4 shows the blending and pressing sequence for the first 6 boards from type MM. The schedule for all 36 boards, with six boards made per day is given in the appendix A.

Table 4. Press sequence schedule (example of first 6 boards)

	Press sequence					
Board	Board code	Day	task	furnish weight, kg	flake type	layer
1,2,3	MM1,MM2,MM3	1	blend	6.4	Moso	surface
1,2	MM1,MM2	1	blend	6.4	Aspen	core
1	MM1	1	form and press	4.26	Hybrid	surface+core
2	MM2	1	form and press	4.26	Hybrid	surface+core
3,4	MM3,MM4	1	blend	6.4	Aspen	core
3	MM3	1	form and press	4.26	Hybrid	surface+core
4,5,6	MM4,MM5,MM6	1	blend	6.4	Moso	surface
4	MM4	1	form and press	4.26	Hybrid	surface+core
5,6	MM5,MM6	1	blend	6.4	Aspen	core
5	MM5	1	form and press	4.26	Hybrid	surface+core
6	MM6	1	form and press	4.26	Hybrid	surface+core

3.5.4 Hot Pressing

After blending, the required quantity of strands for each surface layer and core layer was weighed out in plastic tubs. Bamboo strands in the bottom surface layer were evenly spread over an oiled caul plate measuring 740 x 740 x 7.11 mm, with a two inch high wooden forming box used to contain the mat and fix the position (see Figure. 20). A 30 cm high 12- vane orienter as shown in Figure 20 was used to orient the bamboo strands in the bottom and top layers of each board. Strands were manually distributed evenly into the 50 mm wide slots and dropped onto the oiled caul plate. After distributing the bamboo strands in the slots and then removing the orienter, the layer was tamped down to flatten using a wooden slab. After the bottom surface layer was laid down, Aspen core strands were poured in and distributed randomly but evenly without the orienter, and tamped down. The top surface was oriented by placing the orienter on top of the core layer and arranging the top surface strands as described. The completed three-layer mat was flattened and covered with the second oiled caul plate. Figure 20 shows a 45 degree vertical view of the orienter system when making the mat.

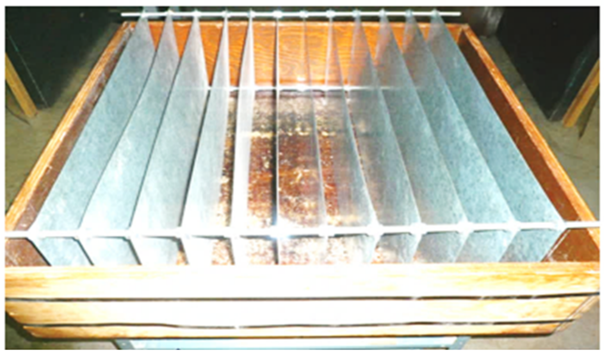


Figure 20. Hand orientation of bamboo strands with orienter

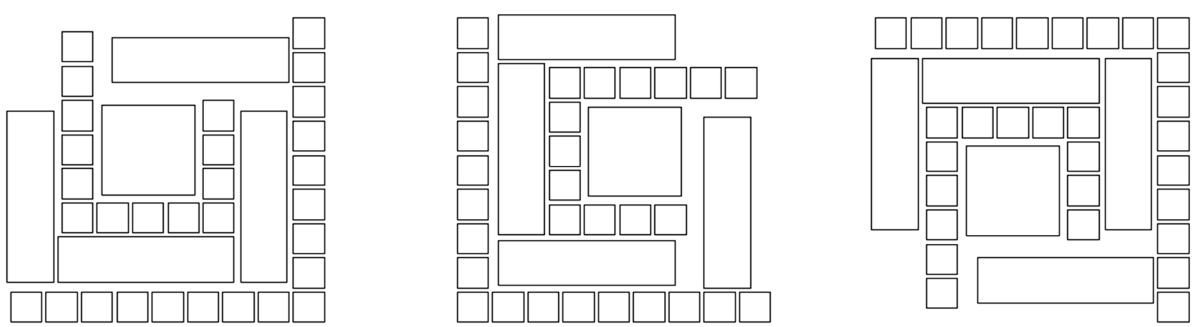
The whole assembly was then placed in a hot press and pressed at 150 °C for 15 minutes. During this process, maximum mat compaction pressure was 5.8 MPa for 14 minutes and then 1 minute for the press closing and opening. All the production parameters are listed in Table 5. After pressing the board was removed, cooled, weighed and labeled with back RH(right hand) corner of press, board number (1-6) and Type (ie, GM, GN, GI, MM, ML1 or ML2). The three layer OSB was isotropic, meaning that both face layers contained the same mass of resinated bamboo strands and were oriented in the same direction.

Table 5. Production parameters

Mat structure	Three-layer sandwich random core
Resin type	PF
Resin solids content	57 wt%
Board length	737 mm
Board width	737 mm
Targeted board thickness	11.1mm
Board resin content	6% w/w (oven dry weight basis)
Board moisture content	2%

3.6 Specimens Cutting

To minimize bias due to sample position, three different cutting patterns were used and randomly assigned to each board (Figure 21). For each type with six replicate boards, two of them were cut according to one of the three different cutting patterns. In all the patterns, 30 IB specimens (51 x 51 mm) were located in different zones on the board (the small squares in Figure 21). To evaluate the effect of strands direction on bending strength (MOR), four bending test specimens (290 x 76 mm) were cut so that two had the long axis parallel-to-strands and two had the long axis perpendicular-to-strands on each board (the rectangles in Figure. 21). One thickness swelling test specimen (152 x 152 mm) was cut per board (the large squares in Figure 21).



1. 2. 3.

Figure 21. Cutting pattern with three different directions

Table 6 summarizes the numbers of test specimens cut for each property test. After cutting, each test specimen was labeled with board type, board (replicate) number, and test piece (observation) number. For instance, Figure 22 shows the 23rd observation of IB specimens for the 4th boards of GI type.

Figure 22. Example of labeling

All test specimens were conditioned at a relative humidity of 65±2% and a temperature of 20 ± 2°C to a constant weight and hence moisture content in accordance with ASTM D1037 (ASTM, 2012). Specimens were kept in the conditioning room untill the weight change during 24 hours was less than 0.2%.

Table 6. Summary of specimens' size and quantity

	Size of specimens mm	Qty. of Specimens per board	Qty. of Specimens per type	Total Qty. Of Specimens
Internal Bond	51x51x10	30	180	1080
Thickness Swelling	152x152x10	1	6	36
MOR/MOE Bending	240x76x10	4	24	144

3.7 Test Methods

Tests included internal bonding test, flexural properties (bending test), and the thickness swelling/water absorption test. The process and the sample preparation were consistent with ASTM D1037 and D4442 (2012, 2014). Photographs of sample in the conditioning room are shown in Figure 23. Before all tests the required dimensions of each specimen were measured using digital calipers to 0.01 mm.

Figure 23. Specimens in the condition room

3.7.1 Internal Bonding Test

The following formula gives the calculation of the IB test, which is also called the tension perpendicular to surface test. Before testing, thickness and weight were measured for each specimen. Density was calculated from the weight and the volume. Volume is the product of a, b and thickness.

$$IB = \frac{P_{\max}}{\mathrm{ab}} \qquad \left[\frac{\mathrm{N}}{\mathrm{mm}^2}\right]$$

$P_{\max}$	maximum load (N)
a	length of specimen (mm)
b	width of specimen (mm)

As shown in Figure 24, the IB test machine designed by Instron according to ASTM Standards D1037 would measure the specimen's tensile strength perpendicular to the surface of the specimen.

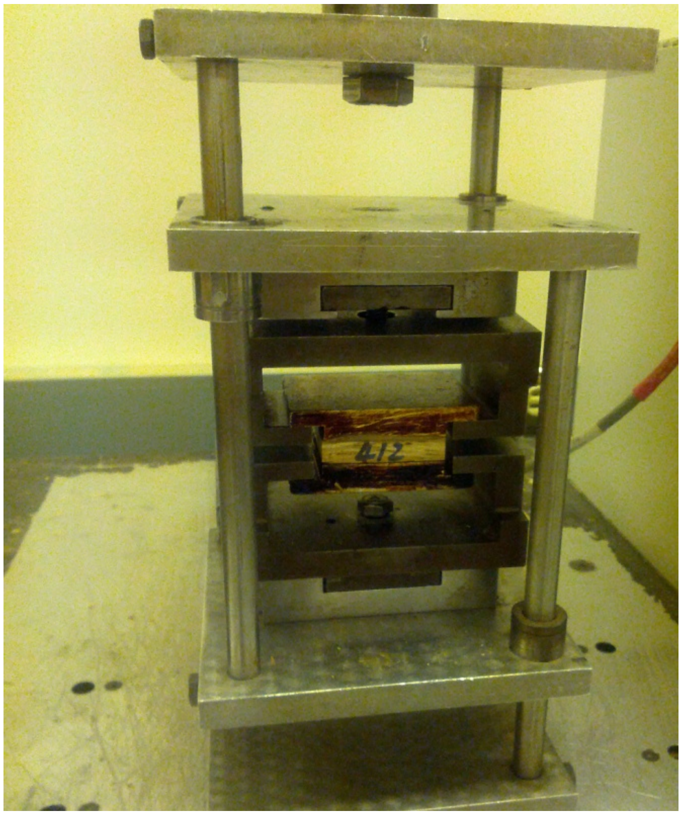


Figure 24. IB test machine

3.7.2 Flexural Property Test

The test used the three point bending test to get the deflection and load for MOE and MOR. The formula below shows the calculation methods.

$$MOE = \frac{L^3}{4bd^3} * \frac{\Delta P}{\Delta y} \quad \left[\frac{\text{N}}{\text{mm}^2}\right]$$

L	Length of span
b	Width of specimen (mm)
d	Thickness of specimen (mm)
$\frac{\Delta P}{\Delta y}$	Slope, ΔP *and* Δy were given by the test machine

$$MOR = \frac{3 * P_{max} * L}{2bd^2} \quad \left[\frac{\text{N}}{\text{mm}^2}\right]$$

P_{max}	Peak Load (N)
L	Length of span (mm)
b	Width of specimen (mm)
d	Thickness of specimen (mm)

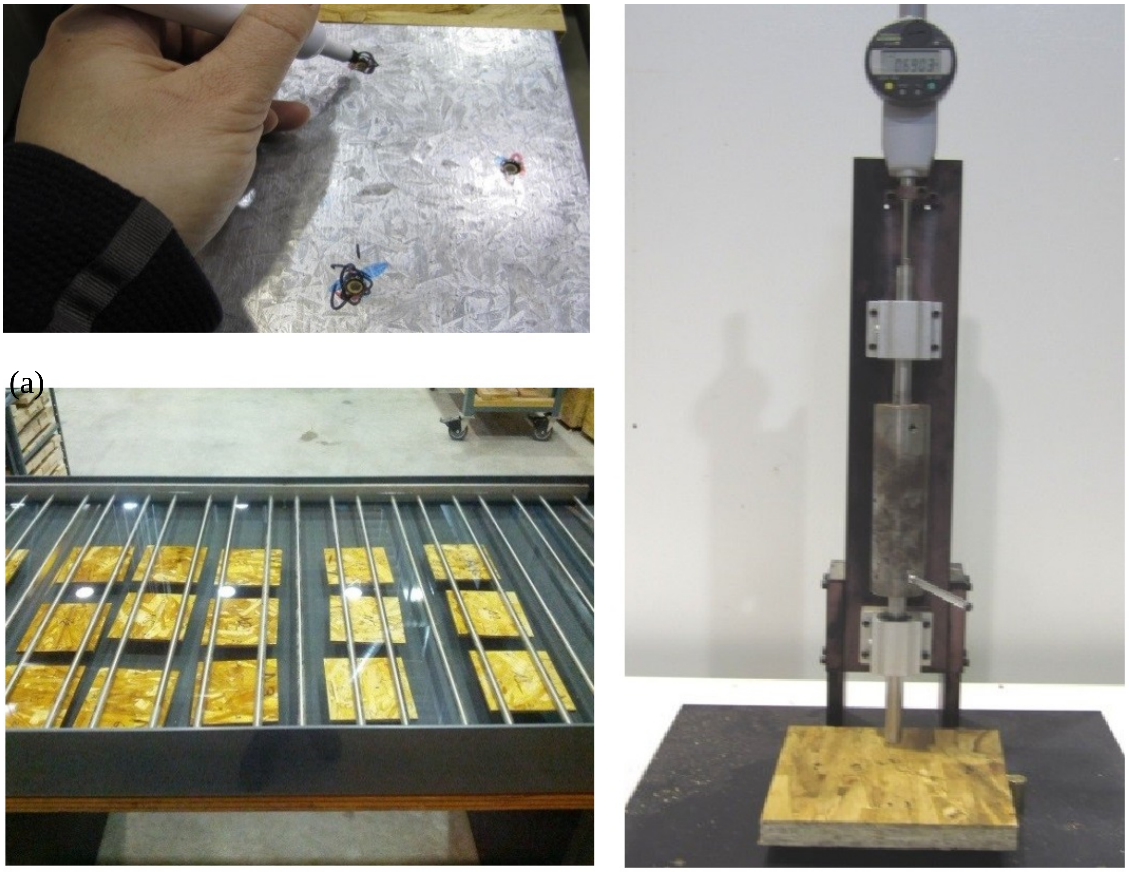
The flexural test, shown in Figure 25, shows the specimen in three-point loading with compression force in the middle of the span perpendicular to the tested surface. Two types of samples were tested; *i*) samples with the long edge parallel to the strand direction and *ii*) samples with their long edge perpendicular to the strand direction as required by the ASTM Standards.

Figure 25. Flexural test machine

3.7.3 Thickness Swelling and Water Absorption

For the thickness swelling and water absorption test, all specimens were weighed and measured for thickness at four points 25 mm in from at the midpoint of each side prior to immersion. Weight and thickness at the same locations were measured after 2 hours soaking and again after 24 hours soaking. After 24 hours soaking the specimens were oven dried for 24 hours at 105 ℃, and re-weighed to give oven dry weight.

Figure 26 (a) is the template for marking and locating thickness measurement points in accordance with the ASTM standard (2014). Figure 26 (b) is the tank used for thickness swelling test. Figure 26 (c) shows the caliper connected to a weight extensometer used to give a precise and consistent thickness reading.



(a)

(b) (c)

Figure 26. Details for thickness swelling test

(a) Marking the 4 measurement points onto a sample using a template (b) TS samples immersed in the swell tank, and (c) measurement of sample thickness at each of the points marked on the sample in (a)

Chapter 4: Results and Discussion

All results were analyzed using single-factor ANOVA (i.e. board type) in JMP 10 (SAS Institute, Inc. 2012), using the 5% significance level (α=0.05). Means were compared for all pairs of means using the t-test for two treatments or using the Tukey-Kramer HSD evaluation for three or more treatments. Board densities and thicknesses were derived from measurements of IB specimens. Flexural properties included MOR and MOE for perpendicular-to-strand direction and parallel-to-strand direction (four groups). Water resistance property was evaluated by water absorption and thickness swelling after 2 hours and 24 hours soaking (four groups). All data are recorded in Appendix B.

4.1 Experiment 1: Comparison of Guadua and Moso Boards

As Guadua has thicker fibre bundles than Moso, it was expected that Guadua-Aspen hybrid OSB would have better properties than Moso-Aspen hybrid OSB. To exclude the possible effect from the presence of a node on the culm, only type GM and MM were compared in this section. Type GM was made from 50% mixed Guadua strands on the surface with 50% aspen strands in the core. Type MM was made from 50% mixed Moso strands on the surface with 50% aspen strands in the core. All mixed bamboo strands contained both node and internode strands as the original ratio of screened strands.

4.1.1 Thickness and Density

After the press was opened, the boards were allowed to cool and then cut into samples as previously described. Comparison of the pressed board thickness in Table 7, with the target board thickness, 11.1 mm, showed there was spring back. The Moso boards spring back more than the Guadua boards while the density of both board types were not significantly different. Note that the levels in Table 7 not followed by same letter are significantly different (same meaning for all the tables following).

Moso mixed strands boards showed a greater spring back than the Guadua boards. We essentially hit the target pressing density, 760 kg/m^3, for both types only slight higher than target. There was no significant difference between them. The full results data are given in Appendix B, while the statistical analysis are given in Appendix C.

Table 7. Thickness and density for MM and GM

Type	Thickness		Density	
	Mean (mm)	COV (%)	Mean (kg/m^3)	COV (%)
MM	11.55a	2.4	764.5a	8.5
GM	11.42b	2.7	770.3a	13.2
p-value	<0.0001		0.5232	

COV = coefficient of variation

4.1.2 Internal Bonding Strength

IB testing is usually used to test the ultimate failure stress under a tensile load perpendicular to the plane of the board, which usually occurs in the weakest region of the core (Dai et al 2008, May 1983). Many studies have revealed a positive correlation between density and IB strength (Sumardi et al., 2007). For a similar final target density, the mat made from lower density material has a better consolidation because of less voids of space.

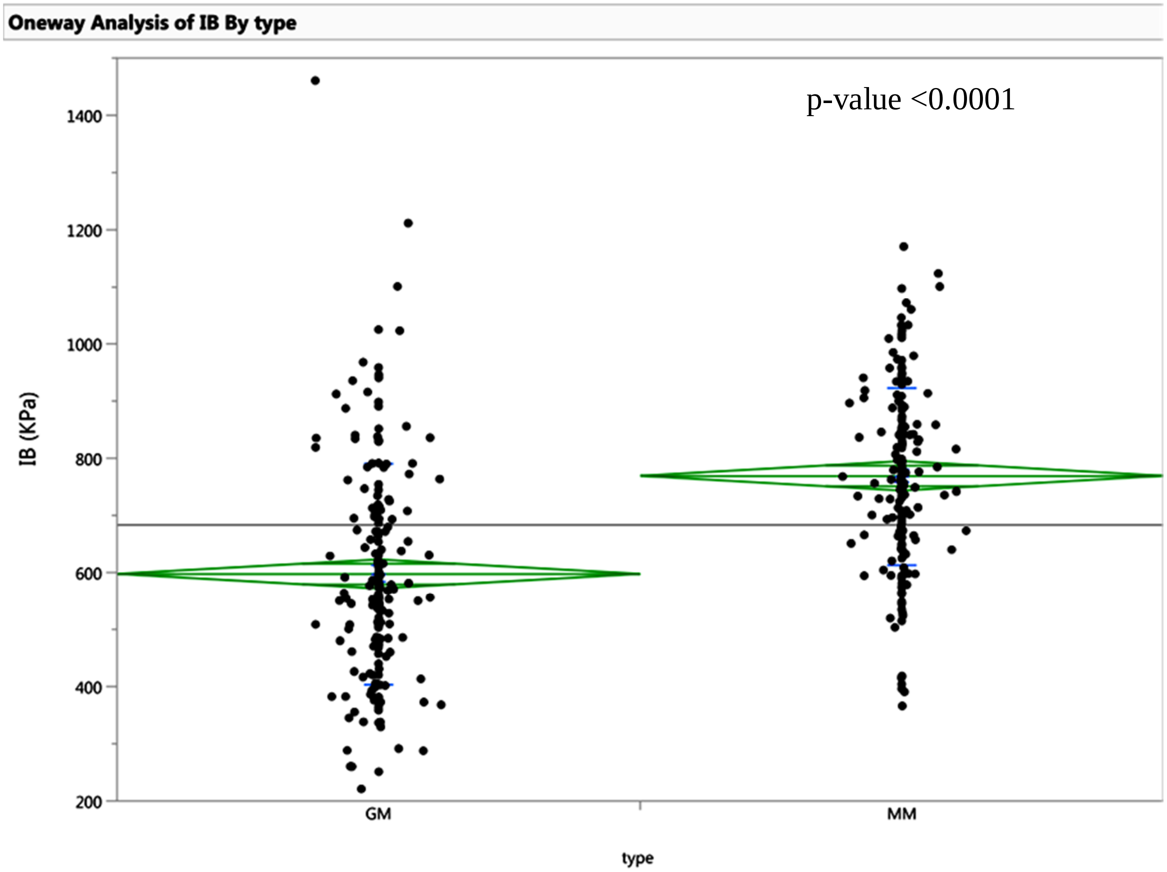


Figure 27. IB test results for GM and MM, n = 180 for each mean

Since Guadua has a higher density tissue than Moso (Dixon et al., 2015), it was expected that Guadua boards would have higher IB strength, but the opposite was observed. Moso hybrid boards had an IB strength at 0.769 MPa, which was 29% better than the Guadua boards that had a value of 0.598 MPa. Compared to the similar product, the pure Aspen three layer board we made in 2013 (Zhang, 2013) even had a stronger IB strength at 0.653 MPa, suggesting that the Guadua was the weak link in the IB samples. Indeed, examination of the IB samples revealed that the most common location of failure was at the interface between the surface and core layers. This was the case for both Guadua and Moso suggesting that the contact area between the bamboo and aspen strands is less than in the case of boards made with aspen surface and core.

The required IB strength for Strandboard and Waferboard in CSA O437.0 is 0.345 MPa (CSA, 2011). For the same applied force, Guadua compressed less than Moso. This means that the compaction ratio for Guadua is lower than for Moso. High-density species make mats with lower compaction ratios compared to low-density species (Hood, 2004).

4.1.3 Flexural Properties

The MOR and MOE perpendicular to the strand direction of both board types were greater than the 12.4 MPa minimum MOR and 1.5 GPa minimum MOE required for OSB products by CSA O437.0. And there was no significant difference between the two boards types (Tables 8 and 9). Similarly, the flexural properties parallel to the strand direction of both board types were greater than the 29 MPa minimum MOR and 5.5 GPa minimum MOE required by the standard. Only MOE parallel to the strand direction test showed a significant difference between two board types. Guadua hybrid board had a 31.6% stiffer property than Moso hybrid board likely due to the different fibre properties of the two species. Since the GM and MM are both made from a mixture of nodes strands and internode strands, another possible reason could be the different nodes structure of Guadua compared with Moso.

Table 8. Results of flexural property test of GM and MM (perpendicular)

Type	Means	COV (%)
	MOR (MPa) p-value = 0.4810	
MM	20.25a	33.7
GM	21.93a	20.3
	MOE (GPa) p-value = 0.4372	
MM	2.14a	20.6
GM	1.99a	23.6

Note: the levels in the table not followed by same letter are significantly different

Table 9. Results of flexural property test of GM and MM (parallel)

Type	Means	COV (%)
	MOR (MPa) p-value = 0.8968	
MM	64.93a	15.5
GM	64.28a	21.3
	MOE (GPa) p-value <0.0001	
MM	8.01b	9.5
GM	10.54a	13.7

Note: the levels in the table not followed by same letter are significantly different

4.1.4 Water Absorption

All the boards were fabricated without any addition of wax (wax is normally added to OSB). Our previous experiment (Semple et al., 2015a) found that the pure Aspen three layer boards had TS values in excess 17% without wax which is above the limit 15% TS set by CSA O437.0 (CSA, 2011). Table 10 shows the TS results summary. GM boards had 55.4% more swelling than the MM boards after 2h soaked in water. This difference reduced to 22.3% for 24 h TS and became non-significant. Intuitively, these results made sense as the higher density surface Guadua strands have more void space between them and are able to absorb more water more quickly than the more compressed Moso boards. After 24 hours water is absorbed into the Aspen core and differencing decreases. Results of the 24 h TS test are also compared in Figures 29.

Table 10. Results of thickness swelling (%) for GM and MM

Type	Means	COV (%)
	2h TS (%) p-value = 0.0349	
MM	2.86b	36.0
GM	4.44a	27.3
	24h TS (%) p-value = 0.0876	
MM	9.57b	23.3
GM	11.70a	13.7

Note: the levels in the table not followed by same letter are significantly different

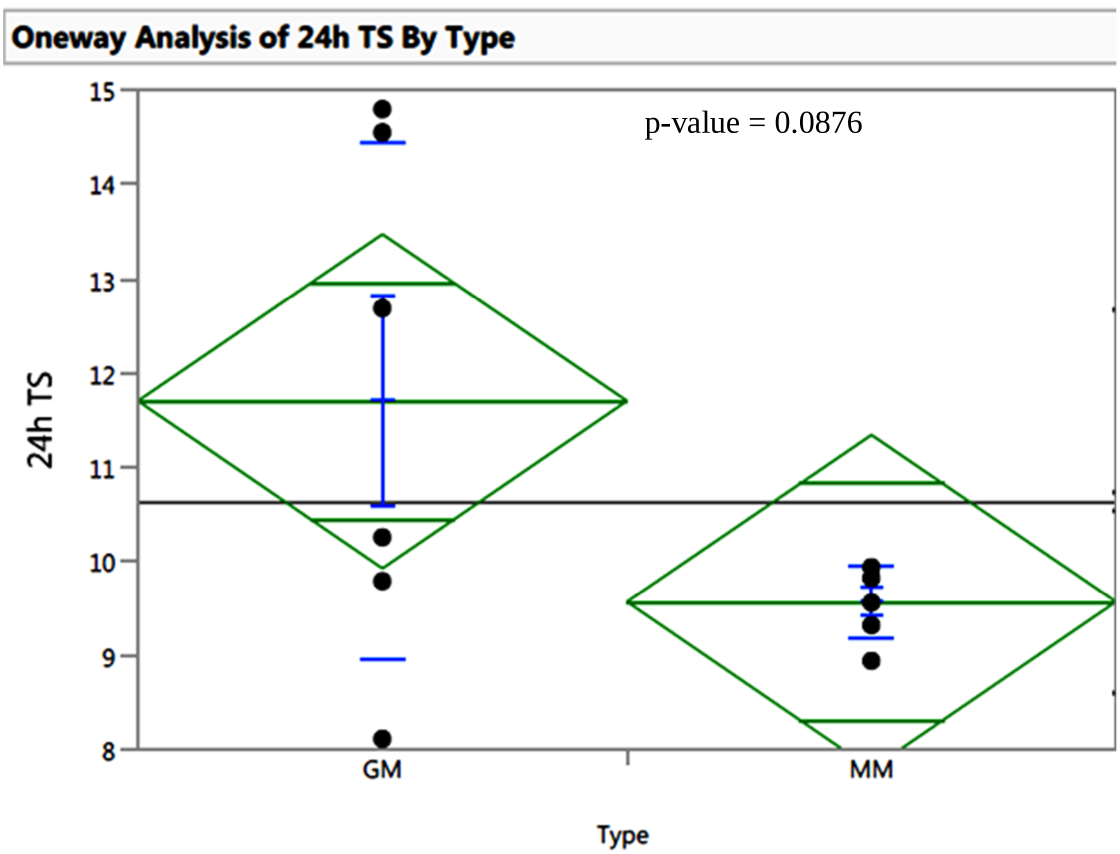


Figure 28. Results of 24h TS of GM and MM, n = 6 for each mean

Similarly, Guadua hybrid board showed less water absorption for 2 h or 24 h WA. The Guadua boards absorbed 18.8% of its original weight water, which is 35.2% more compared to Moso boards at 2 hours (see results in Table 11). After 24 hours, this difference was reduced to 19.9%. After 2 hours Guadua boards absorbed 51.2% of the total weight of water it absorbed in 24 hours, while Moso boards absorbed 56.7% (Figure 30). Water absorbed by the boards was stored in the space in the structure. Less consolidation would permits more water to penetrate into void space between strands.

Lower density board, which has a looser structure, was expected to have more water absorption. However, in this test lower density Moso hybrid board had less water absorption. The Guadua strands have a rougher surface because of the courser grain and larger vascular bundles compared to Moso. This would result to larger void space for water to penetrate which lead to more water absorption of Guadua boards.

Table 11. Results of water absorption (w/%) for GM and MM

Type	Means	COV (%)
	2h WA (w/%) p-value = 0.0355	
MM	13.90b	25.4
GM	18.80a	18.3
	24h WA (w/%) p-value = 0.0408	
MM	32.10b	15.6
GM	38.48a	11.4

Note: the levels in the table not followed by same letter are significantly different

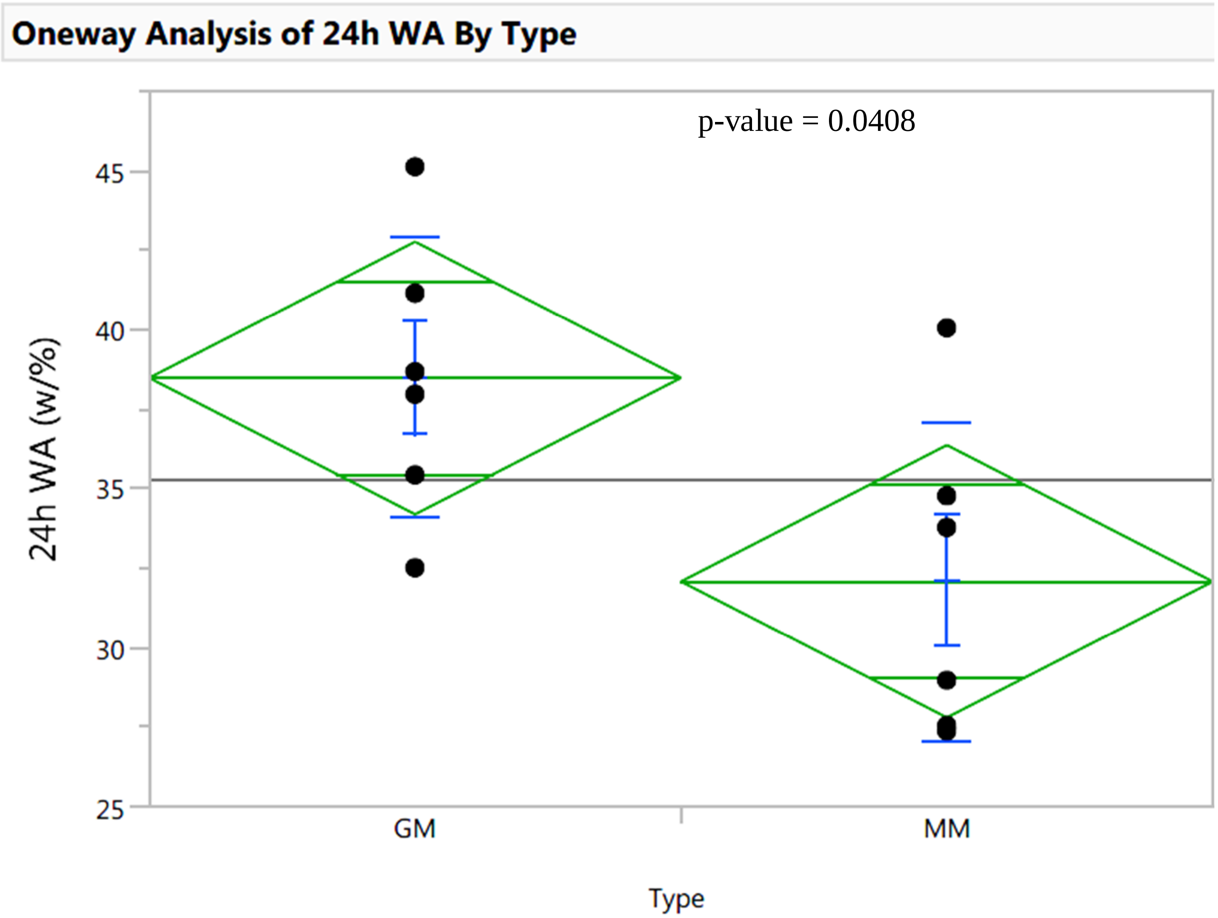


Figure 29. Results of 24h WA of GM and MM, n = 6 for each mean

The IB test and the water absorption property test indicated the Guadua hybrid boards were less consolidated than the Moso hybrid board. Consistent with the findings of Dixon et al. (2015), research on their Moso imported from Bamboo Craftsman Company and Guadua from KoolBamboo showed that Guadua is stiffer than Moso, results in the Guadua hybrid board a higher MOE parallel to the strand direction. However, the positive correlation between density and strength from that finding was contrary with what was found in our study. Possible reason could be the high density of Guadua strands caused a looser structure with same target board thickness and board density. When the hot press closed to the same thickness, the pressure applied to the Moso is higher than for the Guadua due to the larger volume occupied by the Moso strands compared with the Guadua strands. .

Another reason could be the material we used here for Guadua and Moso is mixed with both node and internode strands. The differences of fibre volume fractions between the species may affect the results. Guadua has a relatively coarser grain and larger vascular bundles (Dixon et al., 2015), which could cause a rougher surface after stranding. After being resinated and pressed, Guadua hybrid board is more likely to have uneven structure because of the rougher surface. With the same target density, that is a possible reason for why higher density material produces a lower compaction ratio which results in more water absorption.

4.2 Experiment 2: Density Effects on Mechanical Properties

In CSA-O437.0 (2011), O-2 class OSB is recognized as being structurally equivalent to plywood when used as roof, wall and floor sheathing. Thus our results are compared to the requirements for O-2 class to determine whether low density bamboo hybrid OSB may be qualified to substitute for structural wood OSB. Furthermore, the two lower density boards will be compared with the high density MM board from Experiment 1. To make the group name corresponding to their density level, names with density level will be assigned to the three types (see Table 12). Type MM (50% Moso bamboo strands in the surface layers and 50% Aspen strands in the core with higher target density) is named MHigh to present the highest density level in this comparison. Type ML1 (25% Moso bamboo strands in the surface layers and 75% Aspen strands in the core with higher target density) is named MMed to present the medium density level in this comparison. Type ML2 (25% Moso bamboo strands in the surface layers and 75% Aspen strands in the core with a lower target density) is named MLow to present the lowest density level in this comparison. According to CSA standards, no individual in the five of the panel samples shall have any property more than 20% below or above in the case of thickness swell) the listed five panel average value for that property.

Table 12. Experiment 2 boards types

Assigned Name	Board Type	Target Density (kg/m^3)	Weight ratio of Bamboo surface - Aspen core	
MHigh	MM	760	50% - 50%	Mixture of node and internodes
MMed	ML1	720	25% - 75%	Higher target density
MLow	ML2	628	25% - 75%	Lower target density

4.2.1 Thickness and Density

Due to the spring back of the boards after the pressure was released upon press opening, board thicknesses exceeded the target thickness of 11.1 mm by an average of 0.42 mm. Between the three board types, the differences in average thickness was statistically significant ($p<0.0001$). 50% w/w Moso hybrid boards (MHigh) showed the greatest springback, while 25% w/w Moso hybrid low density boards (MLow) showed the lowest (Table 13). All board types hit the target pressing density within 1.2%.

Table 13. Means and standard deviation for thickness and density

Type	Assigned Name	Thickness		Density	
		Mean (mm)	COV (%)	Mean (kg/m^3)	COV (%)
MM	MHigh	11.55a	2.4	764.5a	8.5
ML1	MMed	11.45b	2.3	728.3b	11.3
ML2	MLow	11.28c	2.7	634.8c	11.6

Note: the levels in the table not followed by same letter are significantly different

4.2.2 Internal Bonding Strength

As might be expected, the low density MLow boards had the lowest IB strength (0.656 MPa). However the medium density MMed boards had the highest IB strength (0.799 MPa), while the high density MHigh boards had a lower IB strength (0.769 MPa). No significant difference was found between MMed and MHigh boards (p-value = 0.1986), whereas MLow boards were significantly lower in density (Figure 32). MMed and MHigh boards had approximately 20% better IB than MLow boards. All groups satisfied CSA-O437.0 requirements for IB strength which is 0.345 MPa (Canadian Standard Association, 2011). The lower 95% confidence interval of MLow boards was 0.632 MPa, which is above the CSA standard (details given in Appendix C).

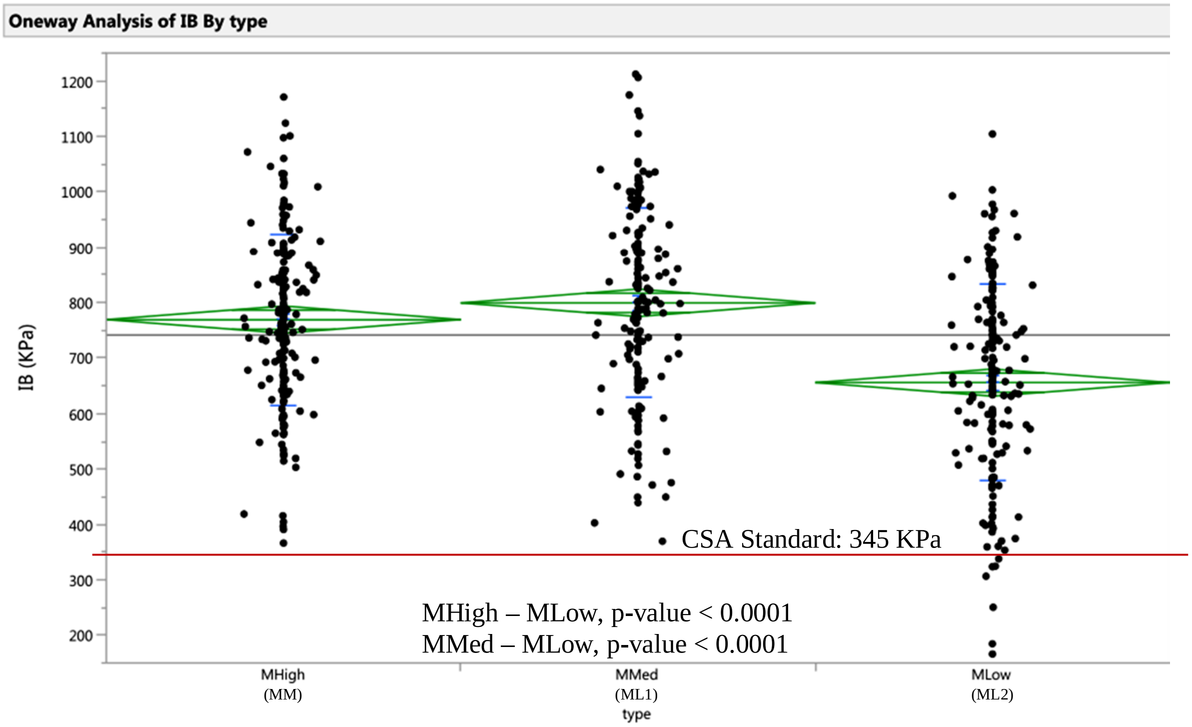


Figure 30. Results of IB test of MM, ML1 and ML2, n = 180 for each mean

4.2.3 Flexural Properties

For the bending test specimens (290 mm x 76 mm) tested perpendicular-to-strand direction, no significant difference between the three different board types was found (see Appendix C for details and p-value). Although both MOR and MOE of perpendicular specimens were much lower than the parallel specimens, all board types met the 12.4 MPa minimum perpendicular MOR and 1.5 GPa minimum perpendicular MOE required for O-2 class products by CSA O437.0 (2011). Results are shown in Tables 14 and 15.

Table 14. Results of MOR of MM, ML1 and ML2 (perpendicular)

Type	Assigned Name	Means for MOR (MPa)	COV(%)
MM	**MHigh**	20.25a	33.7
ML1	**MMed**	24.38a	25.1

ML2	**MLow**	20.39a	10.9

CSA Standard: 12.4 MPa

Table 15. Results of MOE of MM, ML1 and ML2 (perpendicular)

Type	Assigned Name	Means for MOE (GPa)	COV(%)
MM	**MHigh**	2.14b	20.6
ML1	**MMed**	2.72a	15.9
ML2	**MLow**	2.41a,b	18.0

CSA Standard: 1.5 GPa

MLow boards had significantly lower parallel MOR and MOE than MMed or MHigh types. Nevertheless they met the 29 MPa minimum parallel MOR and 5.5 GPa minimum parallel MOE required for O-2 class products by CSA O437.0 (2011). Results are shown in Tables 16 and 17.

Table 16. Results of MOR of MM, ML1 and ML2 (parallel)

Type	Assigned Name	Means for MOR (MPa)	COV(%)
MM	**MHigh**	64.93a	15.5
ML1	**MMed**	59.09a	19.1
ML2	**MLow**	44.23a	19.5

CSA Standard: 29.0 MPa

Table 17. Results of MOE of MM, ML1 and ML2 (parallel)

Type	Assigned Name	Means for MOE (GPa)	COV(%)
MM	**MHigh**	8.01a	9.5
ML1	**MMed**	7.44a	10.1
ML2	**MLow**	6.05b	12.0

CSA Standard: 5.5 GPa

Compared with CSA Standards, all lower 95% confidence interval for MLow boards were above the requirements as shown in Table 18. Also, it met the requirement that no individual in the five panel samples had any property more than 20% below the listed five panel average value for that property.

Table 18. Comparision between MLow boards and CSA standards for flexural properties

MLow (type ML2)	MOR-PD (MPa)	MOE-PD (GPa)	MOR-PL (MPa)	MOE-PL (GPa)
Lower 95% confidence interval	17.18	2.15	38.33	5.61
Means of results	20.39	2.41	44.23	6.05
CSA O437.0 Standards	≥ 12.4	≥ 1.5	≥ 29.0	≥ 5.5

4.2.4 Water Absorption

All three types of boards were fabricated without the addition of wax, which is normally added at about 1% w/w to wood-based OSB products (SBA 2010). Our previous study (Semple et al. 2015) found the all bamboo surface boards were below the maximum of 15% in 24 h TS required by CSA-O437.0 (2011) whereas pure Aspen boards made without wax were above 15% 24 h TS. As shown in Table 19, there was no significant difference between MMed and MHigh boards for 2 h or 24 h TS. Both types were at least 43.3% lower than MLow for 2 h TS. However, this difference reduced to 24.7% for 24 h TS. Nevertheless MLow boards still met the requirements of CSA-O437.0 for 24 h TS with the upper 95% confidence interval of 14.3% less than the maximum TS of 15% required by the standard. Figure 32 shows the big difference of 24h thickness swelling between ML2 and other two types.

Table 19. Results of thickness swelling (%) for MM, ML1 and ML2

Type	Assigned Name	Means	COV (%)
		2h TS (%)	
MM	**MHigh**	2.86b	40.0
ML1	**MMed**	2.37b	22.6
ML2	**MLow**	5.05a	30.3
		24h TS (%) CSA Standard: ≤15	
MM	**MHigh**	9.57b	4.0
ML1	**MMed**	9.84b	15.3
ML2	**MLow**	13.07a	14.0

Note: the levels in the table not followed by same letter are significantly different

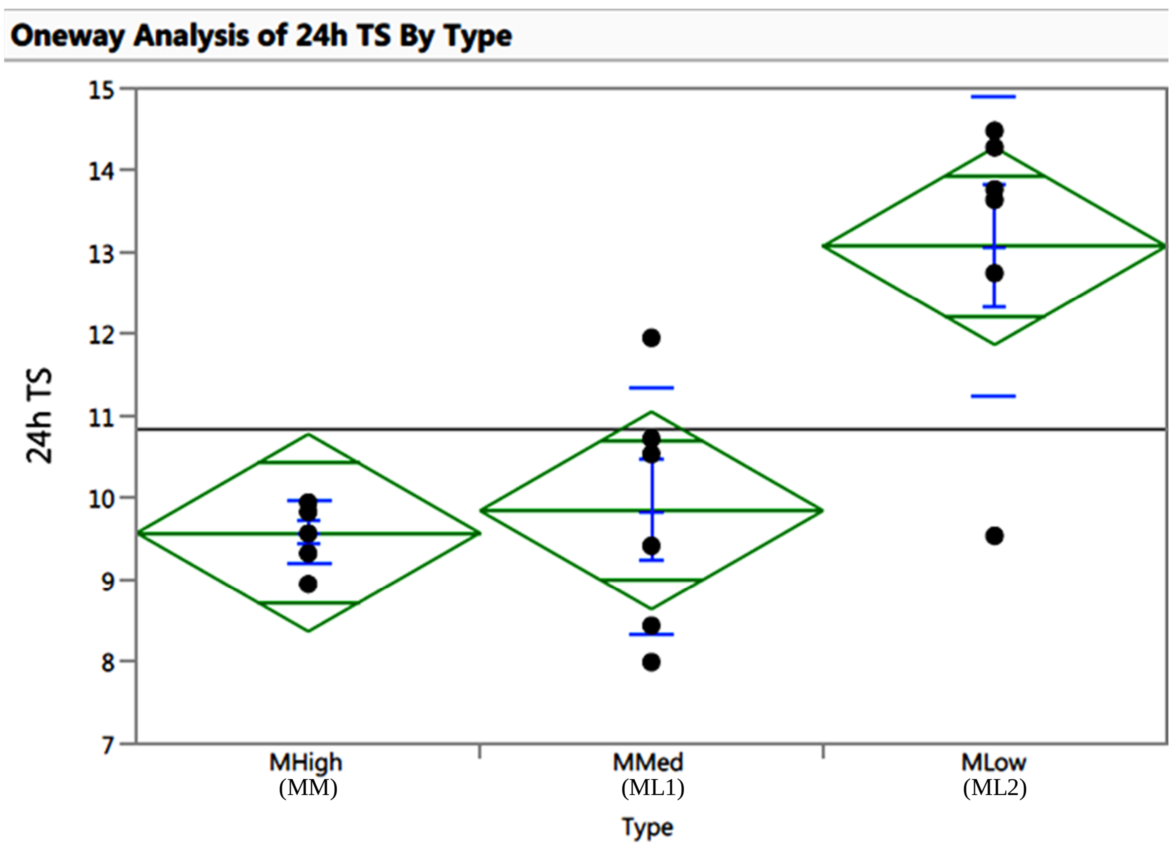


Figure 31. Results of 24h TS of MM, ML1 and ML2, n = 6 for each mean

Similarly, there was no significant difference between MMed and MHigh for 2 h or 24 h WA. As shown in Table 20, they absorbed significantly less water compared to MLow at 2 hours. After 24 hours, this difference was still significant. After 2 hours MLow boards absorbed 43.4% of the total weight of water it absorbed in 24 hours, while MMed absorbed 59.0% and MHigh absorbed 56.7% of the total weight of water it absorbed. That indicated most water were absorbed in the first few hours. Figure 33 shows the big difference of 24h water absorption between ML2 and other two types.

Table 20. Results of water absorption (w/%) for MM, ML1 and ML2

Type	Assigned Name	Means	COV (%)
2h WA (w/%)			
MM	**MHigh**	13.90b	2.5
MH	**MMed**	16.15b	44.8
ML	**MLow**	27.81a	18.3
24h WA (w/%)			
MM	**MHigh**	32.10b	15.6
MH	**MMed**	34.64b	19.8
ML	**MLow**	51.92a	11.5

Note: the levels in the table not followed by same letter are significantly different

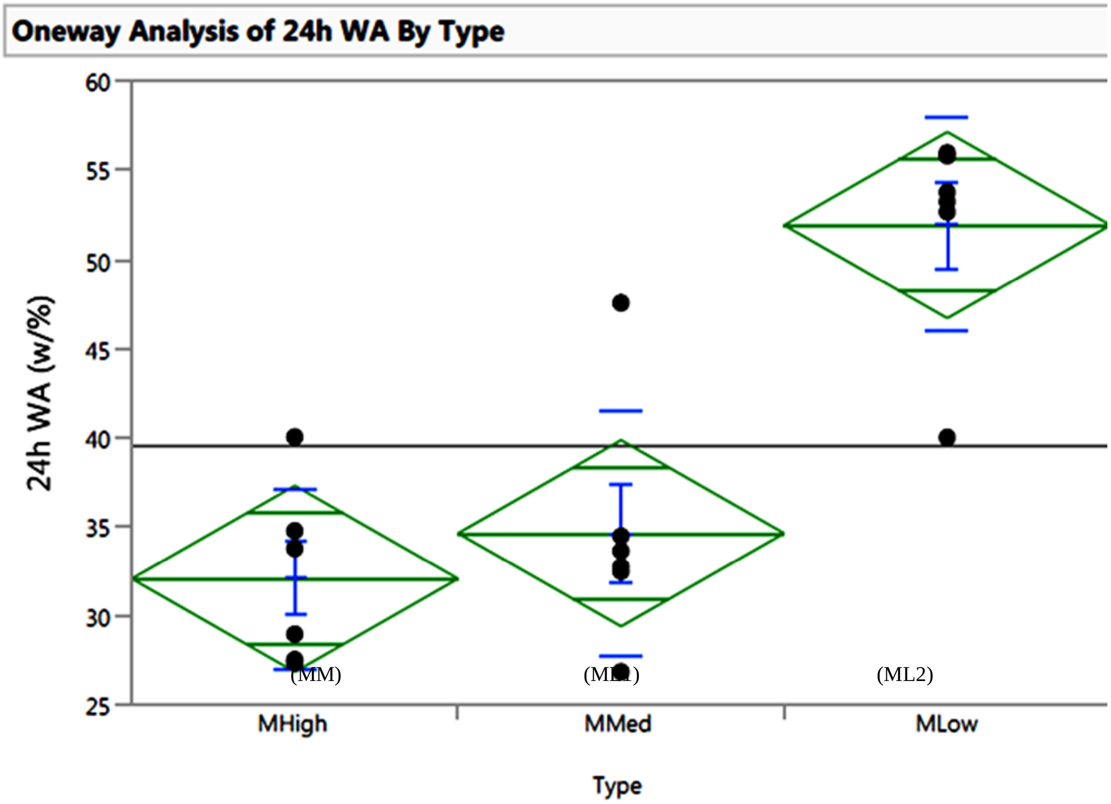


Figure 32. Results of 24h WA of MM, ML1 and ML2, n = 6 for each mean

All three groups hit the target density with a less than 1.2% difference. The MLow group, which had the lowest density, showed the lowest mechanical properties and worst water resistance. Most tests showed a positive correlation between the properties and the density, even though IB strength property and perpendicular-to-strand direction flexural properties showed that the high density group (MM) was a little weaker than the medium density group (ML1). However there was no significant difference between them in those two tests.

Yet, all properties tests showed that the 25% w/w low density bamboo hybrid board met the requirements by CSA-O437.0 (Table 21). It is noticeable that with a low density (634.8 kg/m^3) and no wax addition in the fabrication, bamboo surface/Aspen core 3-layer hybrid boards still showed satisfied properties to meet the requirements for the structure OSB materials. With these results, it is worth to carry on more research about how to retain the low density but improve the consolidation during the fabrication. Even though the lowest density group showed the weakest mechanical properties and water resistance ability, the lower 95% confidence interval for the group means is greater than the CSA standards (see Table 22).

Table 21. Comparison between experiment results and CSA standard

Type	Assigned Name	Means of						
		Density (kg/m^3)	IB (MPa)	MOR-PD (MPa)	MOE-PD (GPa)	MOR-PL (MPa)	MOE-PL (GPa)	TS (%)
MM	MHigh	764.5a	0.769a	20.25a	2.14a	64.93a	8.01a	9.6a
ML1	MMed	728.3b	0.800a	24.38a	2.72a,b	59.09a	7.44a	9.8a
ML2	MLow	634.8c	0.656b	20.39a	2.41b	44.23b	6.05b	13.1b
CSA Standard		≈640*	≥ 0.345	≥ 12.4	≥ 1.5	≥ 29.0	≥ 5.5	≤ 15

*: Preferable density, no requirement in standard for density (TECO, 2008)

Table 22. Summary of comparisons between MLow group results and CSA standards.

MLow (type ML2)	IB (MPa)	MOR-PD (MPa)	MOE-PD (GPa)	MOR-PL (MPa)	MOE-PL (GPa)	TS (%)
Lower 95% confidence interval	0.632	17.18	2.15	38.33	5.61	14.3*
Means of results	0.656	20.39	2.41	44.23	6.05	13.1
CSA O437.0 Standards	≥ 0.345	≥ 12.4	≥ 1.5	≥ 29.0	≥ 5.5	≤ 15

*: Upper 95% confidence interval

Along with IB strength, TS and WA are possibly related to consolidation of the boards. Winistorfer and Xu (1995) have found that total thickness swelling has two components: the swelling of the wood due to MC change, and a combined effect of residual stress release from the pressing and potential variance between high and low density areas in the plane of the panel.

With the similar final size, low density boards have more voids of space for water than the high density boards. The water absorption test result in this section is consistent with that finding.

4.3 Experiment 3: Node Effect on Guadua-Aspen Hybrid OSB

As discussed in Chapter 2, the microstructure, strength and density of nodes may affect the property of OSB products made from bamboo. It was expected that internode Guadua-Aspen hybrid OSB would have better properties than node Guadua-Aspen boards. Type GI has a surface made from 50% Guadua strands without node and a core made from 50% aspen strands. Type GN has a surface made from 50% Guadua strands with a node near the middle and a core made from 50% aspen strands. The average node frequency of Guadua was 3.3 nodes per meter of pole, less than Moso poles we imported. However, the nodes of Guadua poles are 2.66 times thicker than those of Moso and are much harder which required a Dremel Saw to remove while the Moso nodes could be removed by hand or a hammer.

4.3.1 Thickness and Density

Similar to the other types of board, spring back was observed with these boards. Rather than the target thickness 11.1 mm, both types of boards had a thickness exceeding 11.3 mm (see Table 23). The density of the boards also exceeded the original target by about 0.2% and 0.4%. There was no significant difference between internode Guadua board and node Guadua board for both thickness and density. This result is consistent with previous study on the effect of node on Moso-Aspen hybrid board (Semple et al., 2015b). The node has no significant effect on the spring back of thickness. In terms of density, the GI and GN boards are essentially identical.

Table 23. Thickness and density of GI and GN

Type	Thickness		Density	
	Mean (mm)	COV (%)	Mean (kg/m^3)	COV (%)
GI	11.35a	2.7	763.3a	11.6
GN	11.39a	3.0	761.8a	10.2
p-value	0.2395		0.3224	

4.3.2 Internal Bonding Strength

Previously, Semple et al. (2015b) found that the IB strength of boards made from internode or node strands were not significant different, and it was thought that the same result would be found for Guadua. However, IB strength tests showed the presence of nodes had a significant effect on the IB strength. Internode Guadua board (type GI) had a higher IB strength at 0.699 MPa compared to the board made with node strands (type GN) at 0.628 MPa by about 11.48%, which indicated that internode strands were compressed more than the node strands. It is noticeable that even though there was no significant difference between both types on the thickness and density, GN group which was made from nodes Guadua strands had a lower IB could be due to the presence of nodes.

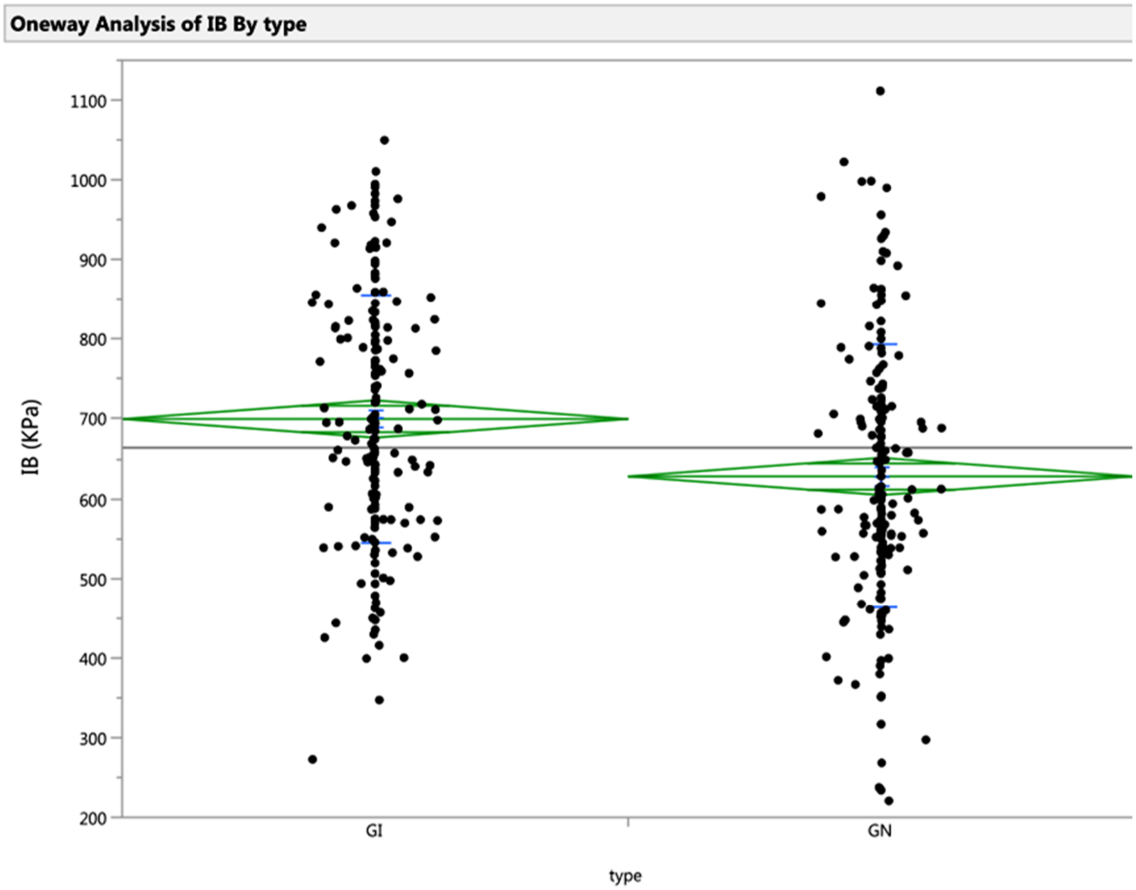


Figure 33. IB test results of GI and GN, n = 180 for each mean

4.3.3 Flexural Properties

The MOR and MOE for both directions and both types were greater than the minimum required for OSB products by CSA O437.0. And there was no significant difference between their MOE and MOR for the perpendicular to the strand direction (Table 24). The effect of nodes on the perpendicular to the strand direction flexural properties was not observed in these tests. Yet, the MOR and MOE parallel to the strand direction demonstrated higher flexural properties of internode Guadua hybrid board. The direction of vascular bundles in nodes becomes irregular compared to internode material. And as such the stiffness of the node material will be lower than the internode material. The properties that one would expect to see a noticeable difference in would be on MOE. This change in structure should affect TS as well. GI group had a 26.7% higher MOR and a 21.5% higher MOE compared to GN group (Table 25). The presence of nodes on the strands significantly affected the strength of the board, which was consistent with previous study on Moso node effect (Semple et al., 2015b).

Table 24. Flexural property test results of GI and GN (perpendicular)

Type	Means	COV (%)
	MOR (MPa) p-value = 0.3224	
GI	21.72a	33.1
GN	19.02a	30.4
	MOE (GPa) p-value = 0.5087	
GI	2.14a	28.1
GN	1.99a	25.8

Note: the levels in the table not followed by same letter are significantly different

Table 25. Flexural property test results of GI and GN (parallel)

Type	Means	COV (%)
	MOR (MPa) p-value < 0.0001	
GI	74.48a	12.7
GN	58.80b	11.8
	MOE (GPa) p-value = 0.0002	
GI	11.48a	11.4
GN	9.45b	9.1

Note: the levels in the table not followed by same letter are significantly different

4.3.4 Water Absorption

All the boards were fabricated without any addition of wax which is normally added to OSB. The previous study about the node effect on the water resistance ability showed no difference in 24 hours thickness swell and water absorption between boards made with internode or node

Moso strands in the surfaces. Contrary to that, the presence of nodes in Guadua strands made a difference on the results. Board made with internode Guadua strands in the surfaces had a 40.6% less thickness swell after 2 hours soaking. After 24 hours soaking in water, internode Guadua hybrid boards still had a 25.8% less thickness swell (Table 26 and Figure 35).

Table 26. Results of thickness swelling (%) for GI and GN

Type	Means	COV (%)
	2h TS (%) p-value = 0.0406	
GI	2.35b	32.7
GN	3.96a	37.6
	24h TS (%) p-value = 0.0103	
GI	9.24b	7.8
GN	12.45a	5.8

Note: the levels in the table not followed by same letter are significantly different

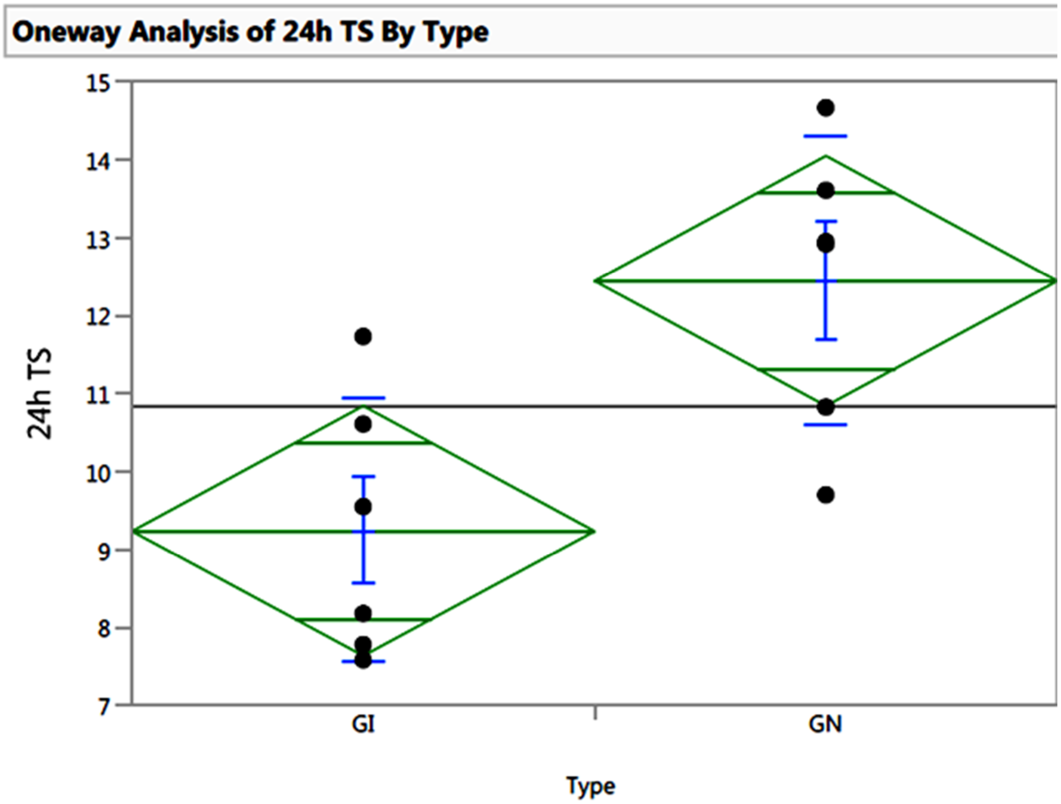


Figure 34. Results of 24h TS of GI and GN, n = 6 for each mean

Also, after 2 hours immersed in water, 16.7% more water was absorbed by the boards made with node Guadua strands on the surface. This number reduced to 14.3% after 24 hours soaking in water. However, a significant difference was found between two groups for both 2 hours TS and 24 hours TS, while no significant difference was found between two groups for neither 2 hours WA and 24 hours WA (Table 27 and Figure 36). In the same duration of time, nodes did not affect the amount of water the boards absorbed. Yet, it demonstrated that with similar percent of their initial weight water absorbed, internode strands had a better ability to maintain the form less swelling. Less deformation of internode strands gave Guadua boards better deformation resistance ability.

Table 27. Results of water absorption (w/%) for GI and GN

Type	Means	COV (%)
	2h WA (w/%) p-value = 0.3033	
GI	14.43a	22.9
GN	17.32a	32.5
	24h WA (w/%) p-value = 0.0992	
GI	35.51a	13.1
GN	39.10a	15.7

Note: the levels in the table not followed by same letter are significantly different

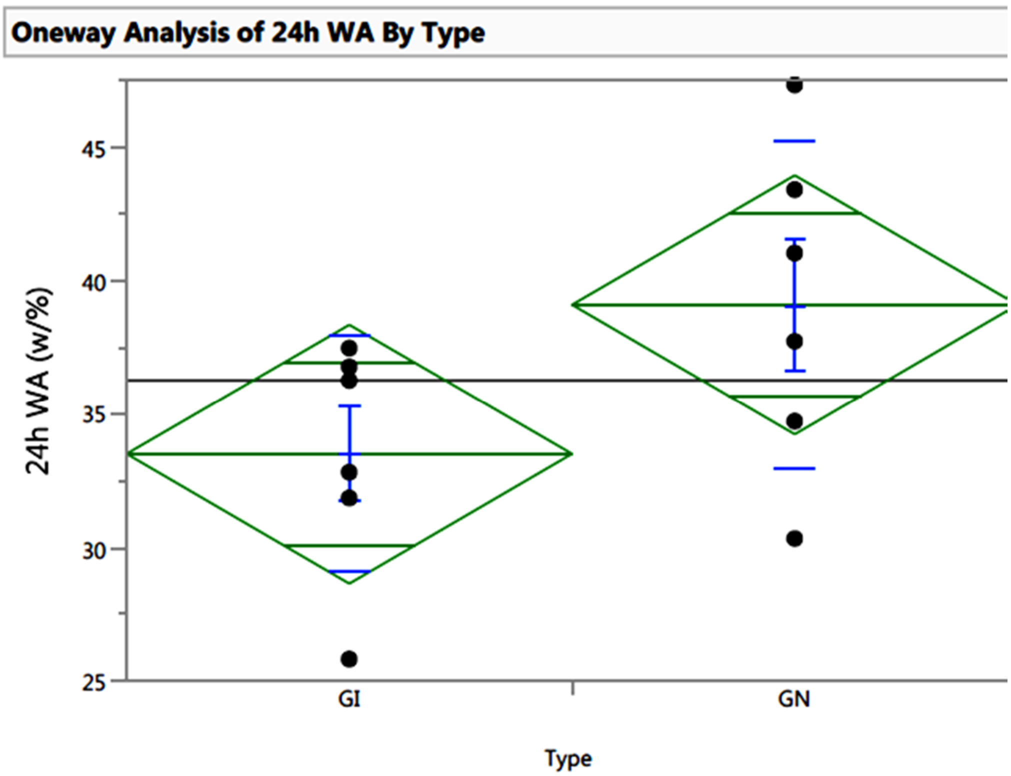


Figure 35. Results of 24h WA of GI and GN, n = 6 for each mean

The internal bonding test showed the internode Guadua hybrid board had better properties than the node Guadua hybrid board. However, for the internal bonding strength both of them were lower than the Moso hybrid board which was made from mixed node and internode Moso strands (see section 4.1.2) even though Guadua had a denser vascular bundles and solid fibre structure (Dixon et al., 2015). Regardless of the target thickness and density, there is a possibility for Guadua board, regardless of strand moisture, internode or node, to be compressed further.

The presence of nodes had little effect on the perpendicular to the strands direction flexural properties, but a significant negative effect on the parallel to the strands direction MOR and MOE. It showed the properties of node region could be different along the strands direction but consistent along the perpendicular direction. There was no significant difference in water absorption between the GN and GI samples. This may be due to the fact that the node strands are not as smooth as the internode strands. The node strands may pack less efficiently, leading to greater densification of the node containing part of the strands resulting in more spring back and swelling.

Chapter 5: Conclusion and Future Work

5.1 Difference between Moso and Guadua

In the comparison between two species of bamboo, Moso had a greater spring back after the press opened and temperature cooled down, which resulted in larger final thickness. The property test showed Guadua and Moso surface hybrid OSB had similar performance except for IB strength and parallel direction MOE. Contrary to expectation, hybrid OSB with surface made from Guadua bamboo, which is denser than Moso, had a lower IB strength. Greater compaction ratio of Moso bamboo strands is a possible reason for that result. With the same target density and weight ratio of bamboo-aspen, Moso strands filled the space better during the compression than Guadua because a lower density object has a larger volume based on the same weight. With higher density and larger vascular bundles, Guadua yet did not show better properties than Moso. Moso showed better consolidation than Guadua.

5.2 Lighter Bamboo OSB Met the CSA Standard

The study on whether bamboo hybrid board could meet the density as well as property standards required by CSA O437.0 (2011) showed that the bamboo boards met the requirements. Even though the lowest density group showed the weakest mechanical properties and water resistance ability, the 95% confidence interval for the group means met the CSA standards. For high density group and medium density group, expect for the significant difference between their density and thickness because the target was set on different level, all the property test showed no significant difference between these two groups. That indicated a non-linear positive correlation between the density and the performance. The density of Moso-Aspen OSB could be as low as normal wood OSB and still show compliant properties required by CSA standards.

5.3 The Effects of Node on Guadua Bamboo OSB

The presence of nodes on Guadua strands affected the hybrid OSB products in terms of mechanical properties. As was with Moso, Guadua-Aspen OSB without nodes had higher IB strength, and was stiffer and stronger in the bending test than similar boards made with strands containing nodes. Nodes had negative effect on the properties of Guadua Bamboo OSB.

5.4 Future Work

Possible future research could be around how to improve the consolidation of Guadua OSB products, etc. adding wood strands to fill up the space in the structure which result from the rough surfaces of Guadua strands or producing narrower Guadua strands to make hybrid OSB. The effect of the differences between the node structures of Guadua and Moso on the boards' properties could be studied.

As the point of the project is to find the best even distribution of board density and the strength properties, there is a potential to get a better strength properties within the proper density range. How to adjust the manufacture process and technique to reinforce the board properties is a possible focus of future research.

With knowing the node have negative effect on the board properties, it is of great interest to find a solution to minimize the nodes effects on the final product. At present, the bamboo strands are produced with lab equipment and high-intensity labor involvement. If the bamboo hybrid OSB products are expected to be applied in the practical manufactures field, more studies on how to improve the production flow are required. A possible solution could be removing the nodes during the process of producing strands efficiently, or changing the location of the node on the strands. A better volume ratio of nodes on Guadua culm could also be studied to show how significant of the effect of nodes on boards' properties. In the future work, more studies could be helpful to promote the three layer hybrid products as practical construction material.

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Appendices

Appendix A : Press Schedule

All 36 boards were pressed in 6 working days.

Press sequence

Board	Board code	Day	Task	Furnish weight, kg	Flake type	Layer
1,2,3	MM1,MM2,MM3	1	blend	6.4	Moso	surface
1,2	MM1,MM2	1	blend	6.4	Aspen	core
1	MM1	1	form and press	4.26	Hybrid	surface+core
2	MM2	1	form and press	4.26	Hybrid	surface+core
3,4	MM3,MM4	1	blend	6.4	Aspen	core
3	MM3	1	form and press	4.26	Hybrid	surface+core
4,5,6	MM4,MM5,MM6	1	blend	6.4	Moso	surface
4	MM4	1	form and press	4.26	Hybrid	surface+core
5,6	MM5,MM6	1	blend	6.4	Aspen	core
5	MM5	1	form and press	4.26	Hybrid	surface+core
6	MM6	1	form and press	4.26	Hybrid	surface+core
1,2,3	GM1,GM2,GM3	2	blend	6.4	Guadua	surface
1,2	GM1,GM2	2	blend	6.4	Aspen	core
1	GM1	2	form and press	4.26	Hybrid	surface+core
2	GM2	2	form and press	4.26	Hybrid	surface+core
3,4	GM3,GM4	2	blend	6.4	Aspen	core
3	GM3	2	form and press	4.26	Hybrid	surface+core
4,5,6	GM4,GM5,GM6	2	blend	6.4	Guadua	surface
4	GM4	2	form and press	4.26	Hybrid	surface+core
5,6	GM5,GM6	2	blend	6.4	Aspen	core
5	GM5	2	form and press	4.26	Hybrid	surface+core
6	GM6	2	form and press	4.26	Hybrid	surface+core

Press sequence – Cont. 1

Board	Board code	Day	Task	Furnish weight, kg	Flake type	Layer
1,2,3	GI1,GI2,GI3	3	blend	6.4	Guadua	surface
1,2	GI1,GI2	3	blend	6.4	Aspen	core
1	GI1	3	form and press	4.26	Hybrid	surface+core
2	GI2	3	form and press	4.26	Hybrid	surface+core
3,4	GI3,GI4	3	blend	6.4	Aspen	core
3	GI3	3	form and press	4.26	Hybrid	surface+core
4,5,6	GI4,GI5,GI6	3	blend	6.4	Guadua	surface
4	GI4	3	form and press	4.26	Hybrid	surface+core
5,6	GI5,GI6	3	blend	6.4	Aspen	core
5	GI5	3	form and press	4.26	Hybrid	surface+core
6	GI6	3	form and press	4.26	Hybrid	surface+core
1,2,3	GN1,GN2,GN3	4	blend	6.4	Guadua	surface
1,2	GN1,GN2	4	blend	6.4	Aspen	core
1	GN1	4	form and press	4.26	Hybrid	surface+core
2	GN2	4	form and press	4.26	Hybrid	surface+core
3,4	GN3,GN4	4	blend	6.4	Aspen	core
3	GN3	4	form and press	4.26	Hybrid	surface+core
4,5,6	GN4,GN5,GN6	4	blend	6.4	Guadua	surface
4	GN4	4	form and press	4.26	Hybrid	surface+core
5,6	GN5,GN6	4	blend	6.4	Aspen	core
5	GN5	4	form and press	4.26	Hybrid	surface+core
6	GN6	4	form and press	4.26	Hybrid	surface+core
1,2,3,4,5,6	ML1(1-6)	5	blend	6.05	Moso	surface
1,2	ML1 (1,2)	5	blend	6.05	Aspen	core
1	ML1(1)	5	form and press	4.04	Hybrid	surface+core
2	ML1(2)	5	form and press	4.04	Hybrid	surface+core
3,4	ML1 (3,4)	5	blend	6.05	Aspen	core

Press sequence – Cont. 2

Board	Board code	Day	Task	Furnish weight, kg	Flake type	Layer
3	ML1(3)	5	form and press	4.04	Hybrid	surface+core
4	ML1(4)	5	form and press	4.04	Hybrid	surface+core
5,6	ML1(5, 6)	5	blend	6.05	Aspen	core
5	ML1(5)	5	form and press	4.04	Hybrid	surface+core
6	ML1(6)	5	form and press	4.04	Hybrid	surface+core
1,2,3,4,5,6	ML2 (1-6)	6	blend	5.28	Moso	surface
1,2	ML2 (1,2)	6	blend	5.28	Aspen	core
1	ML2(1)	6	form and press	3.52	Hybrid	surface+core
2	ML2(2)	6	form and press	3.52	Hybrid	surface+core
3,4	ML2 (3,4)	6	blend	5.28	Aspen	core
3	ML2(3)	6	form and press	3.52	Hybrid	surface+core
4	ML2(4)	6	form and press	3.52	Hybrid	surface+core
5,6	ML2(5,6)	6	blend	5.28	Aspen	core
5	ML2(5)	6	form and press	3.52	Hybrid	surface+core
6	ML2(6)	6	form and press	3.52	Hybrid	surface+core

Appendix B : Test Results

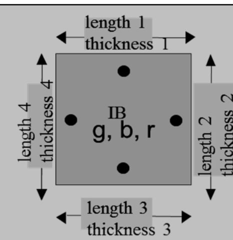
Internal Bonding Test has 30 specimens per board, total 1080 specimens.

IB test for GM

GM GuaduaMixed
MM MosoMixed
Mixed means internode and node mixed

g = Board type (GM)
b = Board No. (1,2,3,4,5,6)
r = Replication (Sample ID)

y = valid test, failure across the overlap length, or
n = either no failure occurred or the end tabs



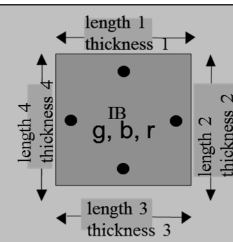
Board No.	Sample ID	Mass (gm)	Length 1 (mm)	Length 2 (mm)	Length 3 (mm)	Length 4 (mm)	Average length13 (mm)	Average length24 (mm)	Thickness (mm)	Density (kg/m^3)	Valid test (y or n)	Stress (KPa)
GM1	1	20.54	51.12	52.17	50.96	52.01	51.04	52.09	11.27	685.51	y	403.9
	2	23.03	51.18	52.11	51.18	52.08	51.18	52.10	11.35	761.03	y	563.8
	3	21.72	51.27	52.16	51.28	52.19	51.28	52.18	11.15	728.14	y	548.7
	4	21.61	51.53	52.08	51.28	52.01	51.41	52.05	11.38	709.79	y	568.1
	5	22.90	51.70	52.05	51.59	52.11	51.65	52.08	11.47	742.29	y	601.9
	6	24.05	52.23	51.13	52.16	51.20	52.20	51.17	11.29	797.66	y	653.9
	7	18.40	52.11	51.24	52.14	51.30	52.13	51.27	11.21	614.19	y	380.1
	8	22.82	52.08	51.43	52.08	51.48	52.08	51.46	11.28	754.93	y	559.5
	9	28.54	52.14	51.58	52.13	51.80	52.14	51.69	11.24	942.22	y	791.0
	10	25.47	52.01	51.78	52.12	51.83	52.07	51.81	11.21	842.38	y	474.4
	11	24.03	51.38	52.13	51.41	52.18	51.40	52.16	11.15	804.01	y	610.1
	12	24.72	51.37	52.20	51.38	52.09	51.38	52.15	11.16	826.84	y	587.8
	13	21.56	51.32	52.09	51.24	52.11	51.28	52.10	11.12	725.70	y	460.2
	14	19.53	51.20	52.08	51.16	52.04	51.18	52.06	11.21	653.87	y	452.6
	15	21.30	51.15	52.12	51.14	52.07	51.15	52.10	11.40	701.25	y	405.5
	16	18.59	51.87	51.08	51.86	51.12	51.87	51.10	11.80	594.43	y	358.7
	17	24.12	52.13	51.19	52.11	51.23	52.12	51.21	11.75	769.10	y	637.8
	18	27.91	52.17	51.13	52.19	51.14	52.18	51.14	11.82	884.95	y	629.2
	19	24.19	52.08	51.79	52.08	51.88	52.08	51.84	11.36	788.79	y	544.4
	20	25.39	52.02	51.82	52.13	51.94	52.08	51.88	11.27	833.89	y	670.3
	21	26.65	52.10	51.11	52.12	51.06	52.11	51.09	11.68	857.12	y	654.6
	22	25.74	52.18	51.11	52.12	51.15	52.15	51.13	11.70	825.07	y	586.6
	23	22.76	52.17	51.15	52.16	51.20	52.17	51.18	11.77	724.37	y	577.1
	24	18.92	51.03	52.07	51.07	52.14	51.05	52.11	11.41	623.39	y	430.9
	25	22.75	52.12	51.11	52.14	51.13	52.13	51.12	11.74	727.17	y	468.8
	26	19.92	52.12	51.15	52.11	51.19	52.12	51.17	11.73	636.81	y	420.3
	27	20.58	52.08	51.19	52.18	51.28	52.13	51.24	11.68	659.70	y	335.7
	28	21.48	52.03	51.59	52.13	51.32	52.08	51.46	11.67	686.85	y	513.0
	29	20.55	52.11	51.29	52.07	51.21	52.09	51.25	11.80	652.35	y	484.4
	30	19.44	51.16	52.15	51.09	52.08	51.13	52.12	11.07	659.10	y	372.8

IB test for GM

GM GuaduaMixed
MM MosoMixed
Mixed means internode and node mixed

g = Board type (GM)
b = Board No. (1,2,3,4,5,6)
r = Replication (Sample ID)

y = valid test, failure across the overlap length, or
n = either no failure occurred or the end tabs



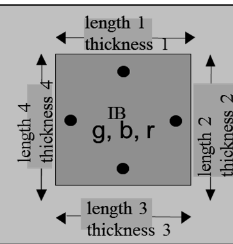
Board No.	Sample ID	Specimen Characteristics										
		Mass	Length				Average length13	Average length24	Thickness	Density	Valid test	Stress
			1	2	3	4						
		(gm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(kg/m^3)	(y or n)	(KPa)
GM2	1	26.45	52.45	51.11	52.41	50.9	52.43	51.01	12.05	820.82	y	695.2
	2	26.07	50.89	52.42	51	52.42	50.95	52.42	11.88	821.72	y	545.2
	3	26.45	52.29	50.89	52.38	50.88	52.34	50.89	11.93	832.54	y	593.9
	4	26.29	50.79	52.39	50.82	52.47	50.81	52.43	11.67	845.73	y	528.2
	5	20.37	50.69	52.48	50.81	52.48	50.75	52.48	11.57	661.04	y	372.9
	6	16.19	50.55	52.22	50.74	52.32	50.65	52.27	11.66	524.52	y	251.2
	7	24.27	52.37	51.11	52.45	51.34	52.41	51.23	11.21	806.43	y	376.2
	8	25.47	52.42	51.28	52.38	51.28	52.40	51.28	11.13	851.64	y	671.8
	9	27.33	52.39	51.34	52.43	51.3	52.41	51.32	11.20	907.24	y	744.8
	10	22.12	51.33	52.51	51.64	52.5	51.49	52.51	11.11	736.53	y	402.7
	11	22.19	52.38	51.27	52.45	51.23	52.42	51.25	10.89	758.54	y	474.2
	12	24.42	52.39	51.2	52.4	51.32	52.40	51.26	10.94	831.11	y	470.3
	13	24.67	52.37	51.32	52.5	51.37	52.44	51.35	11.09	826.26	y	542.3
	14	26.14	52.17	51.25	52.2	51.2	52.19	51.23	11.00	888.97	y	472.8
	15	24.37	51.26	52.31	51.56	52.2	51.41	52.26	11.05	820.95	y	520.9
	16	22.58	51.7	52.43	51.29	52.41	51.50	52.42	11.07	755.64	y	573.9
	17	22.76	51.32	52.39	51.24	52.38	51.28	52.39	11.05	766.75	y	581.8
	18	24.09	51.21	52.63	51.26	52.42	51.24	52.53	10.98	815.27	y	708.3
	19	26.33	51.23	52.37	51.22	52.41	51.23	52.39	11.02	890.31	y	834.1
	20	22.90	51.12	52.39	51.15	52.5	51.14	52.45	11.00	776.28	y	392.7
	21	21.98	52.3	51.32	52.37	51.18	52.34	51.25	10.94	749.07	y	381.7
	22	23.37	52.49	51.27	52.47	51.25	52.48	51.26	11.34	766.08	y	480.1
	23	24.61	52.35	51.32	52.35	51.21	52.35	51.27	10.92	839.75	y	550.6
	24	22.42	52.25	51.33	52.3	51.36	52.28	51.35	11.20	745.81	y	533.0
	25	25.39	52.48	51.28	52.41	51.31	52.45	51.30	11.58	815.03	y	719.1
	26	25.81	52.26	51.39	52.32	51.34	52.29	51.37	11.34	847.40	y	549.8
	27	25.28	52.34	51.32	52.31	51.29	52.33	51.31	11.39	826.77	y	664.7
	28	26.61	51.07	52.49	51.04	52.4	51.06	52.45	12.00	828.17	y	552.6
	29	25.94	51.07	52.34	51.01	52.36	51.04	52.35	11.97	811.05	y	593.4
	30	25.00	51.2	52.41	51.06	52.3	51.13	52.36	12.11	771.19	y	633.0

IB test for GM

GM GuaduaMixed
MM MosoMixed
Mixed means internode and node mixed

g = Board type (GM)
b = Board No. (1,2,3,4,5,6)
r = Replication (Sample ID)

y = valid test, failure across the overlap length, or
n = either no failure occurred or the end tabs



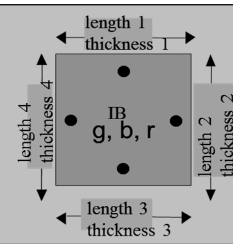
Board No.	Sample ID	Specimen Characteristics										
		Mass	Length				Average	Average	Thickness	Density	Valid	Stress
			1	2	3	4	length13	length24			test	
		(gm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(kg/m^3)	(y or n)	(KPa)
GM3	1	23.63	51.71	51.27	51.80	51.35	51.76	51.31	11.55	770.42	y	422.8
	2	20.69	51.81	51.33	51.78	51.38	51.80	51.36	11.50	676.38	y	355.5
	3	22.32	51.57	51.78	51.42	51.82	51.50	51.80	11.53	725.72	y	500.7
	4	23.18	51.82	51.60	51.83	51.66	51.83	51.63	11.52	752.00	y	672.1
	5	23.39	51.77	51.76	51.83	51.61	51.80	51.69	11.44	763.68	y	507.2
	6	21.70	51.81	51.64	51.64	51.65	51.73	51.65	11.44	710.08	y	382.5
	7	25.68	50.89	51.87	50.84	51.88	50.87	51.88	11.59	839.72	y	581.6
	8	25.97	50.95	51.84	50.91	51.88	50.93	51.86	11.56	850.57	y	657.8
	9	24.98	51.10	51.78	51.11	51.79	51.11	51.79	11.72	805.37	y	542.4
	10	21.86	51.16	51.75	51.08	51.88	51.12	51.82	11.45	720.77	y	287.8
	11	24.75	51.96	50.78	51.85	50.82	51.91	50.80	11.56	811.98	y	413.5
	12	27.20	51.96	50.63	51.84	50.75	51.90	50.69	11.64	888.23	y	484.5
	13	22.72	51.14	51.58	51.06	51.60	51.10	51.59	11.52	748.12	y	573.2
	14	21.49	51.38	51.72	51.17	51.75	51.28	51.74	11.62	697.17	y	336.9
	15	24.10	51.24	51.79	51.18	51.82	51.21	51.81	11.73	774.45	y	554.4
	16	23.71	51.70	51.38	51.78	51.44	51.74	51.41	11.70	761.85	y	508.7
	17	24.05	51.82	51.38	51.79	51.28	51.81	51.33	11.61	779.00	y	509.3
	18	24.19	51.70	51.18	51.76	51.14	51.73	51.16	11.62	786.61	y	556.1
	19	24.31	51.59	50.74	51.61	50.79	51.60	50.77	11.94	777.26	y	337.9
	20	22.80	51.86	50.79	51.81	50.79	51.84	50.79	11.97	723.50	y	401.9
	21	25.51	51.82	50.76	51.84	50.78	51.83	50.77	12.05	804.52	y	483.7
	22	26.44	51.56	50.75	51.50	50.71	51.53	50.73	11.88	851.37	y	596.0
	23	24.69	51.55	51.34	51.48	51.40	51.52	51.37	11.62	802.92	y	694.4
	24	25.81	50.56	51.82	50.67	51.86	50.62	51.84	11.81	832.90	y	640.2
	25	23.21	50.53	51.83	50.56	51.80	50.55	51.82	11.85	747.86	y	398.3
	26	18.98	50.54	50.81	50.50	50.66	50.52	50.74	11.75	630.21	y	221.1
	27	27.55	50.58	51.86	50.61	51.85	50.60	51.86	11.88	883.91	y	707.9
	28	23.65	51.85	50.78	51.87	50.63	51.86	50.71	11.86	758.34	y	594.8
	29	20.79	51.81	50.64	51.86	50.67	51.84	50.66	11.87	667.05	y	386.2
	30	16.73	50.80	51.93	50.77	51.94	50.79	51.94	11.24	564.33	y	260.2

IB test for GM

GM GuaduaMixed
MM MosoMixed
Mixed means internode and node mixed

g = Board type (GM)
b = Board No. (1,2,3,4,5,6)
r = Replication (Sample ID)

y = valid test, failure across the overlap length, or
n = either no failure occurred or the end tabs



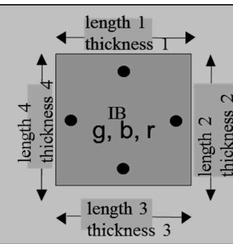
		Specimen Characteristics										
Board No.	Sample ID	Mass (gm)	Length 1 (mm)	Length 2 (mm)	Length 3 (mm)	Length 4 (mm)	Average length13 (mm)	Average length24 (mm)	Thickness (mm)	Density (kg/m^3)	Valid test (y or n)	Stress (KPa)
GM4	1	21.43	51.69	50.84	51.68	51.11	51.69	50.98	11.54	704.85	y	508.3
	2	25.61	51.87	51.11	51.90	51.29	51.89	51.20	11.56	833.95	y	630.4
	3	24.99	51.86	51.33	51.86	51.55	51.86	51.44	11.50	814.58	y	550.3
	4	22.64	51.88	51.56	51.92	51.73	51.90	51.65	11.39	741.58	y	595.9
	5	22.47	51.86	51.86	51.94	52.01	51.90	51.94	11.36	733.83	y	503.1
	6	26.20	51.88	52.05	51.95	52.16	51.92	52.11	11.18	866.34	y	671.0
	7	23.90	50.54	51.38	50.38	51.42	50.46	51.40	11.09	830.91	y	581.4
	8	24.23	50.80	51.93	50.66	51.85	50.73	51.89	11.02	835.26	y	686.9
	9	20.02	52.10	51.99	51.85	51.86	51.98	51.93	11.07	670.11	y	338.3
	10	21.84	51.81	52.10	51.49	51.90	51.65	52.00	11.05	735.90	y	457.4
	11	17.82	50.56	51.84	50.51	51.90	50.54	51.87	11.71	580.55	y	416.7
	12	19.54	51.88	50.45	51.85	50.39	51.87	50.42	11.67	640.29	y	288.5
	13	21.76	51.91	51.13	51.92	51.20	51.92	51.17	11.40	718.60	y	512.4
	14	24.96	51.88	51.22	51.85	51.24	51.87	51.23	11.48	818.28	y	506.7
	15	24.14	51.29	51.91	51.25	51.95	51.27	51.93	11.66	777.60	y	440.1
	16	20.17	51.96	50.26	51.96	50.27	51.96	50.27	11.85	651.71	y	485.8
	17	25.24	51.30	51.94	51.29	51.96	51.30	51.95	11.51	822.91	y	630.7
	18	23.51	51.16	51.93	51.21	51.90	51.19	51.92	11.69	756.84	y	482.3
	19	24.12	51.94	51.19	51.93	51.17	51.94	51.18	11.47	791.14	y	461.1
	20	27.33	51.18	51.93	51.17	51.94	51.18	51.94	11.44	898.87	y	734.5
	21	23.08	51.11	51.86	51.17	51.84	51.14	51.85	11.71	743.31	y	570.6
	22	26.69	51.90	51.67	51.77	51.62	51.84	51.65	11.76	847.79	y	615.7
	23	18.52	51.90	50.37	51.96	50.52	51.93	50.45	11.09	637.49	y	260.6
	24	25.50	51.89	51.55	51.88	51.58	51.89	51.57	11.77	809.78	y	591.5
	25	21.25	51.92	50.67	51.91	50.72	51.92	50.70	11.39	708.89	y	382.6
	26	21.99	51.91	50.57	51.92	50.63	51.92	50.60	11.33	738.84	y	291.6
	27	25.25	51.88	51.34	51.88	51.49	51.88	51.42	11.70	809.07	y	619.8
	28	21.77	51.93	50.77	51.92	50.87	51.93	50.82	11.53	715.51	y	375.3
	29	25.10	51.82	51.35	51.83	51.30	51.83	51.33	11.69	807.22	y	420.2
	30	21.45	51.85	51.05	51.87	51.13	51.86	51.09	11.67	693.73	y	364.8

IB test for GM

GM GuaduaMixed
MM MosoMixed
Mixed means internode and node mixed

g = Board type (GM)
b = Board No. (1,2,3,4,5,6)
r = Replication (Sample ID)

y = valid test, failure across the overlap length, or
n = either no failure occurred or the end tabs

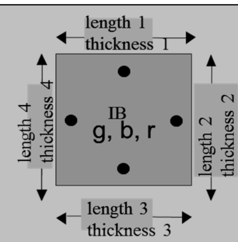


Board No.	Sample ID	Specimen Characteristics										
		Mass	Length				Average length13	Average length24	Thickness	Density	Valid test	Stress
		(gm)	1 (mm)	2 (mm)	3 (mm)	4 (mm)	(mm)	(mm)	(mm)	(kg/m^3)	(y or n)	(KPa)
GM5	1	25.10	50.98	52.01	51.02	51.88	51.00	51.95	11.89	796.85	y	935.7
	2	27.10	51.84	51.01	51.89	50.98	51.87	51.00	11.74	872.77	y	1101.2
	3	22.70	50.95	51.81	51.24	51.88	51.10	51.85	11.90	720.10	y	829.2
	4	22.30	51.19	51.87	51.32	51.91	51.26	51.89	11.11	754.69	y	536.1
	5	23.30	51.94	51.24	51.91	51.21	51.93	51.23	11.31	774.52	y	754.3
	6	27.10	51.07	51.96	51.09	51.99	51.08	51.98	11.34	900.14	y	1211.9
	7	25.70	51.77	51.34	51.84	51.33	51.81	51.34	11.49	841.06	y	763.6
	8	20.00	51.34	51.84	51.42	52.06	51.38	51.95	11.49	652.12	y	345.3
	9	19.80	51.95	51.48	51.93	51.31	51.94	51.40	11.49	645.54	y	562.0
	10	25.30	51.97	51.24	51.97	51.25	51.97	51.25	11.39	834.05	y	790.1
	11	22.40	51.79	51.61	51.76	51.75	51.78	51.68	11.80	709.45	y	856.0
	12	22.40	10.79	51.80	51.84	51.95	31.32	51.88	10.80	1276.77	y	1460.8
	13	23.60	51.79	51.91	51.72	51.94	51.76	51.93	10.91	804.93	y	715.4
	14	23.80	51.88	51.85	51.96	51.40	51.92	51.63	10.87	816.87	y	762.0
	15	24.60	51.30	51.87	51.66	51.88	51.48	51.88	10.91	844.33	y	1025.1
	16	23.60	51.93	51.27	51.83	51.25	51.88	51.26	10.87	816.40	y	851.7
	17	23.20	51.87	51.35	51.95	51.64	51.91	51.50	10.83	801.39	y	699.6
	18	24.10	51.85	51.62	51.94	51.61	51.90	51.62	10.89	826.20	y	709.4
	19	24.30	51.49	51.88	51.56	51.89	51.53	51.89	11.00	826.33	y	1023.1
	20	29.40	51.90	51.10	51.94	51.13	51.92	51.12	11.90	930.93	y	915.9
	21	24.50	51.9	51.01	51.9	51.1	51.90	51.06	11.82	782.25	y	790.8
	22	23.60	51.85	51.02	51.83	51.14	51.84	51.08	11.69	762.40	y	725.1
	23	21.60	51.87	51.05	51.87	51.11	51.87	51.08	11.71	696.19	y	772.4
	24	24.90	51.84	51.1	51.83	51.16	51.84	51.13	11.87	791.50	y	693.3
	25	20.70	50.97	51.82	50.94	51.82	50.96	51.82	11.70	670.04	y	614.5
	26	27.30	51.52	51.96	51.81	52.25	51.67	52.11	10.92	928.68	y	946.3
	27	24.60	51.92	51.36	51.87	51.21	51.90	51.29	11.40	810.80	y	831.3
	28	25.20	51.9	51.07	51.86	51.06	51.88	51.07	11.69	813.70	y	783.9
	29	24.50	51.15	51.85	51.14	51.88	51.15	51.87	11.44	807.35	y	836.1
	30	18.40	51.85	50.79	51.82	50.73	51.84	50.76	11.25	621.61	y	486.7

IB test for GM

GM GuaduaMixed
MM MosoMixed
Mixed means internode and node mixed

g = Board type (GM)
b = Board No. (1,2,3,4,5,6)
r = Replication (Sample ID)



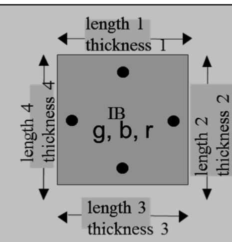
y = valid test, failure across the overlap length, or
n = either no failure occurred or the end tabs

Board No.	Sample ID	Specimen Characteristics										
		Mass	Length				Average length13	Average length24	Thickness	Density	Valid test	Stress
			1	2	3	4						
		(gm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(kg/m^3)	(y or n)	(KPa)
GM6	1	26.78	51.33	51.93	51.15	51.86	51.24	51.90	11.22	897.60	y	837.8
	2	23.45	51.12	51.82	50.99	51.85	51.06	51.84	11.17	793.28	y	728.1
	3	24.13	51.92	50.78	51.98	50.95	51.95	50.87	11.15	818.99	y	679.5
	4	24.97	51.82	50.72	51.98	50.56	51.90	50.64	11.19	849.04	y	890.9
	5	22.62	51.32	51.85	51.21	51.69	51.27	51.77	11.14	765.08	y	697.9
	6	24.42	51.36	51.87	51.36	51.81	51.36	51.84	11.04	830.78	y	713.0
	7	23.25	51.26	51.92	51.27	51.86	51.27	51.89	11.02	793.12	y	958.6
	8	23.54	51.84	51.26	51.92	51.38	51.88	51.32	10.91	810.39	y	835.3
	9	23.05	51.87	51.47	51.89	51.40	51.88	51.44	11.13	776.10	y	704.8
	10	24.24	51.91	51.95	51.84	51.94	51.88	51.95	11.33	793.96	y	912.3
	11	22.87	51.72	51.88	51.57	51.78	51.65	51.83	11.20	762.85	y	784.6
	12	26.68	51.43	51.95	51.30	52.02	51.37	51.99	11.17	894.51	y	791.7
	13	18.78	51.07	51.81	51.09	51.92	51.08	51.87	11.53	614.81	y	553.0
	14	25.79	51.28	51.97	51.34	51.93	51.31	51.95	11.27	858.50	y	840.5
	15	21.17	51.88	51.33	51.86	51.42	51.87	51.38	11.36	699.32	y	643.9
	16	26.62	51.39	51.99	51.49	51.89	51.44	51.94	11.42	872.45	y	898.5
	17	23.56	51.46	51.93	51.51	51.95	51.49	51.94	11.00	800.94	y	940.5
	18	22.45	51.46	51.90	51.34	51.84	51.40	51.87	11.23	749.82	y	747.0
	19	27.78	51.93	51.37	51.94	51.31	51.94	51.34	11.29	922.83	y	819.0
	20	17.60	51.94	50.98	51.95	51.09	51.95	51.04	11.45	579.82	y	329.4
	21	24.92	48.90	51.90	49.22	51.91	49.06	51.91	11.25	869.88	y	968.0
	22	23.81	51.89	48.90	51.81	48.60	51.85	48.75	11.32	832.13	y	707.2
	23	18.58	51.01	51.93	51.10	51.87	51.06	51.90	11.50	609.74	y	555.1
	24	24.47	49.90	51.81	49.63	51.79	49.77	51.80	11.29	840.79	y	674.4
	25	20.74	51.81	50.05	51.82	50.39	51.82	50.22	11.14	715.47	y	536.2
	26	26.22	49.57	51.89	49.28	51.90	49.43	51.90	11.19	913.55	y	887.3
	27	21.25	51.85	48.28	51.84	48.62	51.85	48.45	11.30	748.65	y	578.9
	28	18.16	50.97	51.85	50.99	51.87	50.98	51.86	11.41	602.00	y	368.2
	29	19.39	51.63	50.82	52.14	51.05	51.89	50.94	10.99	667.61	y	537.6
	30	17.69	51.00	51.94	50.98	51.79	50.99	51.87	11.35	589.35	y	426.4

IB test for MM

GM	GuaduaMixed	g = Board type (MM)
MM	MosoMixed	b = Board No. (1,2,3,4,5,6)
Mixed means internode and node mixed		r = Replication (Sample ID)

y = valid test, failure across the overlap length, or
n = either no failure occurred or the end tabs

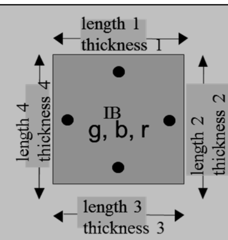


Board No.	Sample ID	Specimen Characteristics										
		Mass	Length				Average length13	Average length24	Thickness	Density	Valid test	Stress
		(gm)	1 (mm)	2 (mm)	3 (mm)	4 (mm)	(mm)	(mm)	(mm)	(kg/m^3)	(y or n)	(KPa)
MM1	1	20.35	51.15	51.96	51.11	51.78	51.13	51.87	10.89	704.60	y	698.0
	2	23.36	51.72	51.15	51.82	51.28	51.77	51.22	10.97	803.14	y	594.6
	3	20.49	51.77	51.15	51.76	51.10	51.77	51.13	11.07	699.40	y	762.7
	4	20.92	51.83	51.15	51.77	51.12	51.80	51.14	11.18	706.43	y	673.3
	5	24.85	51.79	51.12	51.83	51.05	51.81	51.09	11.18	839.80	y	1046.0
	6	28.00	51.90	51.21	51.91	51.06	51.91	51.14	11.30	933.58	y	590.2
	7	25.21	50.22	51.81	50.35	51.80	50.29	51.81	11.40	848.90	y	1101.0
	8	28.13	49.96	51.94	50.19	51.96	50.08	51.95	11.98	902.62	y	935.1
	9	23.96	49.76	51.74	49.94	51.67	49.85	51.71	11.50	808.33	y	841.0
	10	19.15	51.02	51.90	50.94	51.84	50.98	51.87	11.20	646.60	y	733.8
	11	27.18	51.48	51.92	51.27	51.81	51.38	51.87	11.28	904.30	y	913.6
	12	24.28	51.35	51.84	51.05	51.89	51.20	51.87	11.21	815.64	y	907.5
	13	26.27	50.98	51.87	50.80	51.89	50.89	51.88	11.27	882.88	y	1072.0
	14	23.42	50.59	51.86	50.78	51.83	50.69	51.85	11.28	790.12	y	793.9
	15	21.47	50.57	51.84	50.45	51.87	50.51	51.86	11.34	722.85	y	768.1
	16	24.00	51.22	51.84	51.17	51.79	51.20	51.82	11.56	782.65	y	823.0
	17	24.47	50.71	51.85	50.63	51.78	50.67	51.82	10.97	849.61	y	1033.0
	18	23.31	50.60	51.80	50.55	51.77	50.58	51.79	11.01	808.38	y	1124.0
	19	21.16	50.74	51.81	50.76	51.81	50.75	51.81	11.15	721.76	y	728.7
	20	23.02	51.77	50.99	51.83	51.05	51.80	51.02	11.30	770.83	y	896.6
	21	23.24	50.19	51.83	50.34	51.93	50.27	51.88	11.47	776.98	y	713.5
	22	23.91	50.46	51.85	50.55	51.86	50.51	51.86	11.48	795.27	y	1023.4
	23	24.29	50.59	51.90	50.75	51.89	50.67	51.90	11.52	801.86	y	959.6
	24	27.62	50.75	51.84	50.99	51.77	50.87	51.81	11.58	905.07	y	889.8
	25	26.87	51.00	51.85	51.11	51.84	51.06	51.85	11.58	876.63	y	1009.4
	26	21.15	50.69	51.88	50.67	51.89	50.68	51.89	11.12	723.31	y	708.6
	27	24.85	51.53	52.01	51.33	51.77	51.43	51.89	11.36	819.69	y	884.8
	28	24.04	51.14	51.87	50.95	51.91	51.05	51.89	11.70	775.73	y	746.5
	29	25.78	50.94	51.88	50.86	51.86	50.90	51.87	11.27	866.41	y	934.2
	30	19.22	50.99	51.84	51.14	51.74	51.07	51.79	10.91	666.13	y	564.8

IB test for MM

GM	GuaduaMixed	g = Board type (MM)
MM	MosoMixed	b = Board No. (1,2,3,4,5,6)
Mixed means internode and node mixed		r = Replication (Sample ID)

y = valid test, failure across the overlap length, or
n = either no failure occurred or the end tabs



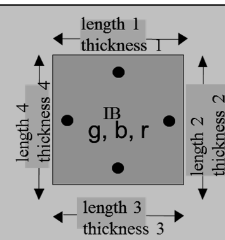
Board No.	Sample ID	Specimen Characteristics Mass (gm)	Length 1 (mm)	Length 2 (mm)	Length 3 (mm)	Length 4 (mm)	Average length13 (mm)	Average length24 (mm)	Thickness (mm)	Density (kg/m^3)	Valid test (y or n)	Stress (KPa)
MM2	1	26.89	51.78	51.55	51.95	51.47	51.87	51.51	11.69	861.01	y	581.4
	2	25.73	51.74	51.44	51.72	51.49	51.73	51.47	11.61	832.44	y	647.7
	3	24.62	51.81	51.45	51.83	51.5	51.82	51.48	11.65	792.26	y	662.8
	4	27.09	51.86	51.44	51.88	51.33	51.87	51.39	12.3	826.33	y	404.2
	5	28.64	51.76	51.29	51.72	51.35	51.74	51.32	11.9	906.39	y	724.5
	6	24.52	51.81	51.37	51.8	51.35	51.81	51.36	11.67	789.68	y	752.5
	7	22.63	51.75	51.34	51.75	51.33	51.75	51.34	11.56	736.89	y	641.9
	8	26.51	51.83	51.82	51.52	51.91	51.68	51.87	11.49	860.86	y	595.2
	9	22.66	51.5	51.75	51.4	51.8	51.45	51.78	11.52	738.42	y	574.3
	10	20.58	51.31	51.88	51.22	51.85	51.27	51.87	11.44	676.59	y	594.8
	11	17.93	51.03	51.79	51.02	51.88	51.03	51.84	11.21	604.74	y	418.5
	12	21.57	51.82	51.13	51.83	51.31	51.83	51.22	11.26	721.66	y	844.4
	13	22.14	51.76	50.86	51.81	51.05	51.79	50.96	11.26	745.16	y	836.5
	14	23.49	51.83	50.68	51.86	50.82	51.85	50.75	11.35	786.58	y	608.6
	15	23.47	51.83	50.62	51.84	50.69	51.84	50.66	11.34	788.23	y	948.9
	16	23.69	51.72	50.45	51.78	50.55	51.75	50.50	11.35	798.67	y	787.2
	17	23.47	51.18	51.86	51	51.89	51.09	51.88	11.23	788.57	y	908.7
	18	22.91	51.02	51.86	51	51.86	51.01	51.86	11.34	763.70	y	971.5
	19	24.80	50.93	51.81	50.84	51.86	50.89	51.84	11.34	829.14	y	747.6
	20	21.59	51.03	51.73	51.04	51.77	51.04	51.75	11.36	719.61	y	686.8
	21	22.58	51.82	50.8	51.83	50.89	51.83	50.85	11.87	721.91	y	745.3
	22	23.45	51.78	50.81	51.77	50.79	51.78	50.80	11.83	753.66	y	828.7
	23	26.42	51.86	50.74	51.86	50.78	51.86	50.76	11.85	846.96	y	784.5
	24	23.31	51.84	50.82	51.84	50.74	51.84	50.78	11.95	741.00	y	899.9
	25	22.87	51.76	50.69	51.78	50.7	51.77	50.70	12.04	723.76	y	905.6
	26	22.76	51.81	50.75	51.76	50.68	51.79	50.72	12.05	719.19	y	699.3
	27	21.21	51.78	50.7	51.78	50.68	51.78	50.69	12.03	671.72	y	673.6
	28	23.83	51.85	50.67	51.83	50.63	51.84	50.65	12.03	754.42	y	818.3
	29	22.56	51.69	50.58	51.77	50.58	51.73	50.58	12.01	717.92	y	661.9
	30	24.31	51.85	50.6	51.83	50.61	51.84	50.61	11.83	783.32	y	778.6

IB test for MM

GM GuaduaMixed
MM MosoMixed
Mixed means internode and node mixed

g = Board type (MM)
b = Board No. (1,2,3,4,5,6)
r = Replication (Sample ID)

y = valid test, failure across the overlap length, or
n = either no failure occurred or the end tabs

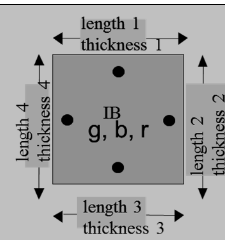


		Specimen Characteristics										
Board No.	Sample ID	Mass (gm)	Length 1 (mm)	Length 2 (mm)	Length 3 (mm)	Length 4 (mm)	Average length13 (mm)	Average length24 (mm)	Thickness (mm)	Density (kg/m^3)	Valid test (y or n)	Stress (KPa)
MM3	1	23.50	51.86	51.38	51.79	51.49	51.83	51.44	11.42	771.98	y	932.1
	2	22.48	51.87	51.32	51.84	51.33	51.86	51.33	11.39	741.57	y	736.4
	3	24.24	51.82	50.60	51.72	50.69	51.77	50.65	11.48	805.33	y	1032.7
	4	22.20	50.86	51.80	50.71	51.84	50.79	51.82	11.56	729.73	y	798.8
	5	24.26	51.10	51.80	50.91	51.83	51.01	51.82	11.52	796.84	y	597.8
	6	24.61	51.13	51.73	51.31	51.57	51.22	51.65	11.55	805.42	y	867.3
	7	24.53	51.71	51.62	52.00	51.58	51.86	51.60	11.73	781.55	y	911.1
	8	25.85	51.57	51.76	51.60	51.75	51.59	51.76	11.64	831.82	y	889.9
	9	26.24	51.77	51.57	51.78	51.54	51.78	51.56	11.73	838.06	y	1097.7
	10	25.27	51.80	51.52	51.83	51.57	51.82	51.55	11.55	819.18	y	1016.5
	11	25.52	51.53	51.89	51.46	51.90	51.50	51.90	11.65	819.72	y	859.4
	12	23.52	51.51	51.76	51.51	51.73	51.51	51.75	11.77	749.72	y	650.4
	13	21.08	51.24	51.78	51.03	51.58	51.14	51.68	11.35	702.80	y	708.7
	14	21.17	51.00	51.81	50.78	51.78	50.89	51.80	11.47	700.22	y	693.4
	15	23.54	50.77	51.86	50.70	51.69	50.74	51.78	11.47	781.30	y	623.8
	16	21.83	49.79	51.87	49.99	52.06	49.89	51.97	11.26	747.81	y	772.7
	17	23.14	50.12	51.81	50.24	51.78	50.18	51.80	11.35	784.42	y	640.2
	18	20.42	50.28	51.74	50.58	51.72	50.43	51.73	11.43	684.82	y	534.8
	19	20.01	50.53	51.84	50.78	51.80	50.66	51.82	11.46	665.19	y	664.9
	20	24.90	51.81	51.49	51.81	51.53	51.81	51.51	11.64	801.57	y	853.5
	21	26.76	51.76	51.52	51.70	51.55	51.73	51.54	12.09	830.26	y	524.1
	22	29.29	51.83	51.39	51.78	51.46	51.81	51.43	12.15	904.89	y	824.5
	23	24.11	51.84	51.32	51.85	51.45	51.85	51.39	12.08	749.18	y	824.5
	24	23.47	51.37	51.93	51.29	51.93	51.33	51.93	11.43	770.33	y	638.6
	25	23.56	51.76	51.23	51.76	51.21	51.76	51.22	12.12	733.23	y	735.6
	26	21.47	51.60	51.47	51.78	51.38	51.69	51.43	11.80	684.49	y	503.5
	27	21.63	51.73	51.28	51.75	51.32	51.74	51.30	12.03	677.40	y	562.3
	28	25.55	51.83	51.31	51.84	51.31	51.84	51.31	12.03	798.55	y	892.2
	29	25.27	51.74	51.32	51.80	51.35	51.77	51.34	11.89	799.71	y	811.7
	30	26.51	51.71	51.47	51.80	51.41	51.76	51.44	11.87	838.89	y	573.5

IB test for MM

GM GuaduaMixed
MM MosoMixed
Mixed means internode and node mixed

g = Board type (MM)
b = Board No. (1,2,3,4,5,6)
r = Replication (Sample ID)



y = valid test, failure across the overlap length, or
n = either no failure occurred or the end tabs

		Specimen Characteristics										
Board No.	Sample ID	Mass (gm)	Length 1 (mm)	Length 2 (mm)	Length 3 (mm)	Length 4 (mm)	Average length13 (mm)	Average length24 (mm)	Thickness (mm)	Density (kg/m^3)	Valid test (y or n)	Stress (KPa)
	1	20.92	51.88	51.10	51.84	51.11	51.86	51.11	11.87	664.99	y	779.5
	2	23.03	51.87	51.09	51.87	51.10	51.87	51.10	11.78	737.66	y	777.6
	3	24.09	51.87	51.05	51.91	51.10	51.89	51.08	11.72	775.56	y	761.4
	4	21.99	51.87	51.09	51.84	51.07	51.86	51.08	11.63	713.85	y	1010.9
	5	23.21	51.81	51.10	51.83	51.12	51.82	51.11	11.64	752.87	y	918.5
	6	25.92	51.38	51.62	51.31	51.84	51.35	51.73	11.37	858.29	y	940.7
	7	21.40	51.84	51.24	51.83	51.17	51.84	51.21	11.54	698.67	y	756.3
	8	24.88	51.84	51.16	51.85	51.22	51.85	51.19	11.61	807.47	y	1170.9
	9	22.21	51.84	51.17	51.85	51.25	51.85	51.21	11.67	716.83	y	665.9
	10	22.74	51.73	51.24	51.84	51.16	51.79	51.20	11.66	735.56	y	873.1
	11	24.13	50.98	52.02	50.99	51.85	50.99	51.94	11.40	799.37	y	825.1
	12	27.74	51.00	51.83	51.00	51.86	51.00	51.85	11.47	914.67	y	957.8
	13	24.66	51.00	51.84	51.08	51.77	51.04	51.81	11.37	820.26	y	816.2
	14	23.67	51.10	51.88	51.10	51.86	51.10	51.87	11.25	793.80	y	858.6
MM4	15	24.81	51.11	51.84	51.22	51.85	51.17	51.85	11.31	826.96	y	979.2
	16	25.78	51.18	51.74	51.21	51.77	51.20	51.76	11.33	858.76	y	907.4
	17	22.65	51.87	51.27	51.96	51.25	51.92	51.26	11.35	749.90	y	852.6
	18	24.77	51.17	51.90	51.23	51.87	51.20	51.89	11.43	815.77	y	957.1
	19	23.80	51.21	51.81	51.24	51.80	51.23	51.81	11.54	777.17	y	841.4
	20	25.14	51.74	51.12	51.82	51.07	51.78	51.10	11.62	817.75	y	767.2
	21	27.06	50.92	51.96	50.79	51.89	50.86	51.93	12.62	812.00	y	671.3
	22	23.91	51.00	51.82	51.10	51.85	51.05	51.84	11.54	782.99	y	548.4
	23	23.79	51.83	50.98	51.81	51.10	51.82	51.04	11.62	774.07	y	849.6
	24	23.70	51.09	51.82	51.12	51.84	51.11	51.83	11.52	776.70	y	888.1
	25	21.22	51.29	51.77	51.24	51.86	51.27	51.82	11.42	699.52	y	625.3
	26	24.03	51.85	51.12	51.88	51.33	51.87	51.23	11.60	779.72	y	749.2
	27	23.16	50.89	52.00	51.03	51.93	50.96	51.97	11.64	751.36	y	735.7
	28	24.24	51.03	51.86	51.10	51.91	51.07	51.89	11.58	790.06	y	840.8
	29	23.52	51.06	51.83	51.13	52.05	51.10	51.94	11.67	759.43	y	973.1
	30	25.30	51.13	51.79	51.22	51.73	51.18	51.76	11.73	814.27	y	750.7

IB test for MM

GM GuaduaMixed
MM MosoMixed
Mixed means internode and node mixed

g = Board type (MM)
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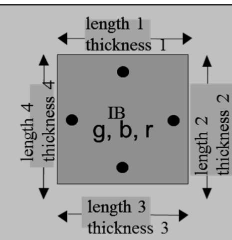

Board No.	Sample ID	Specimen Characteristics: Mass (gm)	Length 1 (mm)	Length 2 (mm)	Length 3 (mm)	Length 4 (mm)	Average length13 (mm)	Average length24 (mm)	Thickness (mm)	Density (kg/m^3)	Valid test (y or n)	Stress (KPa)
MM5	1	22.77	51.91	51.15	51.93	51.11	51.92	51.13	11.15	769.27	y	748.7
	2	22.04	51.20	51.89	51.30	51.86	51.25	51.88	11.23	738.21	y	751.6
	3	20.56	51.19	52.00	51.28	51.90	51.24	51.95	11.30	683.58	y	729.4
	4	21.21	51.26	51.89	51.18	51.86	51.22	51.88	11.32	705.17	y	837.0
	5	21.34	51.17	51.94	51.17	51.94	51.17	51.94	11.34	708.05	y	846.0
	6	20.14	51.17	51.69	51.10	51.76	51.14	51.73	11.30	673.85	y	697.4
	7	22.81	51.13	51.80	51.15	51.83	51.14	51.82	11.33	759.76	y	778.9
	8	23.59	51.16	51.80	51.25	51.99	51.21	51.90	11.35	782.16	y	884.5
	9	24.43	51.09	51.67	51.04	51.67	51.07	51.67	11.82	783.33	y	669.3
	10	18.82	50.79	51.85	50.73	51.86	50.76	51.86	11.82	604.91	y	598.3
	11	23.92	51.72	51.34	51.77	51.27	51.75	51.31	12.03	748.98	y	944.5
	12	22.67	51.77	51.28	51.79	51.27	51.78	51.28	11.99	712.14	y	713.9
	13	24.01	50.93	51.82	50.85	51.92	50.89	51.87	11.79	771.49	y	514.8
	14	21.77	51.06	51.85	50.94	51.84	51.00	51.85	11.76	700.12	y	565.1
	15	21.14	50.99	51.85	51.05	51.79	51.02	51.82	11.76	679.92	y	678.4
	16	23.34	51.06	51.85	51.04	51.86	51.05	51.86	11.82	745.93	y	781.6
	17	25.95	51.20	51.85	51.13	51.84	51.17	51.85	11.75	832.57	y	855.0
	18	26.23	51.28	51.81	51.27	51.83	51.28	51.82	11.73	841.58	y	929.6
	19	22.93	51.42	51.79	51.37	51.73	51.40	51.76	11.68	737.98	y	742.0
	20	22.69	50.84	51.83	50.83	51.88	50.84	51.86	12.17	707.28	y	544.6
	21	24.22	51.82	51.03	51.89	51.07	51.86	51.05	11.69	782.66	y	832.3
	22	23.69	51.79	51.1	51.78	51.13	51.79	51.12	11.69	765.59	y	731.2
	23	21.69	51.85	51.17	51.85	51.29	51.85	51.23	11.58	705.14	y	858.6
	24	22.78	51.78	51.15	51.81	51.16	51.80	51.16	11.67	736.73	y	841.9
	25	22.56	51.77	50.96	51.78	51.11	51.78	51.04	11.68	730.98	y	701.7
	26	21.29	51.76	50.97	51.77	50.99	51.77	50.98	11.49	702.13	y	776.5
	27	19.14	51.62	50.84	51.78	50.92	51.70	50.88	11.45	635.48	y	528.2
	28	18.61	50.84	51.76	50.9	51.78	50.87	51.77	11.93	592.33	y	396.1
	29	22.47	51.84	51.22	51.87	51.3	51.86	51.26	11.57	730.64	y	818.9
	30	19.69	51.78	51.29	51.7	51.34	51.74	51.32	11.5	644.88	y	787.4

IB test for MM

GM GuaduaMixed
MM MosoMixed
Mixed means internode and node mixed

g = Board type (MM)
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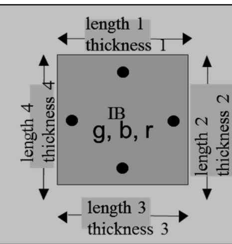
y = valid test, failure across the overlap length, or
n = either no failure occurred or the end tabs

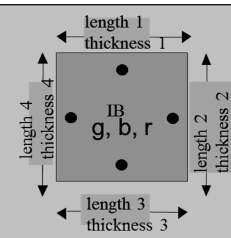


Board No.	Sample ID	Specimen Characteristics										
		Mass	Length				Average length13	Average length24	Thickness	Density	Valid test	Stress
			1	2	3	4						
		(gm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(kg/m^3)	(y or n)	(KPa)
MM6	1	23.06	51.80	50.82	51.88	50.87	51.84	50.85	11.63	752.26	y	772.0
	2	22.59	51.84	50.74	51.80	50.88	51.82	50.81	11.65	736.45	y	634.9
	3	23.57	51.81	51.17	51.81	51.12	51.81	51.15	11.51	772.80	y	578.7
	4	21.64	51.85	51.12	51.87	51.07	51.86	51.10	11.58	705.24	y	620.6
	5	24.67	51.87	51.08	51.87	50.98	51.87	51.03	11.49	811.16	y	985.1
	6	22.59	51.84	50.97	51.86	50.91	51.85	50.94	11.62	736.04	y	415.4
	7	20.19	51.78	50.80	51.79	50.94	51.79	50.87	11.65	657.88	y	390.8
	8	24.36	51.79	50.79	51.84	50.81	51.82	50.80	11.60	797.81	y	519.6
	9	23.71	51.75	50.80	51.81	50.79	51.78	50.80	11.60	777.12	y	663.9
	10	19.39	51.83	50.74	51.81	50.79	51.82	50.77	11.55	638.17	y	366.1
	11	23.01	51.70	51.35	51.79	51.29	51.75	51.32	11.18	775.03	y	692.7
	12	22.55	51.77	51.29	51.85	51.28	51.81	51.29	11.38	745.76	y	700.8
	13	23.86	51.28	51.86	51.35	51.85	51.32	51.86	11.37	788.63	y	847.2
	14	23.30	51.26	51.81	51.18	51.82	51.22	51.82	11.40	770.12	y	830.2
	15	20.74	51.19	51.86	51.24	51.88	51.22	51.87	11.41	684.24	y	604.6
	16	23.80	51.22	51.80	51.26	51.80	51.24	51.80	11.51	779.05	y	755.9
	17	25.84	51.24	51.88	51.22	51.85	51.23	51.87	11.35	856.84	y	696.4
	18	22.13	50.99	51.86	51.02	51.82	51.01	51.84	11.43	732.25	y	898.9
	19	21.33	51.06	51.87	51.11	51.85	51.09	51.86	11.39	706.87	y	806.8
	20	25.17	51.11	51.81	51.07	51.80	51.09	51.81	11.39	834.93	y	934.7
	21	23.09	51.11	51.81	51.08	51.83	51.10	51.82	11.42	763.63	y	797.3
	22	21.36	51.16	51.83	51.10	51.85	51.13	51.84	11.35	710.01	y	632.4
	23	25.94	51.26	51.80	51.17	51.87	51.22	51.84	11.34	861.66	y	1060.4
	24	22.71	51.80	51.27	51.80	51.28	51.80	51.28	11.53	741.57	y	893.4
	25	19.69	51.86	51.27	51.85	51.18	51.86	51.23	11.52	643.46	y	657.4
	26	22.69	51.82	51.30	51.87	51.24	51.85	51.27	11.50	742.28	y	743.3
	27	24.15	51.85	51.28	51.80	51.20	51.83	51.24	11.56	786.70	y	774.7
	28	20.97	51.25	51.81	51.18	51.76	51.22	51.79	11.52	686.35	y	651.1
	29	22.69	51.22	51.79	51.19	51.81	51.21	51.80	11.53	741.93	y	757.1
	30	21.10	51.01	52.04	50.84	51.76	50.93	51.90	11.53	692.40	y	678.2

IB test for MH

MH Moso High Density ML1
ML Moso Low Density ML2

g = Board type (MH)
b = Board No. (1,2,3,4,5,6)
r = Replication (Sample ID)



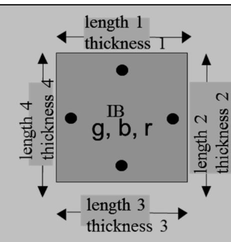
y = valid test, failure across the overlap length, or
n = either no failure occurred or the end tabs

		Specimen Characteristics										
Board No.	Sample ID	Mass (gm)	Length 1 (mm)	Length 2 (mm)	Length 3 (mm)	Length 4 (mm)	Average length13 (mm)	Average length24 (mm)	Thickness (mm)	Density (kg/m^3)	Valid test (y or n)	Stress (KPa)
MH1	1	23.23	50.86	51.80	50.74	51.71	50.80	51.76	12.07	732.03	y	644.1
	2	26.59	50.92	51.87	50.86	51.86	50.89	51.87	11.87	848.71	y	983.2
	3	16.55	50.86	51.73	50.93	51.73	50.90	51.73	11.69	537.73	y	650.6
	4	19.23	50.90	51.81	50.93	51.84	50.92	51.83	11.78	618.66	y	874.8
	5	22.85	51.30	51.70	51.29	51.78	51.30	51.74	11.33	759.90	y	1001.3
	6	23.15	51.33	51.75	51.29	51.75	51.31	51.75	11.32	770.18	y	1026.3
	7	15.85	51.70	51.10	51.78	51.13	51.74	51.12	11.13	538.47	y	450.1
	8	27.91	51.59	51.87	51.58	51.80	51.59	51.84	12.05	866.22	y	921.5
	9	29.48	51.69	51.83	51.65	51.85	51.67	51.84	12.26	897.70	y	854.0
	10	20.60	51.22	51.29	51.25	51.30	51.24	51.30	11.11	705.52	y	667.1
	11	21.71	51.20	51.88	51.23	51.80	51.22	51.84	11.51	710.43	y	737.2
	12	22.29	51.17	51.78	51.14	51.81	51.16	51.80	11.50	731.54	y	733.1
	13	25.02	51.14	51.88	51.16	51.88	51.15	51.88	11.39	827.79	y	923.1
	14	22.57	51.09	51.79	51.05	51.80	51.07	51.80	11.32	753.76	y	802.9
	15	20.80	51.13	51.75	51.15	51.81	51.14	51.78	11.33	693.28	y	730.3
	16	20.50	51.15	51.84	51.23	51.84	51.19	51.84	11.14	693.46	y	439.0
	17	25.38	51.66	51.92	51.64	51.90	51.65	51.91	11.56	818.87	y	690.1
	18	21.65	51.60	51.86	51.46	51.87	51.53	51.87	11.52	703.19	y	825.5
	19	21.88	51.42	51.75	51.35	51.82	51.39	51.79	11.40	721.28	y	837.2
	20	19.53	51.80	51.17	51.77	51.19	51.79	51.18	11.28	653.26	y	402.5
	21	23.30	51.54	51.82	51.57	51.88	51.56	51.85	11.02	790.96	y	798.2
	22	23.17	51.51	51.82	51.51	51.84	51.51	51.83	11.18	776.27	y	1105.0
	23	21.98	51.53	51.80	51.56	51.86	51.55	51.83	11.17	736.56	y	896.7
	24	21.71	51.39	51.78	51.49	51.82	51.44	51.80	11.25	724.23	y	659.1
	25	19.62	51.34	51.80	51.37	51.84	51.36	51.82	11.15	661.22	y	698.9
	26	23.92	51.34	51.81	51.31	51.73	51.33	51.77	11.08	812.48	y	833.2
	27	24.19	51.08	51.84	51.10	51.81	51.09	51.83	11.09	823.81	y	642.2
	28	24.23	51.15	51.67	51.13	51.78	51.14	51.73	11.20	817.85	y	988.6
	29	18.67	51.21	51.11	51.24	51.11	51.23	51.11	11.03	646.52	y	844.9
	30	21.42	51.14	51.85	51.21	51.83	51.18	51.84	11.13	725.44	y	594.0

IB test for MH

MH Moso High Density ML1
ML Moso Low Density ML2

g = Board type (MH)
b = Board No. (1,2,3,4,5,6)
r = Replication (Sample ID)



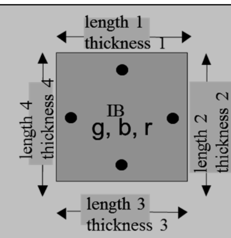
y = valid test, failure across the overlap length, or
n = either no failure occurred or the end tabs

		Specimen Characteristics										
Board No.	Sample ID	Mass (gm)	Length 1 (mm)	Length 2 (mm)	Length 3 (mm)	Length 4 (mm)	Average length13 (mm)	Average length24 (mm)	Thickness (mm)	Density (kg/m^3)	Valid test (y or n)	Stress (KPa)
MH2	1	20.89	51.31	51.83	51.19	51.79	51.25	51.81	11.63	676.47	y	895.1
	2	23.35	51.32	51.78	51.29	51.86	51.31	51.82	11.54	761.07	y	507.1
	3	21.95	51.31	51.85	51.3	51.83	51.31	51.84	11.52	716.40	y	711.2
	4	19.80	51.32	51.85	51.36	51.87	51.34	51.86	11.54	644.42	y	717.4
	5	22.14	50.42	51.81	50.42	51.75	50.42	51.78	11.59	731.69	y	1010.2
	6	24.01	50.4	51.86	50.44	51.85	50.42	51.86	11.49	799.24	y	889.5
	7	24.22	50.43	51.85	50.4	51.85	50.42	51.85	11.72	790.57	y	977.4
	8	22.67	51.86	51.33	51.82	51.17	51.84	51.25	11.56	738.13	y	973.9
	9	25.42	51.82	51.17	51.86	51.27	51.84	51.22	11.53	830.31	y	1000.8
	10	26.38	51.72	51.3	51.81	51.2	51.77	51.25	11.58	858.69	y	1013.0
	11	23.31	51.82	50.4	51.81	50.37	51.82	50.39	11.61	769.05	y	956.4
	12	26.61	51.87	50.36	51.76	50.34	51.82	50.35	11.55	883.10	y	747.2
	13	27.52	51.87	50.38	51.76	50.3	51.82	50.34	11.69	902.54	y	879.7
	14	18.64	50.46	51.85	50.49	51.78	50.48	51.82	11.48	620.83	y	369.4
	15	18.03	50.55	51.83	50.47	51.86	50.51	51.85	11.46	600.80	y	613.7
	16	20.77	50.49	51.86	50.49	51.81	50.49	51.84	11.45	693.11	y	741.5
	17	23.07	51.83	51.09	51.8	51.18	51.82	51.14	11.38	765.12	y	804.6
	18	21.12	51.8	51.16	51.8	51.16	51.80	51.16	11.43	697.25	y	898.0
	19	20.52	51.82	51.17	51.8	51.14	51.81	51.16	11.53	671.50	y	844.6
	20	27.09	51.84	50.35	51.9	50.47	51.87	50.41	11.67	887.78	y	1054.6
	21	21.18	51.41	51.87	51.35	51.82	51.38	51.85	11.29	704.26	y	802.1
	22	20.46	51.39	51.78	51.37	51.74	51.38	51.76	11.21	686.30	y	763.2
	23	20.98	51.39	51.83	51.51	51.82	51.45	51.83	11.25	699.40	y	705.7
	24	20.03	51.34	51.93	51.32	51.89	51.33	51.91	11.31	664.65	y	873.2
	25	26.61	51.35	51.87	51.4	51.82	51.38	51.85	11.28	885.68	y	981.8
	26	21.17	51.82	51.27	51.84	51.26	51.83	51.27	11.51	692.22	y	725.5
	27	19.21	51.16	51.95	51.34	51.79	51.25	51.87	11.53	626.74	y	753.9
	28	21.04	51.22	51.85	51.27	51.78	51.25	51.82	11.53	687.24	y	719.7
	29	23.65	51.4	51.85	51.4	51.86	51.40	51.86	11.22	790.83	y	982.0
	30	22.65	51.84	50.36	51.84	50.37	51.84	50.37	11.59	748.50	y	924.6

IB test for MH

MH Moso High Density ML1
ML Moso Low Density ML2

g = Board type (MH)
b = Board No. (1,2,3,4,5,6)
r = Replication (Sample ID)



y = valid test, failure across the overlap length, or
n = either no failure occurred or the end tabs

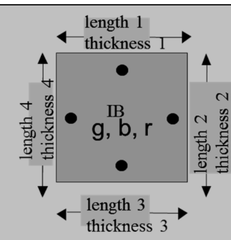
Board No.	Sample ID	Mass (gm)	Length 1 (mm)	Length 2 (mm)	Length 3 (mm)	Length 4 (mm)	Average length13 (mm)	Average length24 (mm)	Thickness (mm)	Density (kg/m^3)	Valid test (y or n)	Stress (KPa)
MH3	1	19.67	51.80	51.30	51.82	51.14	51.81	51.22	11.15	664.78	y	603.4
	2	20.69	51.21	51.92	51.12	51.90	51.17	51.91	11.22	694.29	y	800.7
	3	21.88	51.80	51.16	51.84	51.22	51.82	51.19	11.28	731.23	y	654.6
	4	22.79	51.21	51.75	51.32	51.80	51.27	51.78	11.36	755.83	y	697.8
	5	28.29	51.22	51.82	51.25	51.91	51.24	51.87	12.55	848.30	y	842.4
	6	25.92	51.82	51.18	51.84	51.19	51.83	51.19	11.74	832.23	y	989.5
	7	27.49	51.79	51.16	51.77	51.17	51.78	51.17	11.69	887.62	y	1037.1
	8	25.50	51.14	51.84	51.22	51.86	51.18	51.85	11.61	827.67	y	985.4
	9	22.22	51.25	51.59	51.24	51.73	51.25	51.66	11.73	715.55	y	763.8
	10	22.87	51.11	51.80	51.08	51.77	51.10	51.79	11.53	749.64	y	876.8
	11	19.75	51.78	51.04	51.81	51.05	51.80	51.05	11.36	657.58	y	491.4
	12	19.67	51.78	51.05	51.79	51.05	51.79	51.05	11.50	647.00	y	651.3
	13	18.34	51.71	51.01	51.80	51.03	51.76	51.02	11.54	601.87	y	587.9
	14	19.64	51.81	51.26	51.72	51.09	51.77	51.18	11.54	642.45	y	527.4
	15	18.49	51.58	51.07	51.71	50.98	51.65	51.03	11.58	605.92	y	567.4
	16	25.98	51.20	51.84	51.20	51.84	51.20	51.84	11.56	846.73	y	984.3
	17	23.12	51.81	51.19	51.73	51.23	51.77	51.21	11.56	754.39	y	974.1
	18	20.94	51.16	51.77	51.22	51.61	51.19	51.69	11.57	683.99	y	809.3
	19	17.79	50.70	51.79	50.72	51.74	50.71	51.77	11.58	585.24	y	642.1
	20	20.33	51.74	50.76	51.77	50.72	51.76	50.74	11.94	648.38	y	569.4
	21	25.79	51.37	51.79	51.05	51.86	51.21	51.83	11.39	853.17	y	779.2
	22	20.91	51.43	51.87	51.45	51.83	51.44	51.85	11.56	678.18	y	680.5
	23	26.71	51.45	51.79	51.38	51.78	51.42	51.79	11.60	864.81	y	603.6
	24	21.68	51.28	51.81	51.38	51.76	51.33	51.79	11.71	696.51	y	781.3
	25	22.25	51.30	51.77	51.27	51.69	51.29	51.73	11.77	712.56	y	674.1
	26	21.93	51.25	51.82	51.34	51.90	51.30	51.86	11.87	694.51	y	688.6
	27	21.92	51.84	51.11	51.78	51.00	51.81	51.06	11.07	748.58	y	902.3
	28	21.61	51.14	51.84	51.16	51.82	51.15	51.83	11.23	725.85	y	783.7
	29	21.10	51.31	51.82	51.29	51.65	51.30	51.74	11.28	704.81	y	902.6
	30	19.20	50.71	51.74	50.72	51.74	50.72	51.74	11.94	612.82	y	532.1

IB test for MH

MH Moso High Density ML1
ML Moso Low Density ML2

g = Board type (MH)
b = Board No. (1,2,3,4,5,6)
r = Replication (Sample ID)

y = valid test, failure across the overlap length, or
n = either no failure occurred or the end tabs



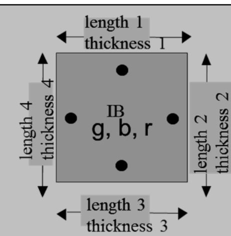
Board No.	Sample ID	Specimen Characteristics										
		Mass (gm)	Length 1 (mm)	2 (mm)	3 (mm)	4 (mm)	Average length13 (mm)	Average length24 (mm)	Thickness (mm)	Density (kg/m^3)	Valid test (y or n)	Stress (KPa)
MH4	1	24.17	51.33	52.42	51.42	52.44	51.38	52.43	11.25	797.61	y	896.9
	2	25.40	51.35	52.47	51.38	52.46	51.37	52.47	11.19	842.30	y	1174.5
	3	23.98	51.29	52.46	51.35	52.45	51.32	52.46	11.26	791.11	y	852.4
	4	23.43	51.32	52.37	51.26	52.41	51.29	52.39	11.41	764.20	y	789.0
	5	23.27	51.27	52.43	51.30	52.38	51.29	52.41	11.40	759.50	y	799.7
	6	26.18	51.25	52.50	51.35	52.46	51.30	52.48	11.33	858.28	y	887.2
	7	24.26	51.40	52.41	51.35	52.48	51.38	52.45	11.45	786.37	y	843.6
	8	25.07	51.79	52.38	51.89	52.27	51.84	52.33	11.57	798.82	y	828.9
	9	19.17	51.88	52.41	51.82	52.39	51.85	52.40	11.57	609.83	y	656.4
	10	17.25	51.18	52.47	51.24	52.36	51.21	52.42	11.51	558.35	y	658.7
	11	19.59	52.30	51.14	52.36	51.17	52.33	51.16	12.08	605.80	y	578.0
	12	22.18	52.42	51.11	52.33	51.14	52.38	51.13	12.07	686.27	y	822.4
	13	22.74	52.43	51.10	52.38	51.11	52.41	51.11	11.99	708.17	y	765.2
	14	24.30	52.40	51.07	52.38	51.13	52.39	51.10	12.02	755.15	y	968.4
	15	23.84	52.38	51.08	52.38	51.22	52.38	51.15	11.98	742.74	y	1040.4
	16	20.52	52.31	51.13	52.45	51.14	52.38	51.14	11.92	642.71	y	836.9
	17	19.66	52.34	51.05	52.40	51.15	52.37	51.10	11.80	622.58	y	648.5
	18	19.76	51.80	52.11	51.71	52.41	51.76	52.26	11.45	638.06	y	449.9
	19	22.59	52.47	51.72	52.37	51.58	52.42	51.65	11.29	739.02	y	664.9
	20	17.80	51.23	52.43	51.14	52.39	51.19	52.41	11.48	577.99	y	543.5
	21	21.58	51.49	52.46	51.39	52.46	51.44	52.46	11.26	710.21	y	847.7
	22	24.75	51.50	52.37	51.53	52.37	51.52	52.37	11.20	819.11	y	1137.0
	23	23.37	51.34	52.42	51.35	52.50	51.35	52.46	11.27	769.85	y	897.5
	24	23.26	51.44	52.40	51.51	52.31	51.48	52.36	11.28	765.15	y	860.5
	25	19.41	52.41	51.52	52.44	51.50	52.43	51.51	11.31	635.53	y	708.0
	26	22.44	52.39	51.48	52.42	51.56	52.41	51.52	11.31	734.87	y	921.4
	27	21.08	52.37	51.59	52.35	51.66	52.36	51.63	11.19	696.92	y	907.9
	28	23.08	52.38	51.66	52.33	51.73	52.36	51.70	11.15	764.81	y	773.1
	29	21.54	51.10	52.41	51.10	52.39	51.10	52.40	11.44	703.18	y	889.9
	30	23.18	52.32	51.23	52.31	51.23	52.32	51.23	11.77	734.83	y	1017.7

IB test for MH

MH Moso High Density
ML Moso Low Density

g = Board type (MH)
b = Board No. (1,2,3,4,5,6)
r = Replication (Sample ID)

y = valid test, failure across the overlap length, or
n = either no failure occurred or the end tabs



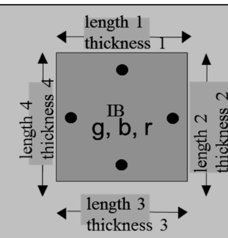
Board No.	Sample ID	Mass (gm)	Length 1 (mm)	Length 2 (mm)	Length 3 (mm)	Length 4 (mm)	Average length13 (mm)	Average length24 (mm)	Thickness (mm)	Density (kg/m^3)	Valid test (y or n)	Stress (KPa)
MH5	1	18.79	51.12	51.87	51.21	51.84	51.17	51.86	11.31	626.18	y	645.6
	2	20.58	51.17	51.80	51.22	51.84	51.20	51.82	11.32	685.29	y	748.4
	3	23.83	51.20	51.96	51.24	51.87	51.22	51.92	11.28	794.48	y	1032.3
	4	24.02	51.33	51.92	51.27	51.93	51.30	51.93	11.28	799.41	y	825.8
	5	15.67	50.72	51.87	50.54	51.84	50.63	51.86	11.20	532.91	y	486.7
	6	20.42	50.70	51.83	50.64	51.87	50.67	51.85	11.30	687.82	y	769.9
	7	21.70	50.74	51.83	50.72	51.78	50.73	51.81	11.41	723.66	y	789.8
	8	17.83	50.73	51.77	50.72	51.70	50.73	51.74	11.44	593.91	y	471.6
	9	19.21	50.73	51.85	50.73	51.66	50.73	51.76	11.54	634.02	y	609.5
	10	24.64	51.41	51.73	51.42	51.87	51.42	51.80	11.43	809.42	y	930.7
	11	25.30	52.13	51.43	51.84	51.41	51.99	51.42	11.47	825.18	y	997.0
	12	25.77	51.38	51.88	51.34	51.86	51.36	51.87	11.55	837.51	y	951.6
	13	25.52	51.33	51.82	51.37	51.81	51.35	51.82	11.55	830.43	y	1022.3
	14	25.04	51.36	51.82	51.34	51.85	51.35	51.84	11.90	790.54	y	890.4
	15	24.30	51.33	51.90	51.31	51.94	51.32	51.92	11.55	789.59	y	1145.6
	16	19.27	50.40	51.81	50.46	51.83	50.43	51.82	11.10	664.31	y	837.5
	17	19.30	50.43	51.83	50.41	51.87	50.42	51.85	11.13	663.30	y	741.1
	18	18.43	50.53	51.81	50.67	51.80	50.60	51.81	11.10	633.40	y	782.1
	19	24.44	51.82	51.32	51.82	51.32	51.82	51.32	11.49	799.83	y	1206.1
	20	25.75	51.31	51.87	51.32	51.80	51.32	51.84	11.54	838.89	y	1026.3
	21	20.81	51.78	51.18	51.79	51.15	51.79	51.17	11.84	663.35	y	736.0
	22	18.53	51.79	51.17	51.73	51.16	51.76	51.17	11.89	588.47	y	475.8
	23	20.62	51.8	51.18	51.89	51.22	51.85	51.20	11.15	696.69	y	868.1
	24	20.38	51.82	51.25	51.81	51.22	51.82	51.24	11.26	681.78	y	519.0
	25	22.97	51.84	51.26	51.87	51.25	51.86	51.26	11.28	766.17	y	892.5
	26	23.00	51.84	51.21	51.83	51.24	51.84	51.23	11.33	764.53	y	1000.8
	27	22.71	51.83	51.2	51.89	51.22	51.86	51.21	11.19	764.19	y	653.5
	28	23.44	51.84	51.24	51.79	51.43	51.82	51.34	11.35	776.41	y	898.0
	29	25.47	51.33	51.83	51.3	51.91	51.32	51.87	11.44	836.45	y	737.9
	30	26.05	51.35	51.84	51.33	51.81	51.34	51.83	11.53	849.15	y	1212.1

IB test for MH

MH Moso High Density
ML Moso Low Density

g = Board type (MH)
b = Board No. (1,2,3,4,5,6)
r = Replication (Sample ID)

y = valid test, failure across the overlap length, or
n = either no failure occurred or the end tabs

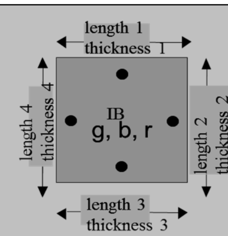


Board No.	Sample ID	Specimen Characteristics										
		Mass	Length				Average length13	Average length24	Thickness	Density	Valid test	Stress
			1	2	3	4						
		(gm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(kg/m^3)	(y or n)	(KPa)
MH6	1	24.95	51.19	51.57	51.14	51.61	51.17	51.59	11.52	820.50	y	1007.7
	2	21.23	51.27	51.85	51.24	51.84	51.26	51.85	11.48	695.93	y	831.8
	3	22.19	51.30	51.88	51.30	51.86	51.30	51.87	11.45	728.31	y	545.8
	4	22.62	51.31	51.79	51.25	51.78	51.28	51.79	11.32	752.48	y	721.1
	5	22.73	51.39	51.85	51.49	51.81	51.44	51.83	11.14	765.30	y	1051.1
	6	20.31	51.41	51.85	51.35	51.70	51.38	51.78	11.31	675.05	y	733.1
	7	24.84	51.82	50.81	51.88	50.86	51.85	50.84	11.44	823.79	y	788.3
	8	22.14	51.90	50.86	51.89	50.99	51.90	50.93	11.46	731.03	y	831.9
	9	21.79	51.88	50.97	51.88	51.06	51.88	51.02	11.45	719.04	y	598.5
	10	26.36	51.81	51.16	51.77	51.14	51.79	51.15	11.25	884.51	y	863.2
	11	22.17	51.28	51.83	51.25	51.87	51.27	51.85	11.44	729.07	y	898.3
	12	22.28	51.33	51.82	51.27	51.82	51.30	51.82	11.39	735.83	y	592.0
	13	20.36	51.37	51.84	51.37	51.92	51.37	51.88	11.09	688.87	y	861.0
	14	21.23	51.35	51.82	51.35	51.84	51.35	51.83	11.10	718.63	y	716.6
	15	19.05	51.35	51.81	51.40	51.81	51.38	51.81	11.12	643.61	y	788.3
	16	23.87	51.33	51.85	51.31	51.88	51.32	51.87	11.14	805.02	y	1021.9
	17	19.15	51.93	51.46	51.80	51.57	51.87	51.52	11.13	643.80	y	596.7
	18	17.06	51.45	51.74	51.41	51.81	51.43	51.78	11.02	581.38	y	604.3
	19	22.37	51.89	51.07	51.84	51.08	51.87	51.08	11.37	742.72	y	773.2
	20	25.47	51.85	51.12	51.90	51.20	51.88	51.16	11.29	850.05	y	940.7
	21	19.27	51.68	51.48	51.83	51.29	51.76	51.39	11.67	620.90	y	532.8
	22	22.30	51.90	51.36	51.88	51.42	51.89	51.39	11.67	716.59	y	998.3
	23	19.85	51.81	51.24	51.82	51.35	51.82	51.30	11.64	641.62	y	834.5
	24	19.42	51.58	50.97	51.78	50.97	51.68	50.97	11.38	647.84	y	660.4
	25	20.91	51.84	51.16	51.79	51.26	51.82	51.21	11.72	672.38	y	749.0
	26	24.32	51.77	51.09	51.79	51.17	51.78	51.13	11.66	787.82	y	1035.9
	27	21.49	51.82	51.06	51.85	51.11	51.84	51.09	11.72	692.46	y	926.8
	28	20.19	51.08	51.79	51.09	51.78	51.09	51.79	11.11	686.95	y	797.7
	29	21.36	51.81	50.96	51.83	50.97	51.82	50.97	11.40	709.46	y	934.9
	30	18.37	51.26	51.87	51.28	51.89	51.27	51.88	11.07	623.88	y	650.7

IB test for ML

MH Moso High Density
ML Moso Low Density

g = Board type (ML)
b = Board No. (1,2,3,4,5,6)
r = Replication (Sample ID)



y = valid test, failure across the overlap length, or
n = either no failure occurred or the end tabs

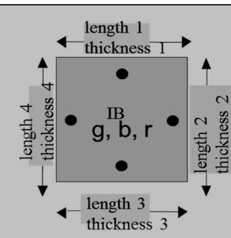
Board No.	Sample ID	Specimen Characteristics										
		Mass	Length				Average length13	Average length24	Thickness	Density	Valid test	Stress
		(gm)	1 (mm)	2 (mm)	3 (mm)	4 (mm)	(mm)	(mm)	(mm)	(kg/m^3)	(y or n)	(KPa)
ML1	1	20.75	51.14	51.78	51.17	51.87	51.16	51.83	11.18	700.08	y	729.4
	2	21.12	51.17	51.89	51.22	51.88	51.20	51.89	11.26	706.13	y	835.0
	3	20.32	51.82	51.56	51.92	51.40	51.87	51.48	11.33	671.64	y	599.3
	4	20.20	51.94	51.28	51.86	51.22	51.90	51.25	11.32	670.88	y	398.1
	5	17.48	51.86	51.22	51.80	51.10	51.83	51.16	11.26	585.45	y	549.1
	6	19.21	51.87	51.13	51.80	51.19	51.84	51.16	11.30	641.05	y	485.1
	7	21.28	51.92	51.24	51.81	51.28	51.87	51.26	11.38	703.36	y	628.8
	8	19.13	51.83	51.27	51.89	51.35	51.86	51.31	11.25	639.04	y	567.9
	9	19.00	51.82	51.15	51.89	51.26	51.86	51.21	11.38	628.79	y	519.6
	10	15.97	51.81	51.25	51.82	51.24	51.82	51.25	11.30	532.25	y	360.2
	11	13.51	51.11	51.88	51.13	51.27	51.12	51.58	11.04	464.15	y	337.8
	12	17.27	51.17	51.87	51.14	51.87	51.16	51.87	11.05	589.01	y	501.1
	13	15.30	51.25	51.86	51.27	51.84	51.26	51.85	11.07	520.02	y	359.3
	14	17.16	51.18	51.78	51.16	51.83	51.17	51.81	11.09	583.71	y	578.1
	15	16.97	51.18	51.98	51.33	51.96	51.26	51.97	11.12	572.91	y	324.5
	16	15.32	50.85	51.82	50.69	51.82	50.77	51.82	11.38	511.70	y	412.6
	17	16.29	50.89	51.81	50.83	51.79	50.86	51.80	11.28	548.16	y	485.4
	18	18.07	50.95	51.84	50.95	51.84	50.95	51.84	11.34	603.30	y	696.1
	19	17.71	51.11	51.90	50.94	51.90	51.03	51.90	11.12	601.40	y	584.6
	20	18.73	51.84	51.02	51.91	50.99	51.88	51.01	11.61	609.73	y	635.6
	21	16.79	51.81	51.21	51.87	51.17	51.84	51.19	11.15	567.45	y	507.7
	22	18.25	51.83	51.20	51.80	51.16	51.82	51.18	11.20	614.45	y	857.1
	23	17.76	51.83	51.15	51.86	51.12	51.85	51.14	11.33	591.27	y	676.9
	24	22.82	51.86	50.98	51.85	51.08	51.86	51.03	11.52	748.60	y	821.5
	25	22.86	51.91	51.05	52.00	51.09	51.96	51.07	11.48	750.48	y	735.8
	26	18.20	51.90	51.07	51.92	51.01	51.91	51.04	11.44	600.46	y	602.1
	27	16.81	51.02	51.87	50.99	51.74	51.01	51.81	11.78	540.06	y	465.7
	28	17.58	50.92	51.96	50.96	51.91	50.94	51.94	11.75	565.54	y	374.3
	29	21.01	51.89	50.84	51.82	50.94	51.86	50.89	11.78	675.86	y	584.5
	30	18.51	51.84	50.91	51.94	51.04	51.89	50.98	11.86	590.04	y	353.3

IB test for ML

MH Moso High Density
ML Moso Low Density

g = Board type (ML)
b = Board No. (1,2,3,4,5,6)
r = Replication (Sample ID)

y = valid test, failure across the overlap length, or
n = either no failure occurred or the end tabs

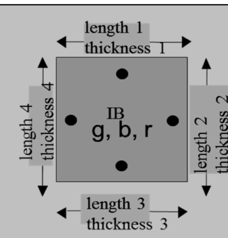


Board No.	Sample ID	Specimen Characteristics										
		Mass (gm)	Length 1 (mm)	2 (mm)	3 (mm)	4 (mm)	Average length13 (mm)	Average length24 (mm)	Thickness (mm)	Density (kg/m^3)	Valid test (y or n)	Stress (KPa)
ML2	1	15.01	51.9	51.19	51.95	51.53	51.93	51.36	11.31	497.64	y	480.2
	2	19.10	51.91	51.01	51.96	51.14	51.94	51.08	11.52	625.05	y	634.0
	3	15.64	51.93	51.08	51.93	51.04	51.93	51.06	11.43	516.05	y	572.5
	4	12.54	51.86	51.09	51.89	51.11	51.88	51.10	11.37	416.06	y	598.9
	5	18.62	51.91	51.28	51.91	51.2	51.91	51.24	11.33	617.86	y	720.0
	6	21.16	51.84	51.12	51.95	51.26	51.90	51.19	11.38	699.94	y	823.1
	7	16.94	51.91	51.1	51.87	51.17	51.89	51.14	11.32	563.98	y	541.4
	8	18.65	51.24	51.93	51.24	51.86	51.24	51.90	11.6	604.63	y	529.5
	9	18.22	51.84	51.3	51.84	51.26	51.84	51.28	11.45	598.59	y	653.2
	10	14.47	51.21	51.86	51.36	51.83	51.29	51.85	11.46	474.88	y	166.1
	11	23.17	51.81	51.27	51.79	51.24	51.80	51.26	11.5	758.86	y	955.7
	12	20.54	51.88	51.25	51.84	51.23	51.86	51.24	11.57	668.08	y	714.4
	13	18.37	51.9	51.22	51.87	51.26	51.89	51.24	11.53	599.28	y	668.3
	14	19.60	51.87	51.22	51.9	51.3	51.89	51.26	11.54	638.60	y	725.6
	15	23.44	51.27	51.9	51.25	51.86	51.26	51.88	11.53	764.45	y	768.0
	16	19.77	51.92	51.35	51.88	51.3	51.90	51.33	11.32	655.64	y	572.0
	17	17.93	51.92	51.28	51.86	51.57	51.89	51.43	11.28	595.68	y	413.1
	18	16.94	51.92	51.25	51.96	51.29	51.94	51.27	11.52	552.20	y	402.1
	19	19.73	51.92	51.22	51.87	51.42	51.90	51.32	11.57	640.30	y	401.3
	20	17.00	51.9	51.33	51.8	51.55	51.85	51.44	11.45	556.66	y	395.6
	21	19.82	51.94	51.27	51.93	51.17	51.94	51.22	11.43	651.87	y	792.5
	22	17.79	51.91	51.17	51.89	51.28	51.90	51.23	11.35	589.56	y	584.2
	23	22.50	51.83	51.45	51.92	51.37	51.88	51.41	11.35	743.33	y	481.6
	24	23.77	51.92	51.34	51.88	51.4	51.90	51.37	11.36	784.83	y	721.3
	25	21.08	51.95	51.35	51.93	51.4	51.94	51.38	11.35	696.02	y	877.5
	26	19.92	52.03	51.48	51.92	51.48	51.98	51.48	11.27	660.59	y	671.3
	27	16.36	51.85	51.02	51.92	50.99	51.89	51.01	11.52	536.63	y	306.3
	28	17.25	51.88	51.04	51.89	51.11	51.89	51.08	11.44	569.00	y	369.7
	29	18.85	51.86	51	51.92	51.04	51.89	51.02	11.41	624.02	y	537.0
	30	17.24	51.28	51.87	51.31	51.95	51.30	51.91	11.54	561.05	y	184.6

IB test for ML

MH Moso High Density
ML Moso Low Density

g = Board type (ML)
b = Board No. (1,2,3,4,5,6)
r = Replication (Sample ID)



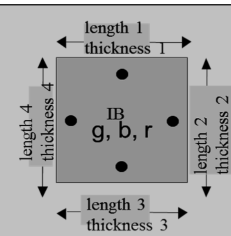
y = valid test, failure across the overlap length, or
n = either no failure occurred or the end tabs

Board No.	Sample ID	Specimen Characteristics Mass (gm)	Length 1 (mm)	Length 2 (mm)	Length 3 (mm)	Length 4 (mm)	Average length13 (mm)	Average length24 (mm)	Thickness (mm)	Density (kg/m^3)	Valid test (y or n)	Stress (KPa)
ML3	1	19.01	51.91	51.51	51.97	51.27	51.94	51.39	11.14	639.32	y	794.2
	2	17.89	51.26	51.89	51.26	51.88	51.26	51.89	11.07	607.63	y	426.2
	3	18.28	51.26	51.87	51.27	51.94	51.27	51.91	11.09	619.46	y	826.2
	4	17.55	51.25	51.84	51.29	51.86	51.27	51.85	11.15	592.09	y	579.1
	5	18.67	51.33	51.89	51.29	51.91	51.31	51.90	11.04	635.05	y	833.6
	6	19.11	51.33	51.80	51.31	51.94	51.32	51.87	11.05	649.67	y	688.8
	7	17.97	51.92	51.29	51.93	51.38	51.93	51.34	11.12	606.25	y	742.0
	8	18.77	51.23	51.90	51.22	51.91	51.23	51.91	11.24	628.07	y	585.6
	9	21.72	51.92	51.22	51.97	51.23	51.95	51.23	11.34	719.82	y	737.0
	10	22.62	51.90	51.20	51.90	51.21	51.90	51.21	11.37	748.60	y	605.1
	11	21.86	51.24	51.91	51.24	51.83	51.24	51.87	11.38	722.74	y	631.3
	12	21.26	51.23	51.85	51.23	51.85	51.23	51.85	11.37	703.93	y	599.9
	13	21.64	51.03	52.00	51.25	51.88	51.14	51.94	11.51	707.81	y	846.8
	14	17.89	51.87	51.34	51.84	51.34	51.86	51.34	11.31	594.16	y	764.3
	15	18.68	51.86	51.33	51.86	51.34	51.86	51.34	11.43	613.88	y	632.4
	16	23.58	51.95	51.39	51.90	51.27	51.93	51.33	11.81	749.11	y	868.9
	17	19.14	51.10	51.86	51.17	51.86	51.14	51.86	11.52	626.53	y	804.6
	18	19.45	51.12	51.88	51.10	51.87	51.11	51.88	11.45	640.69	y	730.8
	19	19.83	51.17	51.87	51.48	51.92	51.33	51.90	11.50	647.40	y	606.0
	20	20.29	51.38	51.81	51.30	51.92	51.34	51.87	11.49	663.18	y	901.1
	21	16.80	51.24	51.89	51.30	51.81	51.27	51.85	11.74	538.31	y	451.1
	22	16.26	51.14	51.82	51.18	51.89	51.16	51.86	11.76	521.19	y	519.3
	23	14.71	50.92	51.89	50.46	51.79	50.69	51.84	11.69	478.86	y	250.3
	24	18.38	51.16	51.88	51.12	51.84	51.14	51.86	11.65	594.88	y	688.0
	25	19.20	51.11	51.88	51.15	51.85	51.13	51.87	11.62	623.08	y	657.1
	26	17.34	51.05	51.92	51.02	51.86	51.04	51.89	11.55	566.91	y	783.8
	27	18.00	51.09	51.89	51.07	51.87	51.08	51.88	11.41	595.30	y	749.2
	28	20.80	51.07	51.89	51.06	51.88	51.07	51.89	11.33	692.90	y	866.0
	29	18.49	51.87	50.94	51.81	50.91	51.84	50.93	11.41	613.84	y	729.5
	30	17.43	50.74	51.85	50.75	51.88	50.75	51.87	11.60	570.92	y	392.7

IB test for ML

MH	Moso High Density
ML	Moso Low Density

g = Board type (ML)
b = Board No. (1,2,3,4,5,6)
r = Replication (Sample ID)



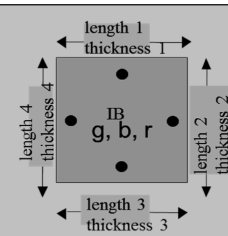
y = valid test, failure across the overlap length, or
n = either no failure occurred or the end tabs

Board No.	Sample ID	Specimen Characteristics										
		Mass	Length				Average length13	Average length24	Thickness	Density	Valid test	Stress
			1	2	3	4						
		(gm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(kg/m^3)	(y or n)	(KPa)
ML4	1	17.17	51.34	51.82	51.45	51.89	51.40	51.86	10.73	600.43	y	759.4
	2	16.49	51.34	51.79	51.35	51.94	51.35	51.87	10.87	569.66	y	581.4
	3	18.23	51.37	51.82	51.23	51.87	51.30	51.85	10.76	637.02	y	551.2
	4	17.82	51.32	51.87	51.29	51.91	51.31	51.89	11.08	604.12	y	579.8
	5	21.58	51.33	51.93	51.38	51.96	51.36	51.95	11.18	723.57	y	681.9
	6	22.54	51.31	51.92	51.47	51.98	51.39	51.95	11.32	745.84	y	644.8
	7	22.80	51.33	51.98	51.35	51.93	51.34	51.96	11.70	730.58	y	527.1
	8	19.88	50.98	51.93	51.19	51.90	51.09	51.92	11.45	654.67	y	434.8
	9	19.65	50.92	51.94	50.91	51.94	50.92	51.94	11.36	654.09	y	699.3
	10	16.49	50.56	51.96	50.71	51.69	50.64	51.83	10.41	603.64	y	466.0
	11	19.01	51.25	52.01	51.23	51.87	51.24	51.94	11.06	645.83	y	847.8
	12	18.66	51.26	51.91	51.26	51.90	51.26	51.91	10.95	640.49	y	657.8
	13	19.09	51.28	51.96	51.25	51.89	51.27	51.93	10.91	657.33	y	650.2
	14	20.63	51.26	51.90	51.15	51.87	51.21	51.89	10.82	717.66	y	607.6
	15	20.46	51.22	51.89	51.26	51.87	51.24	51.88	10.82	711.33	y	736.3
	16	21.20	51.33	51.87	51.28	51.88	51.31	51.88	10.98	725.46	y	765.2
	17	16.36	50.92	51.89	50.91	51.83	50.92	51.86	11.38	544.46	y	471.2
	18	15.38	50.85	51.86	50.86	51.96	50.86	51.91	11.34	513.76	y	323.6
	19	16.74	50.83	51.88	50.87	51.91	50.85	51.90	11.29	561.88	y	529.5
	20	19.16	50.74	51.91	50.75	51.86	50.75	51.89	10.55	689.78	y	752.7
	21	17.80	51.23	51.90	50.95	52.00	51.09	51.95	11.07	605.83	y	776.9
	22	17.96	51.05	51.85	50.91	51.94	50.98	51.90	11.55	587.76	y	436.2
	23	17.00	50.86	51.89	50.84	51.86	50.85	51.88	11.06	582.70	y	414.4
	24	16.33	50.85	52.00	50.84	51.98	50.85	51.99	10.88	567.79	y	533.4
	25	21.05	51.88	51.71	51.97	51.31	51.93	51.51	10.88	723.36	y	678.2
	26	19.77	51.90	51.39	51.89	51.31	51.90	51.35	10.92	679.39	y	470.6
	27	19.32	51.87	51.27	51.88	51.38	51.88	51.33	10.76	674.38	y	748.4
	28	19.16	51.88	50.93	51.87	50.86	51.88	50.90	11.81	614.49	y	583.1
	29	18.84	51.89	50.88	51.89	50.91	51.89	50.90	11.80	604.56	y	386.1
	30	16.18	50.85	51.92	50.85	51.97	50.85	51.95	10.94	559.92	y	511.9

IB test for ML

MH Moso High Density
ML Moso Low Density

g = Board type (ML)
b = Board No. (1,2,3,4,5,6)
r = Replication (Sample ID)



y = valid test, failure across the overlap length, or
n = either no failure occurred or the end tabs

Board No.	Sample ID	Mass (gm)	Length 1 (mm)	Length 2 (mm)	Length 3 (mm)	Length 4 (mm)	Average length13 (mm)	Average length24 (mm)	Thickness (mm)	Density (kg/m^3)	Valid test (y or n)	Stress (KPa)
ML5	1	19.18	51.87	51.12	51.97	51.04	51.92	51.08	11.05	654.49	y	888.8
	2	16.71	51.17	51.86	51.11	51.89	51.14	51.88	11.02	571.58	y	666.1
	3	20.37	51.91	51.18	51.94	51.25	51.93	51.22	11.03	694.45	y	792.0
	4	18.95	51.22	51.90	51.27	51.94	51.25	51.92	10.98	648.67	y	919.1
	5	25.05	51.27	51.99	51.33	51.90	51.30	51.95	11.33	829.69	y	852.6
	6	27.19	51.30	51.99	51.30	51.90	51.30	51.95	11.87	859.60	y	1003.8
	7	23.81	51.27	51.94	51.27	51.85	51.27	51.90	11.24	796.17	y	896.3
	8	19.63	51.26	51.53	51.25	51.98	51.26	51.76	11.14	664.27	y	917.5
	9	20.65	51.21	51.91	51.19	51.84	51.20	51.88	11.09	701.07	y	926.7
	10	22.74	51.28	51.93	51.21	51.90	51.25	51.92	11.02	775.65	y	809.4
	11	22.18	51.16	52.00	51.21	51.97	51.19	51.99	10.95	761.25	y	961.2
	12	14.83	51.31	51.91	51.25	51.95	51.28	51.93	10.87	512.32	y	544.6
	13	17.76	51.75	51.20	51.94	51.25	51.85	51.23	10.90	613.52	y	758.4
	14	14.59	51.18	51.86	51.17	51.91	51.18	51.89	10.74	511.62	y	451.7
	15	18.13	51.13	51.93	51.10	51.94	51.12	51.94	11.19	610.32	y	770.5
	16	16.37	51.26	51.95	51.12	51.93	51.19	51.94	11.10	554.68	y	483.5
	17	20.69	51.24	51.99	51.33	51.97	51.29	51.98	10.99	706.21	y	872.8
	18	18.77	51.20	51.98	51.27	51.94	51.24	51.96	11.00	640.97	y	720.5
	19	19.62	51.03	51.99	51.05	51.86	51.04	51.93	10.97	674.85	y	640.4
	20	19.82	51.88	51.03	51.94	51.09	51.91	51.06	11.00	679.80	y	863.0
	21	21.12	51.09	51.93	51.04	51.87	51.07	51.90	11.9	669.66	y	717.8
	22	19.12	51.87	51.2	51.94	51.19	51.91	51.20	11.9	604.65	y	636.9
	23	21.91	51.24	51.87	51.16	51.88	51.20	51.88	11.87	694.97	y	651.6
	24	19.19	51.17	51.88	51.11	51.88	51.14	51.88	11.9	607.81	y	598.0
	25	18.04	51.92	51.07	52.04	51.05	51.98	51.06	11.69	581.44	y	731.1
	26	17.21	51.26	51.94	51.18	51.93	51.22	51.94	10.65	607.48	y	799.5
	27	21.04	51.88	50.98	51.88	51.01	51.88	51.00	11.78	675.11	y	850.6
	28	17.23	51.91	51.04	51.92	50.98	51.92	51.01	11.74	554.20	y	633.2
	29	20.90	51.1	51.94	51.13	51.88	51.12	51.91	11.9	661.91	y	656.7
	30	15.99	51.11	51.95	51.29	51.85	51.20	51.90	10.63	566.08	y	698.9

IB test for ML

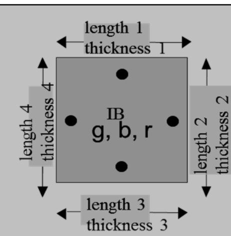
MH Moso High Density

ML Moso Low Density

g = Board type (ML)

b = Board No. (1,2,3,4,5,6)

r = Replication (Sample ID)



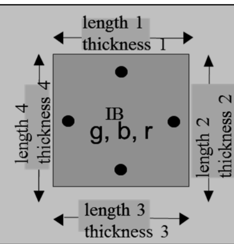
y = valid test, failure across the overlap length, or
n = either no failure occurred or the end tabs

Board No.	Sample ID	Specimen Characteristics										
		Mass	Length				Average length13	Average length24	Thickness	Density	Valid test	Stress
			1	2	3	4						
		(gm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(kg/m^3)	(y or n)	(KPa)
ML6	1	23.17	51.94	51.11	51.90	51.21	51.92	51.16	11.57	753.92	y	977.9
	2	21.75	51.27	52.00	51.19	51.92	51.23	51.96	11.59	704.99	y	744.5
	3	20.38	51.84	51.19	51.87	51.29	51.86	51.24	11.62	660.08	y	875.7
	4	22.14	51.33	51.96	51.23	51.86	51.28	51.91	11.64	714.54	y	869.3
	5	19.23	51.24	51.95	51.24	51.73	51.24	51.84	11.31	640.09	y	632.7
	6	20.53	51.20	51.86	51.23	51.81	51.22	51.84	11.50	672.47	y	930.4
	7	19.35	51.03	51.87	51.14	51.90	51.09	51.89	10.89	670.38	y	741.7
	8	23.90	51.25	51.93	51.22	51.90	51.24	51.92	11.27	797.29	y	1104.4
	9	18.99	51.25	52.02	51.28	51.79	51.27	51.91	11.62	614.17	y	660.7
	10	19.17	51.22	51.94	51.26	51.89	51.24	51.92	11.18	644.58	y	831.3
	11	19.93	51.12	51.93	51.34	51.87	51.23	51.90	10.91	687.05	y	622.5
	12	21.69	51.99	51.27	51.97	51.72	51.98	51.50	11.63	696.75	y	770.0
	13	19.55	51.33	51.97	51.42	52.08	51.38	52.03	10.83	675.39	y	870.5
	14	19.27	51.19	51.89	51.25	52.00	51.22	51.95	10.84	668.14	y	860.9
	15	20.40	51.22	51.93	51.20	51.90	51.21	51.92	11.01	696.94	y	993.0
	16	16.26	51.12	51.84	51.17	51.93	51.15	51.89	10.99	557.54	y	676.9
	17	17.40	51.06	51.97	51.08	51.83	51.07	51.90	11.06	593.55	y	764.3
	18	18.58	51.21	51.95	51.10	51.86	51.16	51.91	11.05	633.27	y	753.0
	19	19.28	51.39	51.93	51.02	51.88	51.21	51.91	11.08	654.71	y	600.6
	20	19.17	51.11	51.92	51.06	51.86	51.09	51.89	11.08	652.69	y	545.6
	21	16.63	51.01	51.93	51.06	51.83	51.04	51.88	10.94	574.13	y	654.1
	22	16.65	50.93	51.94	51.04	51.91	50.99	51.93	10.93	575.41	y	730.4
	23	19.24	51.60	51.98	51.37	51.83	51.49	51.91	10.80	666.64	y	792.9
	24	18.22	51.24	51.92	51.27	51.89	51.26	51.91	11.00	622.60	y	828.5
	25	22.46	51.36	51.89	51.20	51.86	51.28	51.88	11.05	764.08	y	968.0
	26	17.52	51.18	51.89	51.25	51.87	51.22	51.88	11.01	598.89	y	615.9
	27	18.86	51.25	51.89	51.19	51.85	51.22	51.87	11.06	641.85	y	960.7
	28	20.37	51.15	51.89	51.23	51.91	51.19	51.90	11.11	690.12	y	726.4
	29	19.24	51.44	51.96	51.21	51.84	51.33	51.90	10.85	665.70	y	701.3
	30	16.80	50.57	51.90	50.55	51.84	50.56	51.87	11.43	560.45	y	666.2

IB test for GN

GN Guadua Node
GI Guadua Internode

g = Board type (GN)
b = Board No. (1,2,3,4,5,6)
r = Replication (Sample ID)



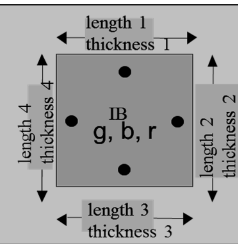
y = valid test, failure across the overlap length, or
n = either no failure occurred or the end tabs

Board No.	Sample ID	Specimen Characteristics										
		Mass	Length				Average length13	Average length24	Thickness	Density	Valid test	Stress
		(gm)	1 (mm)	2 (mm)	3 (mm)	4 (mm)	(mm)	(mm)	(mm)	(kg/m^3)	(y or n)	(KPa)
GN1	1	23.78	52.05	51.37	52.19	51.38	52.12	51.38	11.89	746.92	y	576.7
	2	22.00	52.07	51.18	52.11	51.31	52.09	51.25	11.95	689.68	y	521.3
	3	24.37	52.03	51.22	52.05	51.24	52.04	51.23	11.90	768.15	y	234.0
	4	25.65	51.91	51.30	52.01	51.20	51.96	51.25	11.88	810.79	y	579.2
	5	23.12	52.09	51.19	52.01	51.26	52.05	51.23	11.17	776.30	y	297.2
	6	22.18	52.06	50.91	52.02	51.04	52.04	50.98	11.98	697.93	y	451.7
	7	22.31	52.06	50.82	52.04	50.87	52.05	50.85	11.94	706.04	y	444.6
	8	24.47	52.11	51.13	52.10	50.83	52.11	50.98	12.00	767.67	y	352.2
	9	24.83	52.17	51.32	52.08	51.28	52.13	51.30	11.91	779.65	y	663.0
	10	21.92	52.03	51.04	51.95	50.90	51.99	50.97	11.37	727.52	y	657.6
	11	21.92	51.22	52.10	51.31	52.24	51.27	52.17	11.03	743.06	y	556.6
	12	21.72	51.28	52.11	51.26	52.06	51.27	52.09	11.09	733.42	y	586.1
	13	21.99	51.27	52.17	51.32	52.12	51.30	52.15	11.12	739.32	y	538.9
	14	23.84	51.30	52.06	51.20	52.00	51.25	52.03	11.09	806.17	y	696.1
	15	23.34	51.35	52.16	51.18	51.95	51.27	52.06	11.24	778.13	y	800.6
	16	22.03	51.13	52.14	51.04	52.08	51.09	52.11	11.27	734.30	y	738.2
	17	22.23	50.97	51.95	50.78	51.99	50.88	51.97	11.14	754.74	y	581.9
	18	21.13	50.83	52.05	50.66	52.00	50.75	52.03	11.10	721.06	y	555.7
	19	22.45	50.85	52.10	50.98	52.01	50.92	52.06	11.88	713.00	y	507.6
	20	21.03	52.08	51.12	52.05	51.08	52.07	51.10	11.25	702.62	y	685.9
	21	23.97	52.12	51.08	52.08	51.07	52.10	51.08	11.48	784.66	y	659.6
	22	25.27	52.12	51.21	52.01	51.11	52.07	51.16	11.50	824.96	y	892.7
	23	24.61	52.05	51.18	52.05	51.19	52.05	51.19	11.52	801.85	y	551.7
	24	27.04	52.14	51.20	52.07	51.18	52.11	51.19	11.52	880.01	y	526.8
	25	19.09	52.07	51.22	51.84	51.33	51.96	51.28	11.75	609.87	y	488.1
	26	22.75	51.27	52.09	51.60	52.06	51.44	52.08	11.45	741.80	y	688.6
	27	22.74	51.63	52.05	51.71	51.98	51.67	52.02	11.43	740.25	y	712.2
	28	20.63	50.80	52.07	50.82	52.08	50.81	52.08	11.89	655.75	y	399.1
	29	24.09	50.97	52.03	51.10	52.02	51.04	52.03	11.98	757.36	y	567.6
	30	22.58	52.12	51.00	52.14	51.03	52.13	51.02	11.41	744.14	y	709.0

IB test for GN

GN Guadua Node
GI Guadua Internode

g = Board type (GN)
b = Board No. (1,2,3,4,5,6)
r = Replication (Sample ID)



y = valid test, failure across the overlap length, or
n = either no failure occurred or the end tabs

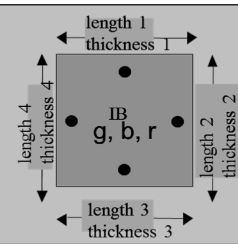
Board No.	Sample ID	Specimen Characteristics										
		Mass (gm)	Length 1 (mm)	Length 2 (mm)	Length 3 (mm)	Length 4 (mm)	Average length13 (mm)	Average length24 (mm)	Thickness (mm)	Density (kg/m^3)	Valid test (y or n)	Stress (KPa)
GN2	1	24.09	51.98	51.31	52.05	51.30	52.02	51.31	10.85	831.99	y	863.5
	2	23.86	52.07	51.27	52.09	51.34	52.08	51.31	10.84	823.78	y	926.7
	3	24.31	52.09	51.35	52.10	51.31	52.10	51.33	10.84	838.66	y	1022.8
	4	21.19	52.09	51.39	52.11	51.56	52.10	51.48	10.84	728.90	y	559.0
	5	23.02	52.09	51.68	52.06	51.44	52.08	51.56	10.86	789.47	y	899.1
	6	23.63	52.11	51.53	52.02	51.45	52.07	51.49	10.84	813.14	y	677.0
	7	24.20	50.99	52.16	51.03	52.08	51.01	52.12	11.38	799.86	y	688.2
	8	20.61	50.95	52.10	51.12	52.06	51.04	52.08	11.26	688.65	y	566.6
	9	23.56	51.19	52.09	51.25	51.99	51.22	52.04	10.88	812.40	y	586.8
	10	23.72	51.37	52.10	51.29	52.19	51.33	52.15	11.19	791.96	y	744.0
	11	22.52	51.19	52.09	51.27	52.07	51.23	52.08	10.81	780.81	y	635.8
	12	18.05	51.97	50.45	51.98	50.40	51.98	50.43	10.84	635.34	y	389.9
	13	20.82	52.12	50.45	52.11	50.37	52.12	50.41	10.94	724.41	y	612.1
	14	16.94	52.05	50.52	52.09	50.42	52.07	50.47	10.93	589.76	y	482.0
	15	26.93	51.05	52.06	50.97	51.98	51.01	52.02	11.67	869.64	y	843.6
	16	28.52	50.92	52.16	51.17	52.15	51.05	52.16	11.66	918.76	y	763.2
	17	25.19	51.19	52.14	51.25	52.19	51.22	52.17	11.67	807.86	y	789.8
	18	25.77	51.28	52.12	51.39	52.14	51.34	52.13	11.70	823.05	y	782.7
	19	26.52	51.62	52.14	51.59	51.96	51.61	52.05	11.72	842.43	y	807.9
	20	25.93	51.54	52.05	51.61	51.94	51.58	52.00	11.55	837.18	y	864.8
	21	28.59	52.04	51.45	52.13	51.40	52.09	51.43	11.63	917.80	y	1111.6
	22	26.63	52.06	51.46	52.18	51.46	52.12	51.46	11.61	855.19	y	726.8
	23	26.96	51.89	51.47	52.03	51.60	51.96	51.54	11.62	866.45	y	908.5
	24	21.90	52.11	51.35	52.14	51.15	52.13	51.25	11.20	731.96	y	560.8
	25	25.52	52.09	51.42	51.99	51.56	52.04	51.49	11.44	832.52	y	845.3
	26	24.52	51.34	52.20	51.35	52.19	51.35	52.20	10.88	840.94	y	715.7
	27	20.63	51.29	52.08	51.34	52.13	51.32	52.11	11.09	695.74	y	503.9
	28	22.27	51.36	52.00	51.12	52.00	51.24	52.00	11.09	753.66	y	598.1
	29	23.96	51.20	52.06	51.06	52.06	51.13	52.06	11.10	810.93	y	574.7
	30	23.62	51.30	52.09	51.41	52.06	51.36	52.08	10.98	804.39	y	740.7

IB test for GN

GN Guadua Node
GI Guadua Internode

g = Board type (GN)
b = Board No. (1,2,3,4,5,6)
r = Replication (Sample ID)

y = valid test, failure across the overlap length, or
n = either no failure occurred or the end tabs



Board No.	Sample ID	Specimen Characteristics										
		Mass (gm)	Length 1 (mm)	2 (mm)	3 (mm)	4 (mm)	Average length13 (mm)	Average length24 (mm)	Thickness (mm)	Density (kg/m^3)	Valid test (y or n)	Stress (KPa)
GN3	1	25.18	51.03	52.08	51.05	52.08	51.04	52.08	11.25	842.02	y	791.3
	2	21.62	51.01	52.04	50.99	52.09	51.00	52.07	11.13	731.55	y	599.6
	3	20.98	51.11	52.19	51.09	52.12	51.10	52.16	11.14	706.65	y	644.9
	4	26.25	51.03	52.12	51.03	52.17	51.03	52.15	11.13	886.33	y	910.5
	5	26.42	52.11	51.13	52.11	51.12	52.11	51.13	11.50	862.34	y	956.5
	6	26.30	52.03	51.08	52.11	51.17	52.07	51.13	11.61	850.95	y	930.0
	7	23.95	51.96	51.20	52.13	51.29	52.05	51.25	11.70	767.52	y	646.9
	8	25.35	52.04	51.31	51.97	51.17	52.01	51.24	11.71	812.39	y	990.2
	9	21.16	52.12	51.15	52.11	51.17	52.12	51.16	11.65	681.23	y	678.5
	10	22.95	52.12	51.17	52.11	51.30	52.12	51.24	11.66	737.15	y	605.2
	11	24.07	51.27	52.05	51.25	52.17	51.26	52.11	11.62	775.48	y	581.1
	12	26.90	51.18	52.08	51.21	52.04	51.20	52.06	11.49	878.42	y	715.9
	13	25.47	51.10	52.02	51.09	52.03	51.10	52.03	11.40	840.49	y	998.2
	14	22.44	51.12	52.11	51.10	52.09	51.11	52.10	11.45	735.99	y	507.8
	15	24.28	51.20	52.16	51.02	52.13	51.11	52.15	11.70	778.65	y	848.8
	16	23.29	50.95	52.19	50.79	52.02	50.87	52.11	11.67	752.94	y	522.7
	17	20.36	50.81	52.07	50.68	52.01	50.75	52.04	11.69	659.53	y	679.5
	18	25.50	52.07	51.18	52.10	51.21	52.09	51.20	11.59	825.12	y	654.9
	19	19.99	50.90	52.09	50.94	52.17	50.92	52.13	11.73	642.01	y	537.8
	20	21.98	50.83	52.08	50.93	52.18	50.88	52.13	11.71	707.68	y	611.5
	21	19.77	52.12	50.98	52.21	50.92	52.17	50.95	11.63	639.59	y	681.8
	22	17.77	51.00	52.13	50.89	51.86	50.95	52.00	11.65	575.84	y	506.0
	23	19.40	52.12	50.90	52.31	50.80	52.22	50.85	11.48	636.46	y	379.6
	24	17.97	52.01	50.86	52.10	50.20	52.06	50.53	11.43	597.71	y	429.1
	25	22.33	51.14	52.18	51.16	52.19	51.15	52.19	11.36	736.41	y	438.9
	26	21.24	51.09	52.12	51.14	52.12	51.12	52.12	11.37	701.20	y	678.3
	27	21.35	51.16	52.11	51.15	52.16	51.16	52.14	11.56	692.50	y	539.0
	28	23.15	51.17	52.08	51.17	52.11	51.17	52.10	11.52	753.85	y	747.4
	29	20.43	50.43	52.01	50.50	52.07	50.47	52.04	11.19	695.20	y	686.6
	30	17.67	52.14	50.86	52.06	50.87	52.10	50.87	11.55	577.29	y	366.4

IB test for GN

GN Guadua Node
GI Guadua Internode

g = Board type (GN)
b = Board No. (1,2,3,4,5,6)
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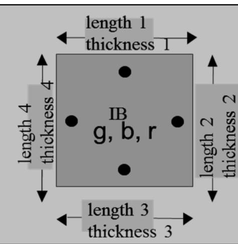
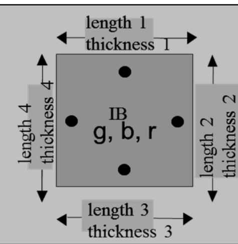


Board No.	Sample ID	Mass (gm)	Length 1 (mm)	Length 2 (mm)	Length 3 (mm)	Length 4 (mm)	Average length13 (mm)	Average length24 (mm)	Thickness (mm)	Density (kg/m^3)	Valid test (y or n)	Stress (KPa)
GN4	1	21.89	51.21	52.09	51.03	51.98	51.12	52.04	11.52	714.34	y	696.0
	2	24.39	51.17	52.12	51.10	52.20	51.14	52.16	11.51	794.48	y	979.4
	3	25.76	51.30	52.02	51.26	52.12	51.28	52.07	11.47	841.10	y	862.2
	4	26.56	52.08	51.29	52.09	51.30	52.09	51.30	11.54	861.46	y	855.1
	5	24.01	52.09	51.18	52.13	51.21	52.11	51.20	11.50	782.61	y	809.0
	6	25.77	52.08	51.20	52.16	51.26	52.12	51.23	11.42	845.12	y	779.6
	7	25.07	52.10	51.24	52.02	51.27	52.06	51.26	11.43	821.99	y	467.4
	8	16.91	52.18	51.10	52.07	51.14	52.13	51.12	11.67	543.80	y	237.5
	9	25.82	52.15	51.17	52.14	51.23	52.15	51.20	11.64	830.85	y	700.0
	10	25.50	52.04	51.20	52.15	51.18	52.10	51.19	11.56	827.18	y	822.9
	11	19.07	50.95	51.97	50.93	51.98	50.94	51.98	11.47	627.96	y	521.5
	12	19.42	51.02	52.08	51.00	52.03	51.01	52.06	11.48	637.07	y	598.2
	13	19.20	51.09	52.06	50.97	52.13	51.03	52.10	11.58	623.69	y	566.9
	14	17.97	51.02	52.00	50.90	52.02	50.96	52.01	11.46	591.63	y	514.6
	15	23.10	52.07	50.82	52.09	50.95	52.08	50.89	11.98	727.60	y	551.7
	16	18.53	52.00	50.82	52.02	50.83	52.01	50.83	11.83	592.55	y	447.4
	17	27.20	52.05	51.12	52.03	51.13	52.04	51.13	11.40	896.80	y	934.6
	18	25.34	51.97	51.06	52.08	51.11	52.03	51.09	11.45	832.71	y	657.8
	19	22.61	52.02	50.87	52.05	50.86	52.04	50.87	11.31	755.31	y	855.8
	20	22.50	51.91	50.79	51.92	50.79	51.92	50.79	11.38	749.84	y	690.9
	21	21.50	52.04	50.98	52.06	51.00	52.05	50.99	11.40	710.60	y	660.2
	22	20.54	52.00	50.79	52.03	50.95	52.02	50.87	11.43	679.15	y	714.8
	23	23.98	52.01	51.16	52.04	51.14	52.03	51.15	11.25	801.01	y	768.3
	24	24.87	51.13	52.07	51.01	52.07	51.07	52.07	11.18	836.53	y	998.8
	25	23.82	52.14	50.99	52.17	51.14	52.16	51.07	11.21	797.84	y	668.9
	26	18.89	51.02	52.18	51.01	52.00	51.02	52.09	11.50	618.13	y	532.1
	27	21.47	51.15	52.34	51.22	52.13	51.19	52.24	11.13	721.49	y	710.8
	28	22.04	50.76	52.19	50.82	52.02	50.79	52.11	11.23	741.61	y	758.1
	29	22.26	51.81	50.77	51.91	50.99	51.86	50.88	11.42	738.72	y	529.5
	30	22.25	51.05	52.05	51.02	52.08	51.04	52.07	11.31	740.38	y	722.5

IB test for GN

GN Guadua Node
GI Guadua Internode

g = Board type (GN)
b = Board No. (1,2,3,4,5,6)
r = Replication (Sample ID)



y = valid test, failure across the overlap length, or
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Board No.	Sample ID	Specimen Characteristics										
		Mass (gm)	Length 1 (mm)	Length 2 (mm)	Length 3 (mm)	Length 4 (mm)	Average length13 (mm)	Average length24 (mm)	Thickness (mm)	Density (kg/m^3)	Valid test (y or n)	Stress (KPa)
GN5	1	25.31	51.87	51.03	51.88	51.04	51.88	51.04	11.94	800.68	y	552.6
	2	27.34	51.86	51.04	51.82	51.06	51.84	51.05	11.94	865.23	y	615.5
	3	22.87	51.03	51.83	51.01	51.88	51.02	51.86	12.02	719.17	y	589.3
	4	22.48	51.88	51.21	51.90	51.32	51.89	51.27	11.29	748.51	y	723.2
	5	23.51	51.91	51.27	51.92	51.21	51.92	51.24	11.51	767.85	y	538.5
	6	27.32	51.92	51.08	51.86	51.14	51.89	51.11	11.47	898.11	y	739.0
	7	25.94	51.36	51.80	51.39	51.81	51.38	51.81	11.50	847.52	y	593.6
	8	20.12	51.38	51.87	51.34	51.88	51.36	51.88	11.49	657.24	y	556.4
	9	19.97	51.89	51.34	51.88	51.41	51.89	51.38	11.53	649.76	y	460.9
	10	25.54	51.28	51.98	51.19	51.92	51.24	51.95	11.52	832.94	y	435.8
	11	22.59	51.59	51.82	51.73	51.68	51.66	51.75	10.82	780.95	y	718.2
	12	22.62	51.85	51.84	51.86	51.91	51.86	51.88	10.92	770.05	y	512.2
	13	23.82	51.95	51.72	51.91	51.81	51.93	51.77	10.93	810.71	y	475.0
	14	23.96	51.91	51.47	51.89	51.67	51.90	51.57	11.19	800.00	y	676.6
	15	24.82	51.89	51.37	51.89	51.45	51.89	51.41	10.98	847.36	y	401.0
	16	23.78	51.94	51.31	51.89	51.30	51.92	51.31	10.93	816.84	y	456.5
	17	23.34	51.85	51.60	51.93	51.42	51.89	51.51	11.01	793.12	y	316.8
	18	24.31	51.85	51.59	51.84	51.63	51.85	51.61	11.02	824.45	y	606.8
	19	24.50	51.89	51.59	51.87	51.59	51.88	51.59	11.06	827.65	y	492.3
	20	29.62	51.94	51.18	51.90	51.17	51.92	51.18	12.22	912.27	y	649.1
	21	24.66	51.90	51.09	51.87	51.07	51.89	51.08	11.97	777.33	y	552.4
	22	23.76	51.84	51.11	51.84	51.12	51.84	51.12	11.99	747.85	y	559.1
	23	21.78	51.89	51.13	51.88	51.15	51.89	51.14	11.87	691.52	y	531.0
	24	25.15	51.85	51.14	51.84	51.13	51.85	51.14	12.01	789.90	y	396.5
	25	20.86	51.82	51.05	51.89	51.00	51.86	51.03	11.86	664.75	y	654.1
	26	27.46	51.97	51.46	51.95	51.55	51.96	51.51	11.02	931.11	y	544.8
	27	24.75	51.94	51.30	51.89	51.39	51.92	51.35	11.20	829.02	y	446.4
	28	25.42	51.90	51.19	51.87	51.12	51.89	51.16	11.94	802.12	y	371.7
	29	24.66	51.19	51.89	51.16	51.88	51.18	51.89	11.50	807.60	y	459.8
	30	18.49	50.84	51.85	50.83	51.90	50.84	51.88	11.16	628.28	y	586.4

IB test for GN

GN Guadua Node
GI Guadua Internode

g = Board type (GN)
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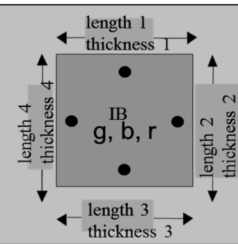

		Specimen Characteristics										
Board No.	Sample ID	Mass (gm)	Length 1 (mm)	Length 2 (mm)	Length 3 (mm)	Length 4 (mm)	Average length13 (mm)	Average length24 (mm)	Thickness (mm)	Density (kg/m^3)	Valid test (y or n)	Stress (KPa)
GN6	1	22.54	50.92	52.04	50.88	52.00	50.90	52.02	11.43	744.77	y	268.3
	2	22.48	51.00	52.17	50.97	52.09	50.99	52.13	11.35	745.20	y	561.9
	3	21.80	51.07	52.03	50.96	52.05	51.02	52.04	11.26	729.26	y	516.3
	4	25.55	51.03	51.99	51.00	52.07	51.02	52.03	11.12	865.63	y	696.0
	5	21.10	51.95	51.31	52.04	51.26	52.00	51.29	10.85	729.29	y	599.8
	6	21.98	51.08	52.06	51.13	52.08	51.11	52.07	11.09	744.81	y	553.8
	7	22.90	51.07	52.01	51.10	52.09	51.09	52.05	11.02	781.52	y	600.4
	8	24.84	51.21	52.12	51.19	51.97	51.20	52.05	10.89	856.00	y	724.5
	9	23.39	51.11	52.07	51.19	52.05	51.15	52.06	10.82	811.81	y	663.9
	10	23.63	50.96	51.92	51.08	51.88	51.02	51.90	10.82	824.76	y	600.6
	11	24.57	51.19	52.05	51.12	52.01	51.16	52.03	10.89	847.69	y	453.1
	12	23.04	51.17	52.00	51.17	52.01	51.17	52.01	10.89	795.05	y	774.9
	13	24.69	51.10	52.02	51.04	52.03	51.07	52.03	10.75	864.44	y	816.7
	14	22.87	51.07	52.21	51.08	52.09	51.08	52.15	10.98	781.99	y	628.0
	15	20.80	51.08	52.09	51.05	52.07	51.07	52.08	10.82	722.84	y	474.1
	16	21.41	51.09	52.15	51.14	52.08	51.12	52.12	10.85	740.76	y	555.8
	17	22.52	51.11	52.07	51.10	52.12	51.11	52.10	11.16	757.96	y	699.8
	18	24.41	51.13	52.08	51.17	52.03	51.15	52.06	11.06	828.90	y	788.8
	19	22.23	51.18	52.10	51.20	52.00	51.19	52.05	11.15	748.27	y	613.1
	20	21.46	51.22	52.23	51.25	52.19	51.24	52.21	11.24	713.74	y	510.6
	21	23.29	51.99	50.98	52.00	51.01	52.00	51.00	11.81	743.76	y	706.3
	22	22.68	52.05	51.00	52.06	50.91	52.06	50.96	11.81	724.01	y	560.4
	23	22.01	52.10	50.95	52.03	50.92	52.07	50.94	11.81	702.76	y	474.4
	24	23.55	52.08	50.90	52.03	50.91	52.06	50.91	11.76	755.72	y	701.6
	25	21.41	51.99	50.94	51.98	50.99	51.99	50.97	11.71	690.10	y	527.4
	26	19.00	52.03	50.82	52.04	50.84	52.04	50.83	11.44	627.93	y	220.7
	27	25.38	52.05	50.89	52.07	50.92	52.06	50.91	11.71	817.84	y	569.1
	28	21.95	52.00	50.83	52.05	50.91	52.03	50.87	11.62	713.76	y	350.6
	29	19.61	51.24	52.15	51.28	52.01	51.26	52.08	10.89	674.53	y	573.0
	30	21.44	51.20	52.03	51.24	52.01	51.22	52.02	10.89	738.90	y	534.3

IB test for GI

GN Guadua Node
GI Guadua Internode

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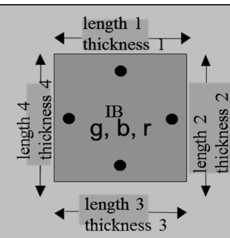
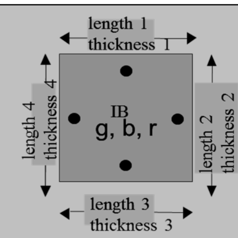


Board No.	Sample ID	Specimen Characteristics										
		Mass	Length				Average length13	Average length24	Thickness	Density	Valid test	Stress
			1	2	3	4						
		(gm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(kg/m^3)	(y or n)	(KPa)
GI1	1	22.76	51.70	51.98	50.99	51.93	51.35	51.96	10.60	804.90	y	762.6
	2	19.75	51.15	51.90	51.06	51.88	51.11	51.89	10.86	685.79	y	633.0
	3	18.48	51.21	51.93	51.23	51.96	51.22	51.95	10.20	680.96	y	574.1
	4	23.76	51.24	51.95	51.23	51.91	51.24	51.93	10.92	817.78	y	976.5
	5	27.41	51.24	51.92	51.20	51.85	51.22	51.89	10.93	943.64	y	917.2
	6	24.35	51.25	51.87	51.30	51.92	51.28	51.90	10.99	832.66	y	589.1
	7	24.28	51.27	51.98	51.33	51.91	51.30	51.95	11.05	824.57	y	740.6
	8	22.45	51.33	51.89	51.19	51.93	51.26	51.91	11.81	714.39	y	648.6
	9	23.13	51.90	51.30	51.91	51.52	51.91	51.41	11.23	771.86	y	835.9
	10	25.27	51.86	51.32	51.86	51.25	51.86	51.29	11.23	846.06	y	881.4
	11	21.50	51.87	51.31	51.88	51.18	51.88	51.25	11.78	686.57	y	605.2
	12	24.39	51.86	51.10	51.87	51.18	51.87	51.14	11.76	781.93	y	592.2
	13	21.52	51.87	51.13	51.83	51.10	51.85	51.12	11.73	692.22	y	540.1
	14	21.43	51.89	51.11	51.87	51.11	51.88	51.11	11.65	693.73	y	572.4
	15	22.92	51.93	51.06	51.89	51.11	51.91	51.09	11.62	743.81	y	663.7
	16	22.35	51.87	51.07	51.84	51.00	51.86	51.04	11.53	732.47	y	652.4
	17	19.43	51.82	51.16	51.86	51.17	51.84	51.17	11.82	619.75	y	456.9
	18	21.94	51.79	51.31	51.86	51.26	51.83	51.29	11.85	696.61	y	589.4
	19	23.03	51.92	51.43	51.93	51.29	51.93	51.36	11.23	768.98	y	883.8
	20	22.39	51.96	51.30	51.96	51.29	51.96	51.30	10.85	774.25	y	846.4
	21	24.28	51.84	51.39	51.93	51.24	51.89	51.32	11.33	804.88	y	570.0
	22	23.42	51.96	51.27	51.92	51.35	51.94	51.31	11.32	776.31	y	713.8
	23	22.58	5.88	51.37	51.98	51.43	28.93	51.40	11.31	1342.61	y	757.3
	24	26.94	51.95	51.26	51.86	51.24	51.91	51.25	11.53	878.35	y	958.3
	25	26.97	51.91	51.26	51.85	51.29	51.88	51.28	11.38	890.91	y	968.2
	26	22.58	51.82	51.28	51.92	51.30	51.87	51.29	10.76	788.79	y	712.4
	27	21.60	51.93	51.29	51.96	51.38	51.95	51.34	10.81	749.33	y	661.0
	28	21.78	51.89	51.36	51.77	51.30	51.83	51.33	10.66	767.98	y	856.2
	29	19.26	51.90	51.28	51.95	51.32	51.93	51.30	10.76	671.97	y	640.4
	30	18.40	51.28	51.83	51.37	51.89	51.33	51.86	10.97	630.16	y	551.4

IB test for GI

GN Guadua Node
GI Guadua Internode

g = Board type (GI)
b = Board No. (1,2,3,4,5,6)
r = Replication (Sample ID)



y = valid test, failure across the overlap length, or
n = either no failure occurred or the end tabs

		Specimen Characteristics										
Board No.	Sample ID	Mass (gm)	Length 1 (mm)	Length 2 (mm)	Length 3 (mm)	Length 4 (mm)	Average length13 (mm)	Average length24 (mm)	Thickness (mm)	Density (kg/m^3)	Valid test (y or n)	Stress (KPa)
GI2	1	22.13	52.09	51.74	52.05	51.68	52.07	51.71	11.63	706.71	y	651.2
	2	22.03	52.06	51.14	51.90	51.19	51.98	51.17	11.14	743.57	y	845.4
	3	21.11	51.17	51.84	51.18	51.87	51.18	51.86	11.21	709.63	y	805.5
	4	24.21	51.85	51.16	51.91	51.21	51.88	51.19	11.44	796.94	y	921.3
	5	20.34	51.97	51.37	51.84	51.13	51.91	51.25	11.20	682.70	y	773.7
	6	21.77	51.88	51.12	51.87	51.15	51.88	51.14	10.81	759.20	y	771.5
	7	19.80	51.25	51.97	51.20	51.89	51.23	51.93	10.99	677.28	y	641.8
	8	20.20	51.28	51.76	51.33	52.08	51.31	51.92	10.71	708.06	y	658.2
	9	20.43	51.24	51.64	51.29	51.97	51.27	51.81	10.83	710.31	y	689.3
	10	21.97	52.04	51.29	51.98	51.30	52.01	51.30	11.03	746.61	y	814.8
	11	22.07	51.09	52.00	51.36	52.01	51.23	52.01	10.99	753.84	y	795.4
	12	21.37	51.44	51.89	51.42	52.08	51.43	51.99	10.88	734.65	y	563.7
	13	20.80	51.35	51.98	51.38	51.99	51.37	51.99	10.83	719.27	y	544.6
	14	23.40	52.03	51.34	52.20	51.50	52.12	51.42	11.23	777.57	y	700.0
	15	22.30	51.92	51.24	51.97	51.44	51.95	51.34	11.14	750.62	y	695.7
	16	21.90	51.98	51.29	52.00	51.33	51.99	51.31	11.14	736.95	y	645.8
	17	20.40	51.91	51.96	50.25	51.97	51.08	51.97	11.02	697.41	y	443.7
	18	21.40	50.14	51.96	50.20	51.99	50.17	51.98	11.00	746.08	y	847.6
	19	20.10	50.05	51.94	50.14	51.95	50.10	51.95	11.11	695.25	y	573.6
	20	21.20	50.00	51.99	50.08	51.94	50.04	51.97	11.22	726.63	y	736.8
	21	22.00	51.99	51.32	52.03	51.33	52.01	51.33	11.12	741.14	y	272.6
	22	23.30	52.12	51.32	52.01	51.23	52.07	51.28	10.98	794.88	y	876.7
	23	23.10	51.90	51.25	51.93	51.26	51.92	51.26	11.02	787.77	y	633.4
	24	19.90	52.05	50.15	51.96	50.06	52.01	50.11	11.24	679.45	y	650.6
	25	23.90	51.97	49.95	51.97	50.02	51.97	49.99	11.24	818.54	y	574.8
	26	24.90	52.05	50.14	51.98	50.21	52.02	50.18	11.15	855.67	y	852.8
	27	23.40	52.00	50.29	52.00	49.89	52.00	50.09	11.19	802.84	y	551.9
	28	23.70	51.94	51.21	51.86	51.29	51.90	51.25	10.86	820.46	y	895.1
	29	22.90	52.08	51.35	52.00	51.29	52.04	51.32	10.83	791.74	y	718.5
	30	21.30	51.83	50.07	51.97	49.94	51.90	50.01	11.19	733.45	y	529.7

IB test for GI

GN Guadua Node
GI Guadua Internode

g = Board type (GI)
b = Board No. (1,2,3,4,5,6)
r = Replication (Sample ID)

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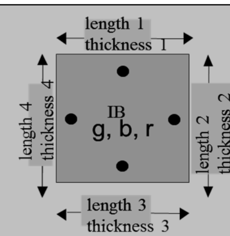

		Specimen Characteristics										
Board No.	Sample ID	Mass (gm)	Length 1 (mm)	Length 2 (mm)	Length 3 (mm)	Length 4 (mm)	Average length13 (mm)	Average length24 (mm)	Thickness (mm)	Density (kg/m^3)	Valid test (y or n)	Stress (KPa)
GI3	1	21.67	51.20	52.07	51.31	52.00	51.26	52.04	11.21	724.81	y	659.5
	2	20.58	51.18	52.05	51.23	51.99	51.21	52.02	11.20	689.83	y	615.9
	3	20.98	51.24	51.97	51.35	52.00	51.30	51.99	11.24	699.98	y	786.2
	4	21.93	51.95	51.25	51.89	51.35	51.92	51.30	11.18	736.45	y	652.3
	5	20.02	52.02	51.27	51.94	51.32	51.98	51.30	11.23	668.61	y	622.6
	6	21.88	52.07	51.42	51.90	51.35	51.99	51.39	11.18	732.64	y	636.9
	7	24.04	52.00	51.32	51.93	51.29	51.97	51.31	11.21	804.37	y	819.1
	8	22.83	52.04	51.29	52.08	51.35	52.06	51.32	11.39	750.22	y	775.5
	9	27.73	52.03	51.17	52.04	51.23	52.04	51.20	11.34	917.85	y	1050.0
	10	25.14	52.06	51.13	52.04	51.17	52.05	51.15	11.34	832.69	y	968.1
	11	24.80	51.87	51.59	52.02	51.23	51.95	51.41	11.17	831.39	y	813.7
	12	26.45	51.07	52.05	51.15	52.08	51.11	52.07	10.98	905.26	y	991.2
	13	22.53	51.15	52.04	51.14	52.05	51.15	52.05	11.10	762.53	y	736.3
	14	20.79	51.27	52.11	51.19	52.13	51.23	52.12	11.22	693.96	y	711.7
	15	21.52	50.92	51.94	50.95	52.15	50.94	52.05	11.35	715.24	y	642.1
	16	19.59	50.89	51.95	50.85	51.93	50.87	51.94	11.47	646.41	y	527.3
	17	18.48	51.91	51.22	51.86	51.26	51.89	51.24	11.65	596.66	y	425.2
	18	23.30	52.04	51.24	52.05	51.25	52.05	51.25	11.70	746.69	y	698.5
	19	21.03	52.00	51.27	52.11	51.27	52.06	51.27	11.66	675.79	y	537.9
	20	23.96	52.04	51.26	52.06	51.23	52.05	51.25	11.74	765.15	y	759.9
	21	27.66	52.02	51.26	52.02	51.28	52.02	51.27	11.70	886.41	y	816.2
	22	25.28	52.02	51.23	51.99	51.18	52.01	51.21	11.73	809.32	y	815.6
	23	20.99	51.96	51.22	52.00	51.19	51.98	51.21	11.63	678.08	y	400.0
	24	24.14	51.97	51.11	52.00	51.12	51.99	51.12	11.62	781.82	y	549.1
	25	25.15	51.97	51.15	51.99	51.12	51.98	51.14	11.58	817.10	y	720.8
	26	24.26	51.92	51.11	51.99	51.15	51.96	51.13	11.55	790.69	y	898.8
	27	23.71	51.93	51.10	52.04	51.09	51.99	51.10	11.57	771.51	y	771.9
	28	28.35	52.07	51.33	52.02	51.32	52.05	51.33	11.37	933.44	y	1010.8
	29	26.00	52.09	51.51	52.06	51.34	52.08	51.43	11.21	866.09	y	923.1
	30	25.67	52.05	51.26	52.02	51.32	52.04	51.29	11.36	846.68	y	940.5

IB test for GI

GN Guadua Node
GI Guadua Internode

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b = Board No. (1,2,3,4,5,6)
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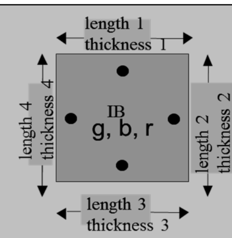

y = valid test, failure across the overlap length, or
n = either no failure occurred or the end tabs

Board No.	Sample ID	Specimen Characteristics										
		Mass	Length				Average length13	Average length24	Thickness	Density	Valid test	Stress
			1	2	3	4						
		(gm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(kg/m^3)	(y or n)	(KPa)
GI4	1	23.03	51.02	51.88	51.03	51.99	51.03	51.94	11.15	779.43	y	825.1
	2	22.35	51.14	51.80	51.08	51.89	51.11	51.85	11.19	753.76	y	685.0
	3	22.83	51.15	51.94	51.26	51.92	51.21	51.93	11.33	757.78	y	787.7
	4	22.40	51.29	51.87	51.24	51.95	51.27	51.91	11.27	746.88	y	994.9
	5	23.70	50.75	51.94	50.88	51.92	50.82	51.93	11.15	805.50	y	864.3
	6	26.08	50.87	51.88	50.91	51.89	50.89	51.89	11.10	889.84	y	918.7
	7	22.73	50.93	51.98	51.02	51.87	50.98	51.93	11.13	771.56	y	914.3
	8	23.23	51.93	51.24	51.98	51.25	51.96	51.25	11.17	781.12	y	704.5
	9	21.77	51.84	51.09	51.90	51.31	51.87	51.20	11.17	733.87	y	741.8
	10	18.22	51.90	51.11	51.85	51.09	51.88	51.10	11.20	613.69	y	493.1
	11	21.32	50.99	51.78	51.09	51.83	51.04	51.81	11.18	721.21	y	693.4
	12	22.64	51.76	50.71	51.86	50.77	51.81	50.74	11.03	780.79	y	973.8
	13	22.41	51.86	50.89	51.94	50.96	51.90	50.93	11.16	759.76	y	700.8
	14	21.26	51.85	50.79	51.92	50.87	51.89	50.83	11.11	725.58	y	820.5
	15	27.48	51.16	51.86	51.10	51.98	51.13	51.92	11.61	891.61	y	656.8
	16	22.13	51.13	51.92	51.03	51.93	51.08	51.93	11.23	742.98	y	722.0
	17	25.95	50.95	51.87	50.91	51.88	50.93	51.88	11.10	884.88	y	963.3
	18	25.02	51.92	51.05	52.03	51.02	51.98	51.04	11.70	806.19	y	953.8
	19	25.12	51.91	51.03	51.90	51.04	51.91	51.04	11.82	802.28	y	823.6
	20	23.55	51.96	51.04	51.92	51.13	51.94	51.09	11.79	752.80	y	820.8
	21	21.01	51.93	50.93	51.94	50.87	51.94	50.90	11.78	674.69	y	435.1
	22	23.76	50.82	51.88	50.87	51.86	50.85	51.87	11.25	800.81	y	705.6
	23	25.45	50.97	51.95	50.94	51.87	50.96	51.91	11.44	841.05	y	983.0
	24	19.26	51.86	50.93	51.94	50.89	51.90	50.91	11.61	627.85	y	587.1
	25	19.97	51.89	50.90	51.86	50.94	51.88	50.92	11.68	647.27	y	535.3
	26	18.20	51.92	50.90	51.98	50.86	51.95	50.88	11.43	602.41	y	497.1
	27	20.14	51.93	50.91	51.98	50.94	51.96	50.93	11.60	656.21	y	505.9
	28	21.93	51.26	51.82	51.46	51.90	51.36	51.86	11.33	726.69	y	798.5
	29	25.55	51.12	51.95	51.20	52.08	51.16	52.02	11.37	844.44	y	921.5
	30	28.28	51.10	51.99	51.08	51.97	51.09	51.98	11.29	943.22	y	757.3

IB test for GI

GN Guadua Node
GI Guadua Internode

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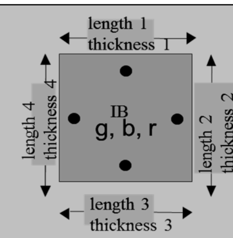

y = valid test, failure across the overlap length, or
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		Specimen Characteristics										
Board No.	Sample ID	Mass (gm)	Length 1 (mm)	Length 2 (mm)	Length 3 (mm)	Length 4 (mm)	Average length13 (mm)	Average length24 (mm)	Thickness (mm)	Density (kg/m^3)	Valid test (y or n)	Stress (KPa)
GI5	1	18.23	51.94	50.91	51.92	50.89	51.93	50.90	11.38	606.05	y	447.4
	2	20.60	51.95	50.80	51.95	50.93	51.95	50.87	11.45	680.86	y	545.1
	3	20.08	51.92	50.90	51.87	50.92	51.90	50.91	11.47	662.63	y	625.3
	4	24.13	52.00	51.29	51.80	51.26	51.90	51.28	11.42	794.00	y	859.9
	5	22.38	52.00	51.27	51.87	51.45	51.94	51.36	11.36	738.58	y	646.6
	6	25.24	51.94	51.39	51.98	51.37	51.96	51.38	11.37	831.51	y	947.6
	7	22.92	51.95	51.36	51.99	51.29	51.97	51.33	11.40	753.75	y	754.3
	8	19.90	51.89	51.28	51.96	51.29	51.93	51.29	11.26	663.66	y	477.9
	9	20.54	51.92	51.25	51.82	51.09	51.87	51.17	11.31	684.24	y	586.7
	10	23.66	51.93	51.39	51.91	51.34	51.92	51.37	11.38	779.60	y	641.9
	11	28.52	51.76	50.60	52.00	50.77	51.88	50.69	11.82	917.60	y	859.4
	12	24.70	51.89	50.82	51.92	50.82	51.91	50.82	11.78	794.89	y	540.8
	13	23.80	51.90	50.83	51.98	50.83	51.94	50.83	11.87	759.46	y	814.1
	14	24.91	51.90	51.18	51.97	51.14	51.94	51.16	11.77	796.54	y	675.7
	15	27.20	51.93	51.10	51.88	51.12	51.91	51.11	11.82	867.43	y	785.7
	16	24.59	51.97	51.05	51.88	50.98	51.93	51.02	11.89	780.73	y	632.9
	17	25.44	51.89	50.98	51.90	50.90	51.90	50.94	11.85	812.11	y	798.5
	18	25.69	51.06	51.99	51.15	51.99	51.11	51.99	11.58	834.97	y	669.0
	19	27.61	50.93	51.94	50.92	51.97	50.93	51.96	11.64	896.51	y	915.6
	20	20.80	51.88	50.90	51.95	50.83	51.92	50.87	11.43	689.14	y	587.7
	21	22.94	51.39	51.97	51.16	51.96	51.28	51.97	11.54	746.06	y	674.8
	22	21.15	51.22	51.94	51.17	51.86	51.20	51.90	11.46	694.59	y	493.4
	23	22.42	51.20	51.86	51.08	51.84	51.14	51.85	11.47	737.16	y	643.1
	24	22.88	50.75	51.85	50.85	51.96	50.80	51.91	11.66	744.19	y	687.7
	25	22.97	50.80	51.98	50.92	52.03	50.86	52.01	11.62	747.37	y	726.6
	26	26.65	52.01	51.32	51.82	51.25	51.92	51.29	11.30	885.80	y	789.8
	27	18.88	50.83	51.94	50.97	51.99	50.90	51.97	11.55	618.00	y	415.5
	28	21.92	51.90	50.98	51.95	50.93	51.93	50.96	11.45	723.56	y	673.2
	29	19.55	50.87	51.93	50.88	51.83	50.88	51.88	11.71	632.54	y	399.0
	30	19.19	51.99	50.90	51.89	51.05	51.94	50.98	11.27	643.12	y	500.5

IB test for GI

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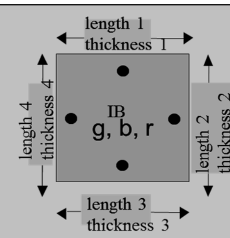


y = valid test, failure across the overlap length, or
n = either no failure occurred or the end tabs

Board No.	Sample ID	Mass (gm)	Length 1 (mm)	Length 2 (mm)	Length 3 (mm)	Length 4 (mm)	Average length13 (mm)	Average length24 (mm)	Thickness (mm)	Density (kg/m^3)	Valid test (y or n)	Stress (KPa)
GI6	1	24.50	51.25	51.84	51.26	51.81	51.26	51.83	11.37	811.20	y	678.5
	2	23.96	51.93	51.07	51.90	51.17	51.92	51.12	11.68	772.97	y	600.4
	3	23.73	51.87	51.13	51.88	51.09	51.88	51.11	11.79	759.14	y	573.6
	4	22.31	51.89	51.44	51.96	51.32	51.93	51.38	11.23	744.64	y	657.2
	5	24.42	51.96	51.30	51.90	51.30	51.93	51.30	11.36	806.92	y	696.0
	6	26.49	51.87	51.24	51.88	51.30	51.88	51.27	11.36	876.76	y	800.0
	7	23.49	51.87	51.22	51.90	51.25	51.89	51.24	11.39	775.80	y	538.5
	8	24.06	51.93	51.26	51.86	51.22	51.90	51.24	11.35	797.20	y	569.4
	9	25.18	51.85	51.30	51.88	51.33	51.87	51.32	11.42	828.46	y	765.6
	10	24.83	51.96	51.02	51.89	51.06	51.93	51.04	11.93	785.32	y	636.4
	11	28.01	51.98	51.17	51.91	51.13	51.95	51.15	11.82	891.88	y	824.4
	12	25.91	51.92	51.21	51.92	51.20	51.92	51.21	11.56	843.07	y	801.8
	13	26.60	51.86	51.24	51.95	51.23	51.91	51.24	11.49	870.53	y	821.5
	14	23.32	51.94	51.26	51.91	51.22	51.93	51.24	11.42	767.50	y	606.2
	15	24.43	51.92	51.26	51.87	51.37	51.90	51.32	11.64	788.14	y	762.6
	16	23.70	51.97	51.28	51.88	51.22	51.93	51.25	11.58	769.08	y	686.8
	17	21.88	51.95	51.29	51.95	51.33	51.95	51.31	11.47	715.64	y	587.5
	18	27.22	51.18	52.00	51.14	52.00	51.16	52.00	11.43	895.18	y	844.4
	19	23.62	51.26	51.96	51.19	52.01	51.23	51.99	11.38	779.43	y	462.5
	20	22.28	51.21	51.99	51.23	51.98	51.22	51.99	11.59	721.96	y	519.2
	21	23.98	51.24	52.00	51.31	51.94	51.28	51.97	11.53	780.48	y	469.2
	22	21.52	51.27	51.98	51.24	52.02	51.26	52.00	11.51	701.50	y	429.3
	23	28.85	51.30	52.06	51.32	51.94	51.31	52.00	11.49	941.07	y	834.2
	24	24.77	51.32	51.93	51.37	51.90	51.35	51.92	11.60	801.08	y	702.9
	25	18.36	51.02	51.83	51.02	51.77	51.02	51.80	11.59	599.40	y	600.3
	26	18.58	51.00	51.99	51.19	51.96	51.10	51.98	11.30	619.15	y	449.7
	27	17.99	51.00	52.00	51.02	51.84	51.01	51.92	11.34	599.00	y	347.0
	28	19.01	51.80	51.10	51.79	51.10	51.80	51.10	11.58	620.25	y	601.3
	29	22.65	51.89	51.10	51.90	51.00	51.90	51.05	11.97	714.25	y	532.2
	30	22.93	51.88	51.00	51.85	51.13	51.87	51.07	11.84	731.23	y	695.3

Flexural Properties Test has 4 specimens per board, total 144 specimens

Data Sheet for MOR/MOE - GM/MM perpendicular

Board type:

GM GuaduaMixed

MM MosoMixed

Mixed means internode and node mixed

Sample ID:

1,3 perpendicular

2,4 parallel

MOR=3*PeakLoad*LengthOfSpan/(2*width*thickness^2)

MOE=LengthOfSpan$^{3/}$Slope/(4*width*thickness^3)

Slope = (P_{max}-P_{min})/(Y_{max}-Y_{min})

Board type	Board No.	Sample ID	Length of span (mm)	Width (mm)	Thickness 1 (mm)	Thickness 2 (mm)	Thickness 3 (mm)	Thickness 4 (mm)	Average thickness (mm)	Results: MOR MPa	MOE GPa	PEAK LOAD N	Slope N/mm	P_{max} N	y_{max} mm	P_{min} N	y_{min} mm
GM	GM1	1	240	76.27	11.24	11.34	11.31	11.24	11.28	14.2387	1.0477	384.00	33.21	198.00	6.030	110.00	3.380
		3	240	76.18	11.34	11.54	11.26	11.15	11.32	14.7816	1.3487	401.00	43.15	216.00	4.860	112.00	2.450
	GM2	1	240	75.20	11.26	11.37	11.53	11.24	11.35	23.1516	1.7749	623.00	56.47	285.00	5.070	106.00	1.900
		3	240	76.17	11.32	11.10	11.40	11.46	11.32	20.7282	1.9021	562.00	60.81	293.00	5.020	113.00	2.060
	GM3	1	240	76.35	11.32	10.97	11.25	11.73	11.32	23.7071	2.7700	644.00	88.71	333.00	3.920	113.00	1.440
		3	240	76.87	11.59	11.51	11.59	11.56	11.56	24.4861	2.2241	699.00	76.47	320.00	4.240	112.00	1.520
	GM4	1	240	76.14	11.03	11.06	11.21	11.06	11.09	16.2233	1.8340	422.00	55.11	239.00	4.330	115.00	2.080
		3	240	76.25	11.49	11.37	11.58	11.54	11.50	24.4042	1.9413	683.00	65.06	344.00	5.310	115.00	1.790
	GM5	1	240	76.25	11.41	11.36	11.65	11.53	11.49	23.4701	2.0645	656.00	69.05	256.00	3.770	111.00	1.670
		3	240	76.17	10.92	11.26	11.11	10.90	11.05	26.8751	2.3996	694.00	71.31	278.00	4.020	109.00	1.650
	GM6	1	240	76.12	11.60	11.71	11.50	11.40	11.55	24.3449	2.1345	687.00	72.49	355.00	4.960	110.00	1.580
		3	240	76.04	11.19	11.33	11.36	11.14	11.26	26.7971	2.4763	717.00	77.68	307.00	4.050	133.00	1.810
MM	MM1	1	240	75.36	11.03	11.26	11.10	11.01	11.10	16.0515	2.0442	414.00	60.96	226.00	3.690	112.00	1.820
		3	240	76.40	11.82	11.86	11.64	11.79	11.78	25.3421	2.1300	746.00	76.92	320.00	4.280	110.00	1.550
	MM2	1	240	76.04	11.68	11.46	11.67	11.84	11.66	12.9137	1.6346	371.00	57.05	201.00	3.480	112.00	1.920
		3	240	76.13	11.53	11.34	11.24	11.20	11.33	21.6330	2.0999	587.00	67.23	229.00	3.360	110.00	1.590
	MM3	1	240	76.26	11.30	11.47	11.27	11.44	11.37	25.5978	2.4777	701.00	80.36	331.00	4.070	110.00	1.320
		3	240	75.74	11.52	11.41	12.51	11.68	11.78	20.2772	2.1606	592.00	77.40	271.00	3.520	110.00	1.440
	MM4	1	240	76.32	11.75	11.73	11.92	11.81	11.80	21.7057	2.0819	641.00	75.59	273.00	3.650	112.00	1.520
		3	240	75.97	11.36	11.36	11.40	11.35	11.37	14.6320	1.6550	399.00	53.44	212.00	4.130	111.00	2.240
	MM5	1	240	75.95	11.66	11.75	11.75	11.71	11.72	15.5697	2.0906	451.00	73.91	247.00	3.450	111.00	1.610
		3	240	76.24	11.26	11.32	11.25	11.17	11.25	12.7597	1.6343	342.00	51.33	188.00	3.640	111.00	2.140
	MM6	1	240	76.13	11.68	11.53	11.44	11.55	11.55	36.7943	3.2122	1038.00	109.03	406.00	3.940	104.00	1.170
		3	240	75.92	11.25	11.56	11.30	11.39	11.38	19.6797	2.4713	537.00	79.90	278.00	3.600	115.00	1.560

Data Sheet for MOR/MOE - GM/MM parallel

Board type:

GM GuaduaMixed

MM MosoMixed

Mixed means internode and node mixed

Sample ID:

1,3 perpendicular

2,4 parallel

MOR=3*PeakLoad*LengthOfSpan/(2*width*thickness^2)

MOE=LengthOfSpan^{3}/Slope/(4*width*thickness^3)

Slope = $(P_{max}-P_{min})/(Y_{max}-Y_{min})$

Board type	Board No.	Sample ID	Length of span (mm)	Width (mm)	Thickness 1 (mm)	Thickness 2 (mm)	Thickness 3 (mm)	Thickness 4 (mm)	Average thickness (mm)	Results: MOR MPa	MOE GPa	PEAK LOAD N	Slope N/mm	P_{max} N	y_{max} mm	P_{min} N	y_{min} mm
GM	GM1	2	240	76.29	11.40	11.28	11.52	11.37	11.39	53.7367	9.8687	1478.00	322.12	1053.00	3.470	383.00	1.390
		4	240	76.65	11.64	11.63	11.75	11.52	11.64	38.4412	7.8071	1108.00	272.73	450.00	1.760	120.00	0.550
	GM2	2	240	75.93	11.17	11.10	11.21	11.05	11.13	61.3250	10.7473	1603.00	325.77	850.00	2.720	534.00	1.750
		4	240	76.29	11.83	11.67	11.43	11.77	11.68	80.4904	11.0799	2325.00	389.22	1469.00	3.860	566.00	1.540
	GM3	2	240	75.38	11.56	11.34	11.50	11.71	11.53	51.1783	9.3462	1424.00	312.26	441.00	1.450	110.00	0.390
		4	240	77.24	11.07	11.04	11.10	11.13	11.09	64.5198	12.3375	1701.00	375.58	440.00	1.210	117.00	0.350
	GM4	2	240	76.07	11.43	11.58	11.55	11.62	11.55	53.8980	9.5040	1518.00	321.90	432.00	1.360	94.00	0.310
		4	240	76.12	11.11	11.05	11.12	10.98	11.07	72.4273	13.0595	1875.00	389.68	1134.00	2.890	530.00	1.340
	GM5	2	240	76.15	11.06	11.09	11.04	11.00	11.05	68.4836	10.7075	1768.00	318.11	830.00	2.790	426.00	1.520
		4	240	76.31	11.73	11.69	11.90	11.78	11.78	66.2468	9.5149	1947.00	343.00	452.00	1.440	109.00	0.440
	GM6	2	240	76.35	11.60	11.50	11.51	11.45	11.52	72.2230	10.7897	2031.00	363.95	953.00	2.630	418.00	1.160
		4	240	76.75	11.60	11.18	11.28	11.36	11.36	88.4008	11.7055	2430.00	380.59	1264.00	3.370	617.00	1.670
MM	MM1	2	240	75.97	11.76	11.78	11.84	11.52	11.73	77.8665	8.2477	2259.00	292.24	444.00	1.620	105.00	0.460
		4	240	76.07	11.44	11.29	11.36	11.16	11.31	74.1088	9.2466	2004.00	294.64	442.00	1.620	112.00	0.500
	MM2	2	240	75.95	11.83	12.04	11.95	11.76	11.90	61.7741	8.9938	1844.00	332.65	443.00	1.340	117.00	0.360
		4	240	76.04	11.42	11.32	11.46	11.46	11.42	64.9282	7.6160	1787.00	249.24	433.00	1.820	104.00	0.500
	MM3	2	240	76.12	11.52	11.52	11.70	11.55	11.57	47.4623	7.2902	1344.00	248.85	445.00	1.800	119.00	0.490
		4	240	75.73	11.94	11.92	12.03	11.96	11.96	65.7078	8.0204	1978.00	300.85	461.00	1.750	109.00	0.580
	MM4	2	240	75.87	11.73	11.47	11.68	11.82	11.68	62.9734	7.6026	1809.00	265.60	436.00	1.750	104.00	0.500
		4	240	76.55	11.78	11.51	11.76	11.70	11.69	53.6047	7.2059	1557.00	254.81	446.00	1.790	102.00	0.440
	MM5	2	240	75.97	11.71	11.83	11.86	11.58	11.75	63.7920	8.5001	1857.00	302.73	448.00	1.600	115.00	0.500
		4	240	76.24	11.48	11.25	11.54	11.73	11.50	57.3773	6.6772	1607.00	224.03	447.00	2.100	102.00	0.560
	MM6	2	240	76.19	11.50	11.36	11.56	11.48	11.48	65.5957	8.0862	1828.00	269.35	446.00	1.750	112.00	0.510
		4	240	75.91	11.64	11.71	11.73	11.69	11.69	83.9121	8.5825	2419.00	301.34	825.00	2.850	376.00	1.360

Data Sheet for MOR/MOE - MH/ML perpendicular

Board type:

MH	Moso High Density
ML	Moso Low Density

Sample ID:

1,3	perpendicular
2,4	parallel

$MOR=3*PeakLoad*LengthOfSpan/(2*width*thickness^2)$

$MOE=LengthOfSpan^{3}/Slope/(4*width*thickness^3)$

$Slope = (P_{max}-P_{min})/(Y_{max}-Y_{min})$

Board type	Board No.	Sample ID	Length of span (mm)	Width (mm)	Thickness 1 (mm)	Thickness 2 (mm)	Thickness 3 (mm)	Thickness 4 (mm)	Average thickness (mm)	Results: MOR MPa	MOE GPa	PEAK LOAD N	Slope N/mm	P_{max} N	y_{max} mm	P_{min} N	y_{min} mm
MH	MH1	1	240	75.95	11.64	11.43	11.38	11.40	11.46	29.8708	3.1384	828.00	103.87	399.00	4.020	104.00	1.180
		3	240	76.06	11.35	11.37	11.42	11.76	11.48	26.7432	2.9102	744.00	96.77	381.00	4.460	111.00	1.670
	MH2	1	240	75.94	11.39	11.30	11.37	11.37	11.36	19.5147	2.4070	531.00	77.49	259.00	3.380	111.00	1.470
		3	240	76.17	11.49	11.51	11.54	11.69	11.56	20.8404	2.4959	589.00	84.92	281.00	3.450	112.00	1.460
	MH3	1	240	76.38	11.86	12.58	11.76	11.83	12.01	36.8746	3.6179	1128.00	138.43	434.00	3.160	117.00	0.870
		3	240	76.15	11.03	10.98	11.15	11.06	11.06	24.1766	2.6336	625.00	78.40	302.00	3.860	106.00	1.360
	MH4	1	240	76.58	11.32	11.50	11.48	11.46	11.44	16.8105	2.3614	468.00	78.34	281.00	3.690	111.00	1.520
		3	240	75.98	11.35	11.27	11.56	11.14	11.33	18.6395	2.5856	505.00	82.68	267.00	3.371	109.00	1.460
	MH5	1	240	76.24	11.20	11.22	11.27	11.67	11.34	28.8980	2.7887	787.00	89.71	326.00	3.630	108.00	1.200
		3	240	75.95	11.50	11.98	11.55	11.71	11.69	29.5078	3.2442	850.00	113.75	387.00	3.390	114.00	0.990
	MH6	1	240	76.03	11.21	11.15	11.36	11.36	11.27	23.1505	2.3490	621.00	73.97	273.00	3.570	111.00	1.380
		3	240	76.11	11.42	11.43	11.47	11.29	11.40	17.5351	2.1480	482.00	70.13	219.00	3.050	111.00	1.510
ML	ML1	1	240	76.03	11.42	11.36	11.33	11.38	11.37	21.5636	2.8309	589.00	91.60	233.00	2.540	113.00	1.230
		3	240	76.00	11.15	11.18	11.08	10.94	11.09	22.0788	2.5176	573.00	75.46	273.00	3.540	110.00	1.380
	ML2	1	240	76.25	11.65	11.48	11.47	11.67	11.57	19.4065	2.4429	550.00	83.42	264.00	3.140	108.00	1.270
		3	240	75.01	11.28	11.29	11.37	11.22	11.29	21.0102	2.5640	558.00	80.08	299.00	3.820	110.00	1.460
	ML3	1	240	76.22	11.38	11.52	11.37	11.62	11.47	20.2035	2.0019	563.00	66.67	224.00	3.160	112.00	1.480
		3	240	75.94	11.34	11.42	11.56	11.60	11.48	17.1220	1.6407	476.00	54.55	191.00	3.240	113.00	1.810
	ML4	1	240	76.33	10.88	10.90	10.93	11.19	10.98	20.2828	2.9700	518.00	86.71	238.00	2.700	114.00	1.270
		3	240	76.37	11.38	11.90	11.24	11.38	11.48	21.5154	2.5724	601.00	85.89	324.00	3.710	117.00	1.300
	ML5	1	240	76.15	11.31	11.22	11.23	11.48	11.31	23.0987	3.0006	625.00	95.65	287.00	3.070	111.00	1.230
		3	240	76.35	11.09	11.34	11.06	10.90	11.10	19.7174	2.0175	515.00	60.91	227.00	3.630	107.00	1.660
	ML6	1	240	76.24	11.09	10.93	11.10	11.21	11.08	22.9519	2.4316	597.00	73.02	249.00	3.580	111.00	1.690
		3	240	76.12	11.39	11.51	11.25	11.09	11.31	15.6763	1.9014	424.00	60.59	216.00	3.450	113.00	1.750

Data Sheet for MOR/MOE - MH/ML parallel

Board type:

MH Moso High Density

ML Moso Low Density

Sample ID:

1,3 perpendicular

2,4 parallel

$MOR=3*PeakLoad*LengthOfSpan/(2*width*thickness^2)$

$MOE=LengthOfSpan^{3/}Slope/(4*width*thickness^3)$

$Slope = (P_{max}-P_{min})/(Y_{max}-Y_{min})$

Board type	Board No.	Sample ID	Length of span (mm)	Width (mm)	Thickness 1 (mm)	Thickness 2 (mm)	Thickness 3 (mm)	Thickness 4 (mm)	Average thickness (mm)	Results: MOR MPa	MOE GPa	PEAK LOAD N	Slope N/mm	P_{max} N	y_{max} mm	P_{min} N	y_{min} mm
MH	MH1	2	240	75.23	12.03	11.96	12.11	12.26	12.09	37.9112	6.5960	1158.00	253.73	445.00	1.780	105.00	0.440
		4	240	75.73	11.15	11.08	11.37	11.26	11.22	57.7888	8.0419	1529.00	248.57	453.00	1.830	105.00	0.430
	MH2	2	240	76.34	11.56	11.77	11.65	11.58	11.64	53.8437	6.7247	1547.00	234.27	443.00	2.000	108.00	0.570
		4	240	76.32	11.54	11.73	11.52	11.57	11.59	40.6636	6.0111	1158.00	206.67	451.00	2.270	110.00	0.620
	MH3	2	240	76.32	11.41	11.88	11.68	11.36	11.58	63.9576	7.9437	1819.00	272.58	446.00	1.720	108.00	0.480
		4	240	75.55	11.80	11.53	12.03	11.75	11.78	50.6360	6.6996	1474.00	239.26	434.00	1.930	111.00	0.580
	MH4	2	240	76.31	11.72	12.00	11.97	11.68	11.84	63.0382	7.7188	1874.00	283.06	454.00	1.620	103.00	0.380
		4	240	76.16	11.26	11.11	11.30	11.22	11.22	69.7711	8.0631	1859.00	251.15	435.00	1.910	106.00	0.600
	MH5	2	240	76.07	11.81	12.00	11.76	11.72	11.82	70.1891	8.5446	2073.00	310.78	432.00	1.480	115.00	0.460
		4	240	76.25	11.42	11.37	11.59	11.57	11.49	61.7880	7.6086	1727.00	254.48	455.00	1.870	114.00	0.530
	MH6	2	240	75.88	11.55	11.55	11.75	11.63	11.62	69.6764	7.6938	1983.00	265.04	434.00	1.670	108.00	0.440
		4	240	76.19	11.35	11.50	11.51	12.05	11.60	69.8130	7.5741	1989.00	260.80	433.00	1.670	107.00	0.420
ML	ML1	2	240	76.19	11.64	11.42	11.54	11.66	11.57	49.9885	7.0851	1415.00	241.61	444.00	1.900	113.00	0.530
		4	240	75.28	11.33	11.30	11.47	11.29	11.35	57.5644	7.1905	1550.00	228.86	445.00	1.990	104.00	0.500
	ML2	2	240	76.35	11.52	11.50	11.60	11.69	11.58	42.1777	5.0088	1199.00	171.72	447.00	2.680	107.00	0.700
		4	240	75.13	11.85	11.53	11.37	11.63	11.60	46.9033	6.0806	1316.00	206.06	444.00	2.180	104.00	0.530
	ML3	2	240	76.66	11.73	11.71	11.62	11.91	11.74	27.4163	4.9998	805.00	179.57	443.00	2.550	109.00	0.690
		4	240	76.13	10.89	11.22	10.94	10.98	11.01	43.5545	6.2146	1116.00	182.58	434.00	2.420	109.00	0.640
	ML4	2	240	76.35	11.27	11.08	10.98	11.03	11.09	43.8971	5.9702	1145.00	179.89	453.00	2.610	113.00	0.720
		4	240	76.31	11.69	11.67	11.80	11.60	11.69	47.0185	6.1762	1362.00	217.86	441.00	2.200	136.00	0.800
	ML5	2	240	76.12	10.91	10.65	10.99	11.13	10.92	40.1364	6.6246	1012.00	190.00	447.00	2.470	105.00	0.670
		4	240	76.01	11.72	11.79	11.77	11.85	11.78	57.2124	6.3314	1677.00	227.78	438.00	2.010	110.00	0.570
	ML6	2	240	76.08	11.82	12.00	11.89	11.82	11.88	33.9154	5.2379	1012.00	193.45	439.00	2.350	114.00	0.670
		4	240	76.18	11.08	11.04	11.09	11.10	11.08	41.0136	5.6414	1065.00	169.04	446.00	2.750	113.00	0.780

Data Sheet for MOR/MOE - GN/GI perpendicular

Board type:

- GN Guadua Node
- GI Guadua Internode

Sample ID:

- 1,3 perpendicular
- 2,4 parallel

$MOR=3*PeakLoad*LengthOfSpan/(2*width*thickness^{2})$

$MOE=LengthOfSpan^{3/}Slope/(4*width*thickness^{3})$

$Slope = (P_{max}-P_{min})/(Y_{max}-Y_{min})$

Board type	Board No.	Sample ID	Length of span (mm)	Width (mm)	Thickness 1 (mm)	Thickness 2 (mm)	Thickness 3 (mm)	Thickness 4 (mm)	Average thickness (mm)	Results: MOR MPa	MOE GPa	PEAK LOAD N	Slope N/mm	P_{max} N	y_{max} mm	P_{min} N	y_{min} mm
GN	GN1	1	240	76.01	11.16	11.33	11.20	11.15	11.21	19.9378	2.0237	529.00	62.70	269.00	4.290	111.00	1.770
		3	240	75.77	11.14	11.11	11.07	11.58	11.23	23.9445	2.6386	635.00	81.82	297.00	3.860	108.00	1.550
	GN2	1	240	75.99	11.27	11.73	11.36	11.18	11.39	28.3258	2.7512	775.00	89.27	321.00	3.850	113.00	1.520
		3	240	76.47	10.98	10.92	10.90	11.14	10.99	9.9874	1.2247	256.00	35.92	177.00	4.240	140.00	3.210
	GN3	1	240	76.12	11.74	11.86	11.73	11.69	11.76	14.3750	1.4301	420.00	51.16	207.00	3.810	141.00	2.520
		3	240	76.02	11.56	11.31	11.49	11.51	11.47	19.6981	1.9540	547.00	64.81	252.00	3.980	112.00	1.820
	GN4	1	240	75.94	11.28	11.30	11.36	11.36	11.33	23.3230	2.3931	631.00	76.38	300.00	4.060	106.00	1.520
		3	240	76.23	11.77	11.94	11.61	11.61	11.73	23.5696	2.4416	687.00	86.98	298.00	3.430	111.00	1.280
	GN5	1	240	76.03	10.87	10.90	10.71	10.81	10.82	11.8853	1.3547	294.00	37.78	164.00	4.500	113.00	3.150
		3	240	76.26	11.56	11.45	11.72	11.67	11.60	23.7508	2.2013	677.00	75.82	347.00	4.660	115.00	1.600
	GN6	1	240	75.95	11.66	11.32	11.59	11.86	11.61	13.4740	1.5644	383.00	53.77	223.00	4.370	116.00	2.380
		3	240	76.00	11.35	11.32	11.40	11.53	11.40	15.9644	1.8934	438.00	61.69	208.00	3.590	113.00	2.050
GI	GI1	1	240	76.37	11.51	11.42	11.04	11.26	11.31	27.7245	2.9667	752.00	94.78	336.00	3.680	118.00	1.380
		3	240	76.09	11.10	11.41	11.08	11.37	11.24	32.7680	3.0915	875.00	96.65	372.00	3.920	112.00	1.230
	GI2	1	240	75.82	11.01	10.99	11.22	11.00	11.06	25.8359	2.2903	665.00	67.89	278.00	4.370	111.00	1.910
		3	240	76.21	11.12	11.31	11.26	11.40	11.27	19.8142	2.0310	533.00	64.15	248.00	3.850	112.00	1.730
	GI3	1	240	75.97	11.38	11.58	11.37	11.21	11.39	32.3182	2.8907	884.00	93.77	396.00	4.170	110.00	1.120
		3	240	76.06	11.25	11.19	11.37	11.30	11.28	13.5836	1.4658	365.00	46.27	176.00	3.650	114.00	2.310
	GI4	1	240	75.57	11.38	11.50	11.41	11.22	11.38	25.6871	2.4235	698.00	78.05	358.00	4.840	102.00	1.560
		3	240	75.99	11.13	11.02	10.95	11.07	11.04	18.4935	2.0147	476.00	59.65	252.00	4.360	116.00	2.080
	GI5	1	240	76.21	11.37	11.61	11.32	11.48	11.45	12.2253	1.3898	339.00	45.95	181.00	4.330	113.00	2.850
		3	240	76.45	11.79	11.81	11.68	11.66	11.74	19.9355	1.9134	583.00	68.40	282.00	4.210	111.00	1.710
	GI6	1	240	76.00	11.52	11.77	11.81	11.40	11.63	12.2329	1.4039	349.00	48.50	193.00	4.190	112.00	2.520
		3	240	76.25	11.35	11.41	11.49	11.38	11.41	19.9909	1.8320	551.00	60.00	233.00	4.160	113.00	2.160

Data Sheet for MOR/MOE - GN/GI parallel

Board type:

GN	Guadua Node
GI	Guadua Internode

Sample ID:

1,3	perpendicular
2,4	parallel

MOR=3*PeakLoad*LengthOfSpan/(2*width*thickness^{2})

MOE=LengthOfSpan$^{3/}$Slope/(4*width*thickness^{3})

Slope = $(P_{max}-P_{min})/(Y_{max}-Y_{min})$

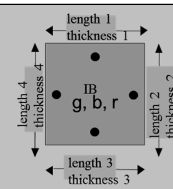
Board type	Board No.	Sample ID	Length of span (mm)	Width (mm)	Thickness 1 (mm)	Thickness 2 (mm)	Thickness 3 (mm)	Thickness 4 (mm)	Average thickness (mm)	Results: MOR MPa	MOE GPa	PEAK LOAD N	Slope N/mm	P_{max} N	y_{max} mm	P_{min} N	y_{min} mm
GN	GN1	2	240	76.22	11.62	11.70	11.60	11.59	11.63	52.9265	8.5509	1515.00	296.46	453.00	1.670	118.00	0.540
		4	240	76.24	11.31	11.20	11.09	11.06	11.17	69.0540	10.6563	1823.00	327.18	449.00	1.430	112.00	0.400
	GN2	2	240	76.10	11.03	10.99	11.00	10.91	10.98	61.4196	9.7176	1566.00	283.45	918.00	3.260	507.00	1.810
		4	240	76.23	12.01	12.04	12.15	11.99	12.05	55.1183	8.2732	1694.00	319.09	464.00	1.540	113.00	0.440
	GN3	2	240	76.14	11.66	11.68	11.67	11.73	11.69	52.3235	8.8773	1511.00	312.04	452.00	1.560	115.00	0.480
		4	240	76.19	11.89	11.70	11.95	11.89	11.86	51.6526	8.5731	1537.00	315.09	449.00	1.570	115.00	0.510
	GN4	2	240	76.00	11.75	11.67	11.77	11.60	11.70	57.3621	8.8818	1657.00	312.62	441.00	1.550	119.00	0.520
		4	240	76.41	11.60	11.73	11.59	11.61	11.63	55.6743	9.8036	1599.00	341.18	448.00	1.580	158.00	0.730
	GN5	2	240	76.35	11.45	11.05	11.77	11.36	11.41	50.8359	9.2032	1403.00	301.82	453.00	1.900	121.00	0.800
		4	240	76.40	11.48	11.52	11.33	11.35	11.42	63.4095	10.0440	1755.00	330.69	444.00	1.710	110.00	0.700
	GN6	2	240	75.67	11.24	11.11	11.18	11.36	11.22	70.6007	10.9932	1869.00	340.21	448.00	1.370	118.00	0.400
		4	240	76.18	11.77	11.75	11.74	11.78	11.76	65.1966	9.8229	1908.00	352.15	1197.00	3.560	542.00	1.700
GI	GI1	2	240	75.24	11.05	11.05	10.78	11.00	10.97	64.5694	11.0249	1624.00	316.86	836.00	2.790	291.00	1.070
		4	240	76.42	11.91	11.57	11.75	11.58	11.70	81.7650	11.6824	2377.00	414.00	1304.00	3.360	476.00	1.360
	GI2	2	240	76.37	11.20	11.17	11.15	11.38	11.23	86.1591	12.0800	2303.00	377.55	1296.00	3.630	556.00	1.670
		4	240	75.74	11.48	11.57	11.53	11.28	11.47	79.9860	11.0120	2212.00	363.70	1164.00	3.490	633.00	2.030
	GI3	2	240	75.42	11.32	11.25	11.00	11.35	11.23	68.7720	11.1447	1817.00	344.44	902.00	2.900	406.00	1.460
		4	240	76.51	11.47	11.53	11.81	11.55	11.59	83.8574	12.9386	2394.00	445.95	446.00	1.020	116.00	0.280
	GI4	2	240	76.14	11.39	11.29	11.46	11.60	11.44	83.7806	12.8341	2317.00	422.78	1327.00	3.640	566.00	1.840
		4	240	76.00	11.25	10.99	11.12	11.24	11.15	58.2949	9.8028	1530.00	298.82	985.00	3.370	477.00	1.670
	GI5	2	240	76.27	12.10	12.24	12.24	11.99	12.14	80.8980	12.9082	2527.00	510.00	1281.00	2.580	618.00	1.280
		4	240	76.20	11.54	11.43	11.63	11.40	11.50	63.5518	10.7910	1779.00	361.86	456.00	1.740	105.00	0.770
	GI6	2	240	76.19	11.63	11.41	11.79	11.60	11.61	69.3320	8.8087	1977.00	303.70	440.00	1.350	112.00	0.270
		4	240	76.37	11.87	11.76	11.99	11.90	11.88	72.7453	12.7200	2178.00	471.29	1053.00	2.560	577.00	1.550

Thickness Swelling Test has 1 specimens per boards, total 36 specimens.

Data Sheet for Thickness Swelling (GM)

GM GuaduaMixed
MM MosoMixed
Mixed means internode and node mixed

g = Board type (GM)
b = Sample ID (1,2,3,4,5,6)
r = Replication (not applicable for this test)



Factors			Specimen Characteristics															
Board type	Duration	Sample ID	Mass (g)	Length 1 (mm)	Length 2 (mm)	Length 3 (mm)	Length 4 (mm)	Average length 1.3 (mm)	Average length 2.4(mm)	Thickness 1 (mm)	Thickness 2 (mm)	Thickness 3 (mm)	Thickness 4 (mm)	Average thickness (mm)	Density (kg/m³)	Volume (cm³)	Water Absorbed By weight %	Water Absorbed By volume g/cm³
GM	0 hr	1	209.59	158.00	152.77	155.81	151.97	156.91	152.37	11.411	11.401	11.380	11.407	*11.400*	769.02	272.54		
		2	216.27	152.49	152.53	152.11	153.89	152.30	153.21	11.343	11.140	11.388	11.492	*11.341*	817.27	264.62		
		3	198.70	151.96	151.92	153.69	152.61	152.83	152.27	11.544	11.415	11.415	11.405	*11.445*	746.10	266.32		
		4	197.93	151.89	152.12	153.32	152.76	152.61	152.44	11.245	11.173	11.228	11.253	*11.225*	758.00	261.12		
		5	198.34	151.93	150.74	153.44	152.31	152.69	151.53	11.016	10.925	10.875	10.986	*10.951*	782.88	253.35		
		6	192.89	152.84	153.03	152.94	151.51	152.89	152.27	10.915	10.980	11.158	11.057	*11.028*	751.34	256.73		
	2 hrs	1	255.57							11.916	12.233	12.105	11.947	*12.050*			21.94	0.17
		2	250.83							11.846	11.764	11.999	11.992	*11.900*			15.98	0.13
		3	245.06							11.936	12.007	12.388	12.043	*12.094*			23.33	0.17
		4	236.78							11.907	11.699	11.497	11.710	*11.703*			19.63	0.15
		5	227.14							11.275	11.117	11.517	11.127	*11.259*			14.52	0.11
		6	226.38							11.210	11.326	11.491	11.530	*11.389*			17.36	0.13
	24 hrs	1	304.15							13.113	12.931	13.148	13.156	*13.087*			45.12	0.35
		2	298.39							12.857	12.820	13.141	13.147	*12.991*			37.97	0.31
		3	280.47							12.741	13.000	13.094	12.752	*12.897*			41.15	0.31
		4	268.08							12.543	12.362	12.004	12.388	*12.324*			35.44	0.27
		5	262.85							11.972	11.739	12.080	11.568	*11.840*			32.52	0.25
		6	267.50							12.151	12.119	12.147	12.219	*12.159*			38.68	0.29

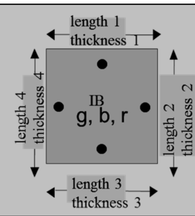
Thickness Swelling			TS 1	TS 2	TS 3	TS 4	*Average*
GM	2 hrs	1	4.43	7.30	6.37	4.73	5.71
		2	4.43	5.60	5.37	4.35	4.93
		3	3.40	5.19	8.52	5.59	5.67
		4	5.89	4.71	2.40	4.06	4.26
		5	2.35	1.76	5.90	1.28	2.82
		6	2.70	3.15	2.98	4.28	3.28
	24 hrs	1	14.92	13.42	15.54	15.33	14.80
		2	13.35	15.08	15.39	14.40	14.55
		3	10.37	13.89	14.71	11.81	12.69
		4	11.54	10.64	6.91	10.09	9.80
		5	8.68	7.45	11.08	5.30	8.12
		6	11.32	10.37	8.86	10.51	10.26

Moisture Content		Dry Oven Weight (g)	MC Before test %	MC After test %
GM	1	190.01	10.30	60.07
	2	196.30	10.17	52.01
	3	179.78	10.52	56.01
	4	179.59	10.21	49.27
	5	180.18	10.08	45.88
	6	174.78	10.36	53.05

Data Sheet for Thickness Swelling (MM)

GM GuaduaMixed
MM MosoMixed
Mixed means internode and node mixed

g = Board type (MM)
b = Sample ID (1,2,3,4,5,6)
r = Replication (not applicable for this test)



Factors			Specimen Characteristics															
Board type	Duration	Sample ID	Mass (g)	Length 1 (mm)	Length 2 (mm)	Length 3 (mm)	Length 4 (mm)	Average length 1.3 (mm)	Average length 2.4(mm)	Thickness 1 (mm)	Thickness 2 (mm)	Thickness 3 (mm)	Thickness 4 (mm)	Average thickness (mm)	Density (kg/m^3)	Volume (cm^3)	Water Absorbed By weight %	Water Absorbed By volume g/cm^3
MM	0 hr	1	216.16	152.23	151.56	151.85	152.77	152.04	152.17	11.425	11.301	11.247	11.384	*11.339*	823.98	262.34		
		2	198.28	152.04	152.38	152.45	152.40	152.25	152.39	11.735	11.750	11.729	11.596	*11.703*	730.30	271.51		
		3	202.93	152.59	152.40	151.81	152.20	152.20	152.30	11.616	11.588	11.605	11.624	*11.608*	754.16	269.08		
		4	210.94	152.90	151.90	152.08	152.07	152.49	151.99	11.400	11.463	11.548	11.412	*11.456*	794.50	265.50		
		5	212.42	152.11	152.84	151.56	152.49	151.84	152.67	11.563	11.504	11.510	11.761	*11.585*	791.06	268.53		
		6	202.14	151.99	151.63	152.47	152.18	152.23	151.91	11.375	11.315	11.378	11.531	*11.400*	766.80	263.61		
	2 hrs	1	241.32							11.755	11.443	12.058	11.508	*11.691*			11.64	0.10
		2	239.06							11.903	12.306	11.948	11.751	*11.977*			20.57	0.15
		3	231.88							11.725	11.816	11.720	11.940	*11.800*			14.27	0.11
		4	234.63							11.550	11.782	11.925	11.682	*11.735*			11.23	0.09
		5	236.91							12.120	12.337	12.473	11.839	*12.192*			11.53	0.09
		6	230.74							11.734	11.443	11.880	11.633	*11.673*			14.15	0.11
	24 hrs	1	278.81							12.708	11.857	12.908	12.342	*12.454*			28.98	0.24
		2	277.70							13.262	12.903	12.841	12.404	*12.853*			40.05	0.29
		3	273.52							12.310	13.005	12.828	12.732	*12.719*			34.79	0.26
		4	268.72							12.189	12.844	12.017	12.873	*12.481*			27.39	0.22
		5	270.97							12.756	13.117	12.701	12.372	*12.737*			27.56	0.22
		6	270.45							12.673	12.035	12.811	12.332	*12.463*			33.79	0.26

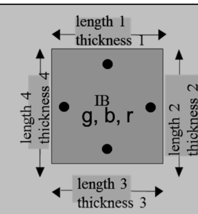
Thickness Swelling			TS 1	TS 2	TS 3	TS 4	*Average*
MM	2 hrs	1	2.89	1.26	7.21	1.09	3.10
		2	1.43	4.73	1.87	1.34	2.35
		3	0.94	1.97	0.99	2.72	1.65
		4	1.32	2.78	3.26	2.37	2.44
		5	4.82	7.24	8.37	0.66	5.25
		6	3.16	1.13	4.41	0.88	2.39
	24 hrs	1	11.23	4.92	14.77	8.42	9.83
		2	13.01	9.81	9.48	6.97	9.83
		3	5.97	12.23	10.54	9.53	9.57
		4	6.92	12.05	4.06	12.80	8.95
		5	10.32	14.02	10.35	5.20	9.94
		6	11.41	6.36	12.59	6.95	9.32

Moisture Content		DryOven Weight (g)	MC Before test %	MC After test %
MM	1	198.82	8.72	40.23
	2	181.95	8.97	52.62
	3	186.51	8.80	46.65
	4	194.07	8.69	38.47
	5	195.82	8.48	38.38
	6	185.67	8.87	45.66

Data Sheet for Thickness Swelling (MH)

MH Moso High Density
ML Moso Low Density

g = Board type (MH)
b = Sample ID (1,2,3,4,5,6)
r = Replication (not applicable for this test)



Board type	Duration	Sample ID	Mass (g)	Length 1 (mm)	Length 2 (mm)	Length 3 (mm)	Length 4 (mm)	Average length 1.3 (mm)	Average length 2.4(mm)	Thickness 1 (mm)	Thickness 2 (mm)	Thickness 3 (mm)	Thickness 4 (mm)	Average thickness (mm)	Density (kg/m^3)	Volume (cm^3)	Water Absorbed By weight %	Water Absorbed By volume g/cm^3
MH	0 hr	1	212.84	152.39	152.23	152.26	152.60	152.33	152.42	11.508	11.582	11.717	11.636	*11.611*	789.58	269.56		
		2	201.73	154.42	153.20	152.96	152.51	153.69	152.86	11.521	11.503	11.574	11.546	*11.536*	744.37	271.01		
		3	196.22	152.37	152.39	152.19	152.70	152.28	152.55	11.247	11.171	11.177	11.164	*11.190*	754.89	259.93		
		4	216.23	152.88	152.68	151.83	152.52	152.36	152.60	11.620	11.486	11.974	11.599	*11.670*	796.97	271.32		
		5	193.85	152.37	152.51	152.16	152.41	152.27	152.46	11.244	10.956	11.142	11.128	*11.118*	751.11	258.09		
		6	201.73	151.92	152.83	151.91	152.70	151.92	152.77	11.456	11.427	11.415	11.379	*11.419*	761.22	265.01		
	2 hrs	1	235.93							11.954	11.659	11.908	12.151	*11.918*			10.8485	0.0857
		2	230.42							11.708	11.657	12.114	11.732	*11.803*			14.2220	0.1059
		3	223.11							11.468	11.452	11.400	11.424	*11.436*			13.7040	0.1034
		4	282.53							11.864	11.651	12.149	12.108	*11.943*			30.6598	0.2443
		5	222.38							11.469	11.149	11.257	11.286	*11.290*			14.7176	0.1105
		6	227.44							12.041	11.587	11.788	11.714	*11.783*			12.7448	0.0970
	24 hrs	1	270.04							12.995	11.954	12.507	12.906	*12.591*			26.8746	0.2122
		2	271.31							12.704	12.808	13.291	12.856	*12.915*			34.4916	0.2567
		3	262.27							12.508	12.438	12.388	12.225	*12.390*			33.6612	0.2541
		4	319.07							12.766	12.110	12.334	13.200	*12.603*			47.5582	0.3790
		5	257.35							12.272	12.410	11.814	12.161	*12.164*			32.7573	0.2460
		6	267.29							13.216	12.154	12.752	12.367	*12.622*			32.4989	0.2474

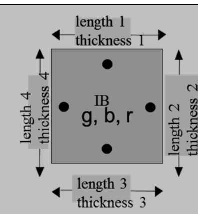
Thickness Swelling			TS 1	TS 2	TS 3	TS 4	*Average*
MH	2 hrs	1	3.8756	0.6648	1.6301	4.4259	2.6463
		2	1.6231	1.3388	4.6656	1.6109	2.3123
		3	1.9650	2.5154	1.9952	2.3289	2.2007
		4	2.0998	1.4365	1.4615	4.3883	2.3415
		5	2.0011	1.7616	1.0321	1.4198	1.5539
		6	5.1065	1.4002	3.2676	2.9440	3.1810
	24 hrs	1	12.9214	3.2119	6.7423	10.9144	8.4383
		2	10.2682	11.3449	14.8350	11.3459	11.9517
		3	11.2119	11.3419	10.8347	9.5038	10.7241
		4	9.8623	5.4327	3.0065	13.8029	7.9929
		5	9.1427	13.2713	6.0312	9.2829	9.4153
		6	15.3631	6.3621	11.7127	8.6827	10.5348

Moisture Content		DryOven Weight (g)	MC Before test %	MC After test %
MH	1	195.81	8.70	37.91
	2	184.99	9.05	46.66
	3	179.83	9.11	45.84
	4	198.65	8.85	60.62
	5	177.84	9.00	44.71
	6	184.98	9.06	44.50

Data Sheet for Thickness Swelling (ML)

MH Moso High Density
ML Moso Low Density

g = Board type (ML)
b = Sample ID (1,2,3,4,5,6)
r = Replication (not applicable for this test)



Board type	Duration	Sample ID	Mass (g)	Length 1 (mm)	Length 2 (mm)	Length 3 (mm)	Length 4 (mm)	Average length 1.3 (mm)	Average length 2.4(mm)	Thickness 1 (mm)	Thickness 2 (mm)	Thickness 3 (mm)	Thickness 4 (mm)	Average thickness (mm)	Density (kg/m^3)	Volume (cm^3)	Water Absorbed By weight %	Water Absorbed By volume g/cm^3
ML	0 hr	1	169.42	152.57	152.25	153.26	152.21	152.92	152.23	11.332	11.275	11.208	11.298	*11.278*	645.32	262.54		
		2	178.32	152.44	151.82	152.88	151.40	152.66	151.61	11.213	11.449	11.391	11.416	*11.367*	677.78	263.09		
		3	176.38	152.36	152.29	152.19	152.41	152.28	152.35	11.292	11.267	11.272	11.340	*11.293*	673.25	261.98		
		4	173.88	152.02	152.13	152.11	152.09	152.07	152.11	11.517	11.349	11.248	11.236	*11.338*	663.05	262.24		
		5	185.51	152.62	152.36	152.59	152.24	152.61	152.30	11.381	11.319	11.829	11.415	*11.486*	694.91	266.95		
		6	177.17	152.19	152.31	152.20	152.24	152.20	152.28	11.438	11.306	11.380	11.009	*11.283*	677.53	261.49		
	2 hrs	1	225.34							11.607	12.227	12.293	11.974	*12.025*			33.01	0.21
		2	234.85							12.365	11.859	11.914	12.182	*12.080*			31.70	0.21
		3	231.52							11.757	12.322	11.519	12.420	*12.005*			31.26	0.21
		4	215.71							12.128	11.808	11.823	11.463	*11.806*			24.06	0.16
		5	222.64							11.703	11.910	11.843	11.846	*11.826*			20.02	0.14
		6	224.73							11.646	12.145	11.768	11.401	*11.740*			26.84	0.18
	24 hrs	1	263.99							13.123	12.540	12.708	12.952	*12.831*			55.82	0.36
		2	274.23							12.681	13.192	13.027	13.153	*13.013*			53.79	0.36
		3	275.13							12.965	12.710	12.863	13.082	*12.905*			55.99	0.38
		4	265.47							13.235	13.062	12.636	12.601	*12.884*			52.67	0.35
		5	259.76							12.725	12.722	12.015	12.864	*12.582*			40.02	0.28
		6	271.52							13.034	12.808	12.677	12.366	*12.721*			53.25	0.36

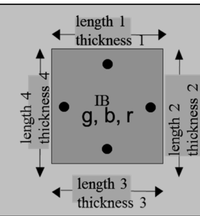
Thickness Swelling			TS 1	TS 2	TS 3	TS 4	*Average*
ML	2 hrs	1	2.43	8.44	9.68	5.98	6.62
		2	10.27	3.58	4.59	6.71	6.27
		3	4.12	9.36	2.19	9.52	6.30
		4	5.31	4.04	5.11	2.02	4.13
		5	2.83	5.22	0.12	3.78	2.96
		6	1.82	7.42	3.41	3.56	4.05
	24 hrs	1	15.80	11.22	13.38	14.64	13.77
		2	13.09	15.22	14.36	15.22	14.48
		3	14.82	12.81	14.11	15.36	14.28
		4	14.92	15.09	12.34	12.15	13.64
		5	11.81	12.40	1.57	12.69	9.54
		6	13.95	13.28	11.40	12.33	12.74

Moisture Content		DryOven Weight (g)	MC Before test %	MC After test %
ML	1	154.19	9.88	71.21
	2	162.23	9.92	69.04
	3	160.36	9.99	71.57
	4	158.30	9.84	67.70
	5	169.54	9.42	53.21
	6	161.72	9.55	67.90

Data Sheet for Thickness Swelling (GN)

GN Guadua Node
GI Guadua Internode

g = Board type (GN)
b = Sample ID (1,2,3,4,5,6)
r = Replication (not applicable for this test)



Factors			Specimen Characteristics																
Board type	Duration	Sample ID	Mass (g)	Length 1 (mm)	Length 2 (mm)	Length 3 (mm)	Length 4 (mm)	Average length 1.3 (mm)	Average length 2.4(mm)	Thickness 1 (mm)	Thickness 2 (mm)	Thickness 3 (mm)	Thickness 4 (mm)	Average thickness (mm)	Density (kg/m^3)	Volume (cm^3)	Water Absorbed By weight %	Water Absorbed By volume g/cm^3
GN	0 hr	1	191.54	152.65	154.93	152.84	154.88	152.75	154.91	11.169	11.190	11.178	11.017	*11.139*	726.78	263.55		
		2	191.15	152.44	146.15	152.63	145.41	152.54	145.78	10.891	10.709	10.869	11.113	*10.896*	788.97	242.28		
		3	208.30	152.14	152.13	151.95	152.88	152.05	152.51	11.258	11.468	11.380	11.609	*11.429*	786.02	265.01		
		4	193.61	144.92	152.42	145.80	152.18	145.36	152.30	11.451	11.547	11.519	11.506	*11.506*	760.10	254.72		
		5	214.83	148.02	152.89	146.80	152.61	147.41	152.75	11.119	11.316	11.382	11.569	*11.347*	840.86	255.49		
		6	214.90	150.25	152.38	149.65	152.42	149.95	152.40	11.472	11.441	11.560	11.445	*11.480*	819.19	262.33		
	2 hrs	1	245.38							11.730	11.837	11.630	12.107	*11.826*			28.11	0.20
		2	222.55							11.554	11.325	11.363	11.325	*11.392*			16.43	0.13
		3	234.99							11.599	11.902	11.569	11.712	*11.696*			12.81	0.10
		4	224.95							11.658	11.794	11.793	11.909	*11.789*			16.19	0.12
		5	242.57							11.319	11.627	11.968	12.039	*11.738*			12.91	0.11
		6	252.46							11.875	12.048	11.844	12.350	*12.029*			17.48	0.14
	24 hrs	1	282.21							12.899	12.851	12.916	12.422	*12.772*			47.34	0.34
		2	269.60							12.479	12.443	12.300	12.291	*12.378*			41.04	0.32
		3	280.66							12.638	12.823	12.482	12.209	*12.538*			34.74	0.27
		4	277.67							12.886	13.044	12.980	13.074	*12.996*			43.42	0.33
		5	280.02							12.039	12.149	13.172	12.941	*12.575*			30.34	0.26
		6	296.01							13.003	13.170	12.447	13.230	*12.963*			37.74	0.31

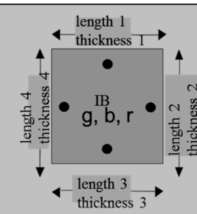
Thickness Swelling			TS				
			1	2	3	4	*Average*
GN	2 hrs	1	5.02	5.78	4.04	9.89	6.17
		2	6.09	5.75	4.55	1.91	4.55
		3	3.03	3.78	1.66	0.89	2.33
		4	1.81	2.14	2.38	3.50	2.46
		5	1.80	2.75	5.15	4.06	3.45
		6	3.51	5.31	2.46	7.91	4.79
	24 hrs	1	15.49	14.84	15.55	12.75	14.67
		2	14.58	16.19	13.17	10.60	13.61
		3	12.26	11.82	9.68	5.17	9.71
		4	12.53	12.96	12.68	13.63	12.95
		5	8.27	7.36	15.73	11.86	10.83
		6	13.35	15.11	7.67	15.60	12.92

Moisture Content		DryOven Weight (g)	MC Before test %	MC After test %
GN	1	173.07	10.67	63.06
	2	173.13	10.41	55.72
	3	189.36	10.00	48.22
	4	177.68	8.97	56.28
	5	195.40	9.94	43.31
	6	195.94	9.68	51.07

Data Sheet for Thickness Swelling (GI)

GN Guadua Node
GI Guadua Internode

g = Board type (GI)
b = Sample ID (1,2,3,4,5,6)
r = Replication (not applicable for this test)



Board type	Duration	Sample ID	Mass (g)	Length 1 (mm)	Length 2 (mm)	Length 3 (mm)	Length 4 (mm)	Average length 1.3 (mm)	Average length 2.4(mm)	Thickness 1 (mm)	Thickness 2 (mm)	Thickness 3 (mm)	Thickness 4 (mm)	Average thickness (mm)	Density (kg/m^3)	Volume (cm^3)	Water Absorbed By weight %	Water Absorbed By volume g/cm^3
GI	0 hr	1	204.47	152.54	152.38	152.69	152.27	152.62	152.33	11.464	11.420	11.433	11.480	*11.449*	768.22	266.16		
		2	192.54	151.46	152.36	151.80	152.54	151.63	152.45	11.438	11.412	11.449	11.569	*11.467*	726.37	265.07		
		3	205.91	151.33	152.08	151.51	151.94	151.42	152.01	11.148	11.102	11.194	11.204	*11.162*	801.46	256.92		
		4	196.11	152.40	152.46	152.38	152.19	152.39	152.33	11.161	11.304	11.230	11.256	*11.238*	751.78	260.86		
		5	201.00	152.33	152.46	152.38	152.47	152.36	152.47	10.968	10.847	11.046	11.035	*10.974*	788.50	254.91		
		6	202.61	152.54	152.35	152.49	152.03	152.52	152.19	10.953	10.893	10.924	10.942	*10.928*	798.77	253.65		
	2 hrs	1	225.96							11.638	11.670	11.696	11.984	*11.747*			10.51	0.08
		2	229.92							11.904	11.624	11.941	12.021	*11.873*			19.41	0.14
		3	228.58							11.313	11.204	11.433	11.302	*11.313*			11.01	0.09
		4	227.53							11.262	11.639	11.428	11.638	*11.492*			16.02	0.12
		5	230.37							11.235	10.991	11.206	11.216	*11.162*			14.61	0.12
		6	233.02							11.156	11.124	11.317	11.270	*11.217*			15.01	0.12
	24 hrs	1	257.29							12.026	12.853	12.763	13.015	*12.664*			25.83	0.20
		2	264.72							12.711	12.592	12.732	13.214	*12.812*			37.49	0.27
		3	271.52							12.226	11.646	12.435	11.728	*12.009*			31.86	0.26
		4	260.48							11.518	12.629	12.427	12.672	*12.312*			32.82	0.25
		5	273.91							12.012	11.839	11.726	11.735	*11.828*			36.27	0.29
		6	277.14							11.486	11.539	12.148	12.115	*11.822*			36.78	0.29

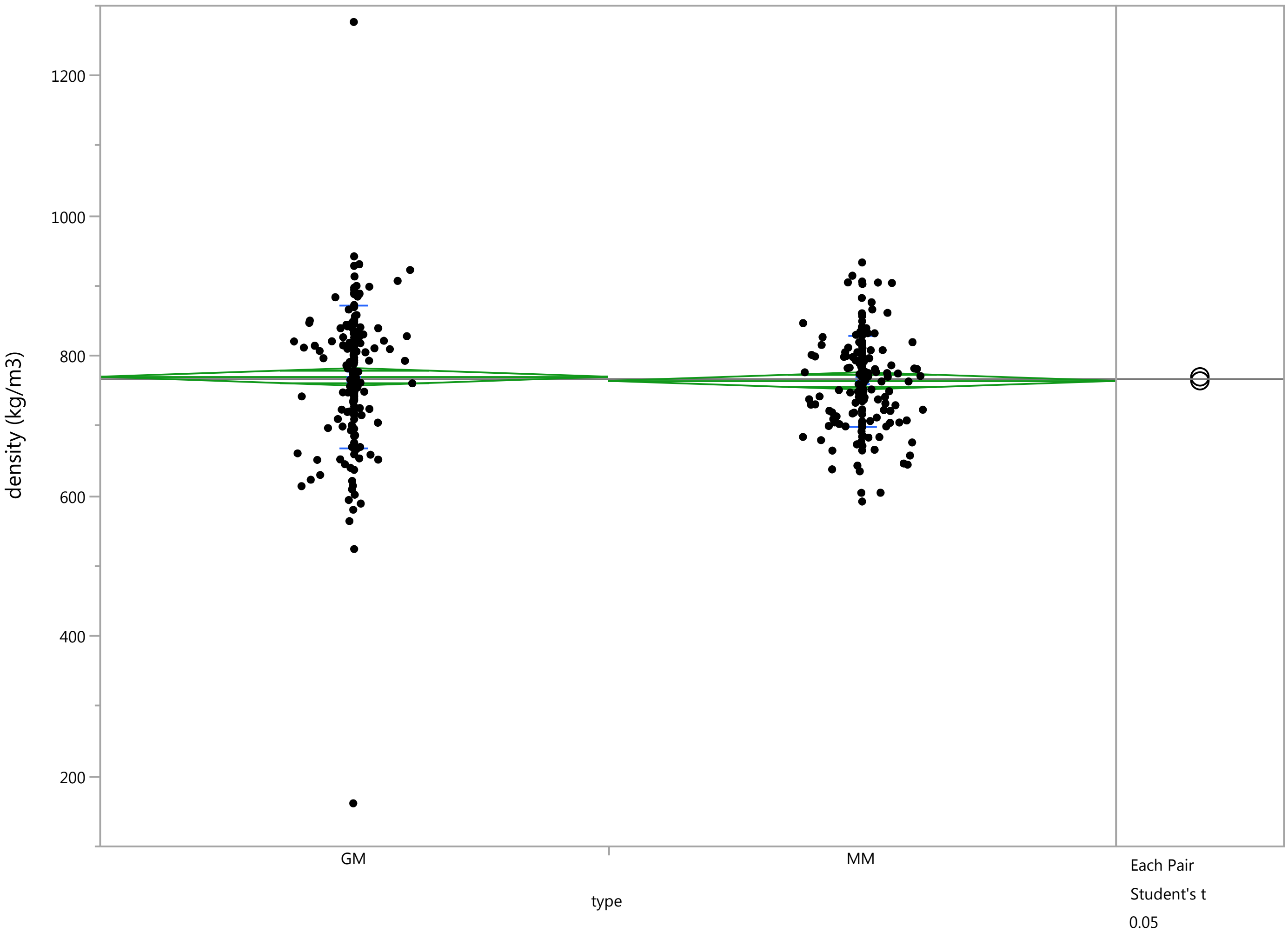
Thickness Swelling			TS 1	TS 2	TS 3	TS 4	*Average*
GI	2 hrs	1	1.52	2.19	2.30	4.39	2.60
		2	4.07	1.86	4.30	3.91	3.54
		3	1.48	0.92	2.14	0.87	1.35
		4	0.90	2.96	1.76	3.39	2.26
		5	2.43	1.33	1.45	1.64	1.71
		6	1.85	2.12	3.60	3.00	2.64
	24 hrs	1	4.90	12.55	11.63	13.37	10.61
		2	11.13	10.34	11.21	14.22	11.73
		3	9.67	4.90	11.09	4.68	7.59
		4	3.20	11.72	10.66	12.58	9.55
		5	9.52	9.15	6.16	6.34	7.78
		6	4.87	5.93	11.20	10.72	8.18

Moisture Content		DryOven Weight (g)	MC Before test %	MC After test %
GI	1	185.13	10.45	38.98
	2	174.02	10.64	52.12
	3	186.59	10.35	45.52
	4	177.25	10.64	46.96
	5	182.14	10.35	50.38
	6	184.33	9.92	50.35

Appendix C : Data Analysis in JMP

Following pages show the data analysis results using JMP 10. They are in the order of density, thickness, IB, MOR – perpendicular, MOR – parallel, MOE – perpendicular, MOE – parallel, thickness swelling in 2hrs, water absorption in 2hrs, thickness swelling in 24hrs, water absorption in 24hrs.

Oneway Analysis of density By type



Oneway Anova

Summary of Fit

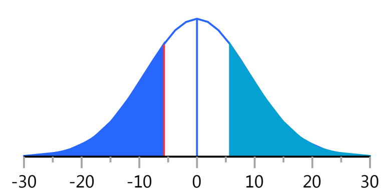
Rsquare	0.001139
Adj Rsquare	-0.00165
Root Mean Square Error	85.36834
Mean of Response	767.3973
Observations (or Sum Wgts)	360

t Test

MM-GM

Assuming equal variances

Difference	-5.750	t Ratio	-0.63898
Std Err Dif	8.999	DF	358
Upper CL Dif	11.947	Prob > |t|	0.5232
Lower CL Dif	-23.447	Prob > t	0.7384
Confidence	0.95	Prob < t	0.2616



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
type	1	2975.5	2975.51	0.4083	0.5232
Error	358	2609015.5	7287.75		
C. Total	359	2611991.0			

Oneway Analysis of density By type

Oneway Anova

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
GM	180	770.272	6.3630	757.76	782.79
MM	180	764.522	6.3630	752.01	777.04

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
GM	180	770.272	101.820	7.5893	755.30	785.25
MM	180	764.522	64.870	4.8351	754.98	774.06

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
1.96661	0.05

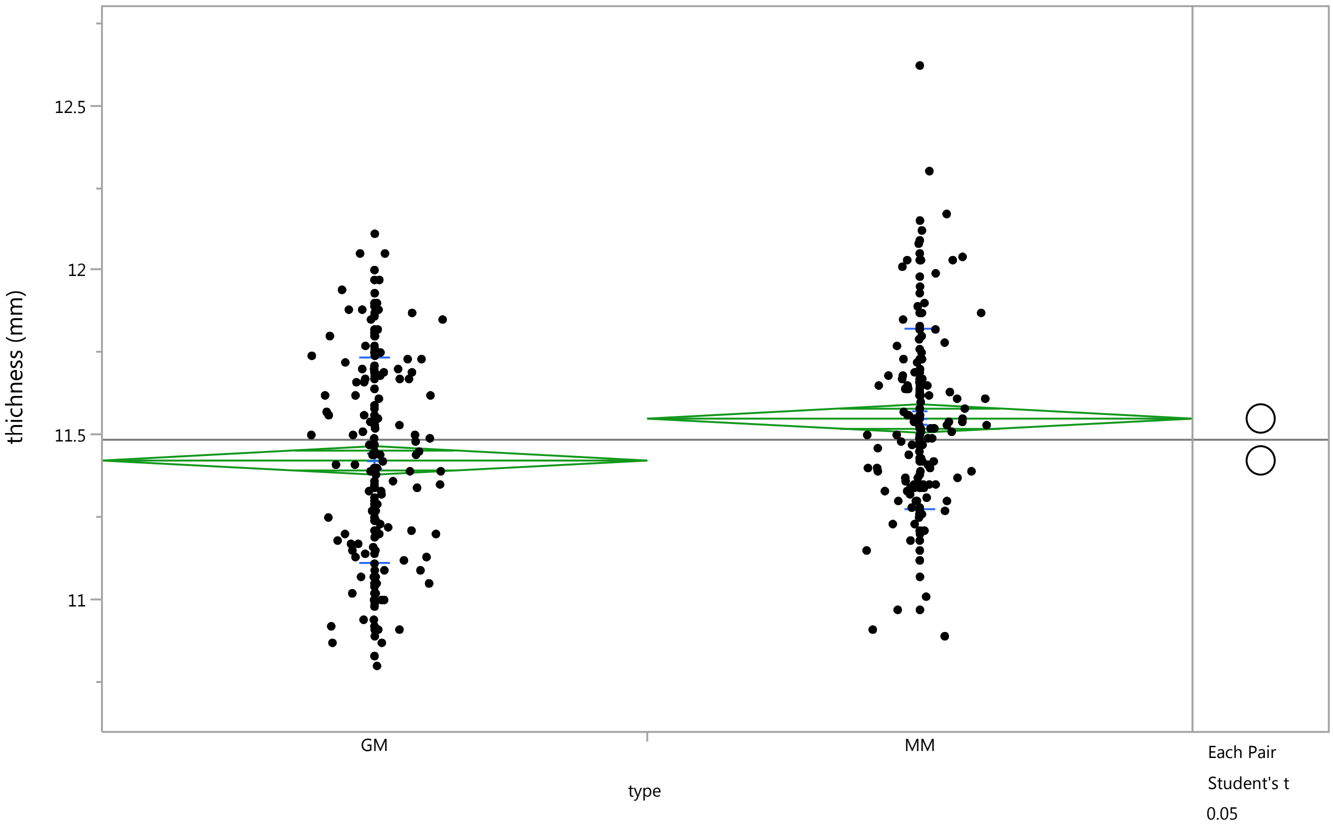
LSD Threshold Matrix

Abs(Dif)-LSD

	GM	MM
GM	-17.697	-11.947
MM	-11.947	-17.697

Positive values show pairs of means that are significantly different.

Oneway Analysis of thichness By type



Oneway Anova

Summary of Fit

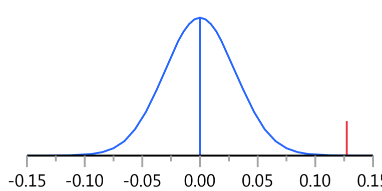
Rsquare	0.045182
Adj Rsquare	0.042515
Root Mean Square Error	0.292855
Mean of Response	11.48636
Observations (or Sum Wgts)	360

t Test

MM-GM

Assuming equal variances

Difference	0.127056	t Ratio	4.115881
Std Err Dif	0.030870	DF	358
Upper CL Dif	0.187764	Prob > |t|	<.0001*
Lower CL Dif	0.066347	Prob > t	<.0001*
Confidence	0.95	Prob < t	1.0000



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
type	1	1.452880	1.45288	16.9405	<.0001*
Error	358	30.703453	0.08576		
C. Total	359	32.156333			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
GM	180	11.4228	0.02183	11.380	11.466
MM	180	11.5499	0.02183	11.507	11.593

Std Error uses a pooled estimate of error variance

Oneway Analysis of thichness By type

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
GM	180	11.4228	0.310241	0.02312	11.377	11.468
MM	180	11.5499	0.274369	0.02045	11.510	11.590

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
1.96661	0.05

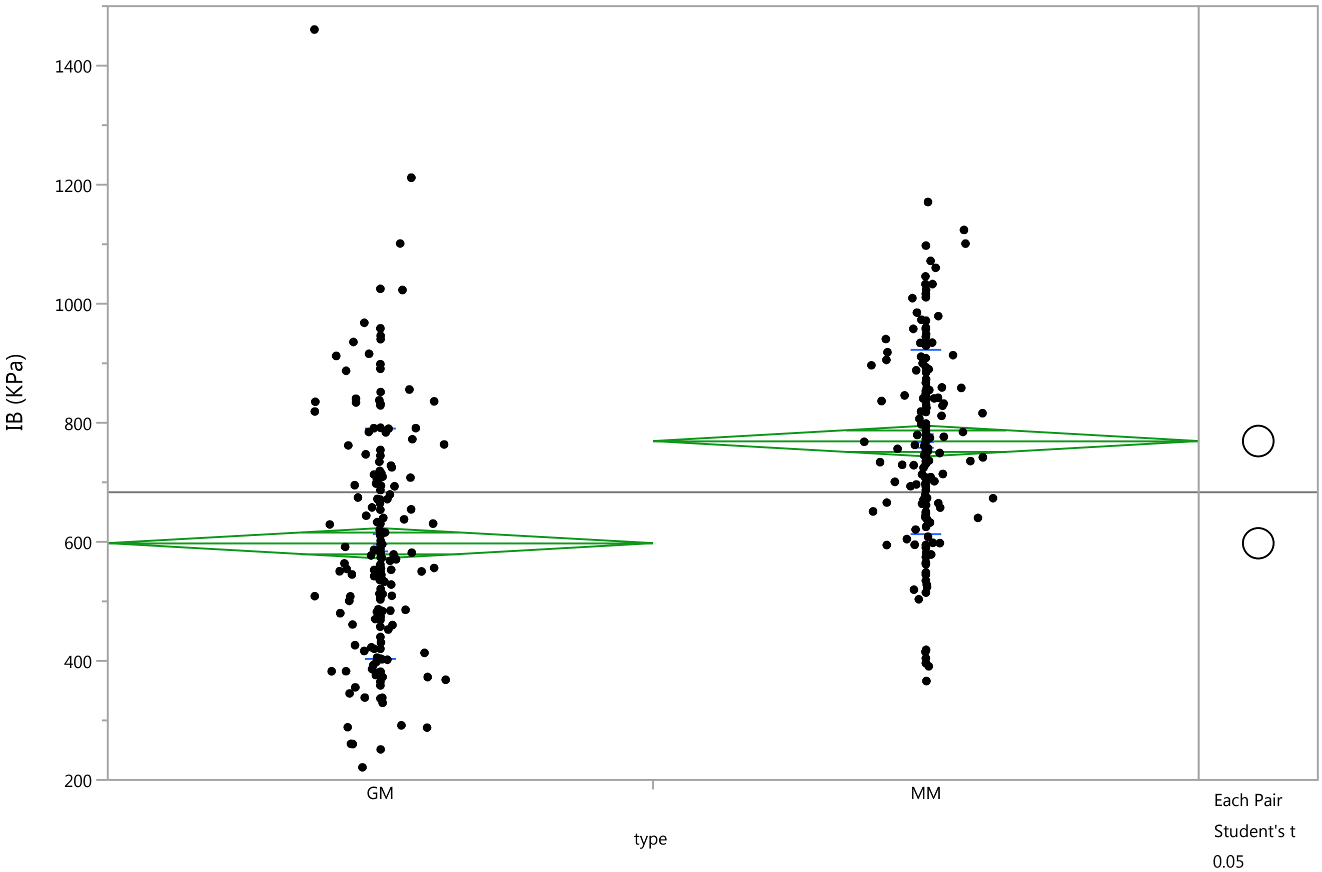
LSD Threshold Matrix

Abs(Dif)-LSD

	MM	GM
MM	-0.06071	0.06635
GM	0.06635	-0.06071

Positive values show pairs of means that are significantly different.

Oneway Analysis of IB By type



Oneway Anova

Summary of Fit

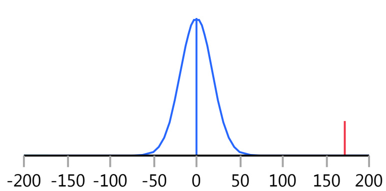
Rsquare	0.193838
Adj Rsquare	0.191586
Root Mean Square Error	175.5018
Mean of Response	683.4628
Observations (or Sum Wgts)	360

t Test

MM-GM

Assuming equal variances

Difference	171.637	t Ratio	9.277902
Std Err Dif	18.500	DF	358
Upper CL Dif	208.018	Prob > |t|	<.0001*
Lower CL Dif	135.255	Prob > t	<.0001*
Confidence	0.95	Prob < t	1.0000



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
type	1	2651323	2651323	86.0795	<.0001*
Error	358	11026715	30801		
C. Total	359	13678038			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
GM	180	597.644	13.081	571.92	623.37
MM	180	769.281	13.081	743.56	795.01

Std Error uses a pooled estimate of error variance

Oneway Analysis of IB By type

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
GM	180	597.644	193.956	14.457	569.12	626.17
MM	180	769.281	154.863	11.543	746.50	792.06

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
1.96661	0.05

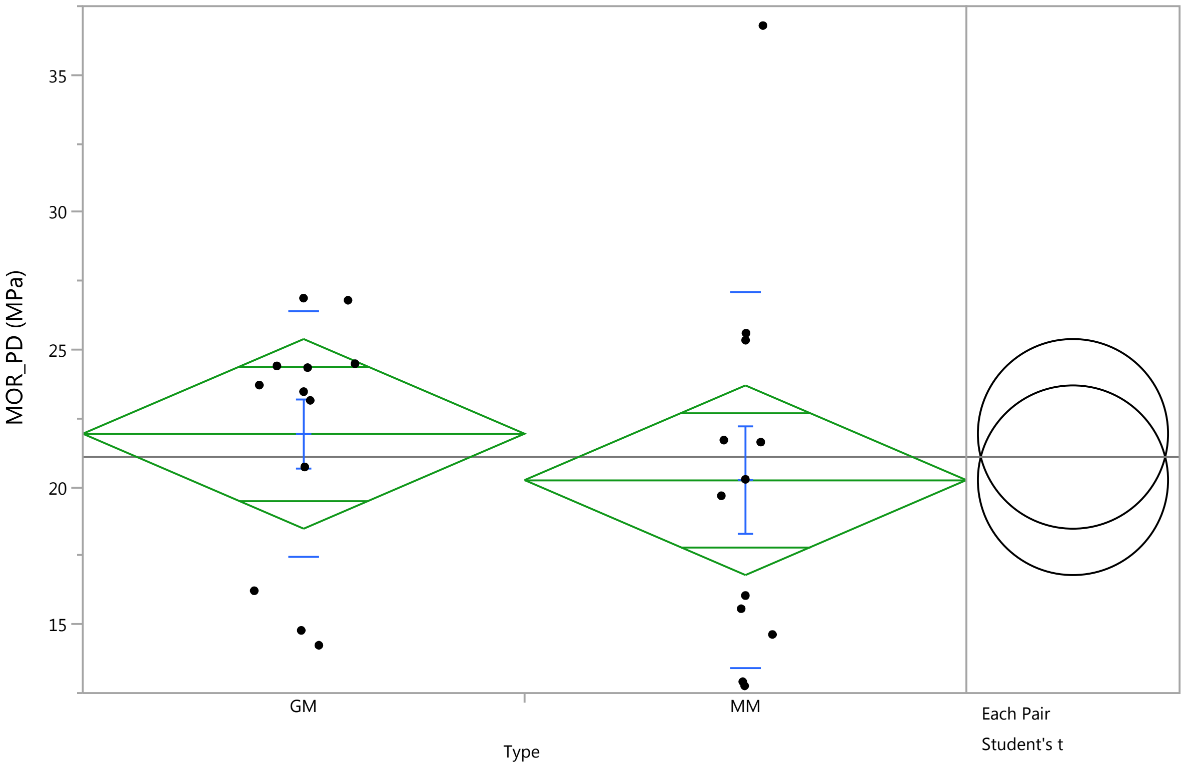
LSD Threshold Matrix

Abs(Dif)-LSD

	MM	GM
MM	-36.38	135.26
GM	135.26	-36.38

Positive values show pairs of means that are significantly different.

Oneway Analysis of MOR_PD By Type



Each Pair
Student's t
0.05

Oneway Anova

Summary of Fit

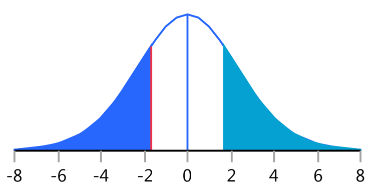
Rsquare	0.022827
Adj Rsquare	-0.02159
Root Mean Square Error	5.766433
Mean of Response	21.09018
Observations (or Sum Wgts)	24

t Test

MM-GM

Assuming equal variances

Difference	-1.6876	t Ratio	-0.71688
Std Err Dif	2.3541	DF	22
Upper CL Dif	3.1945	Prob > |t|	0.4810
Lower CL Dif	-6.5698	Prob > t	0.7595
Confidence	0.95	Prob < t	0.2405



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Type	1	17.08864	17.0886	0.5139	0.4810
Error	22	731.53862	33.2518		
C. Total	23	748.62725			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
GM	12	21.9340	1.6646	18.482	25.386
MM	12	20.2464	1.6646	16.794	23.699

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
GM	12	21.9340	4.45093	1.2849	19.106	24.762
MM	12	20.2464	6.83321	1.9726	15.905	24.588

Oneway Analysis of MOR_PD By Type

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
2.07387	0.05

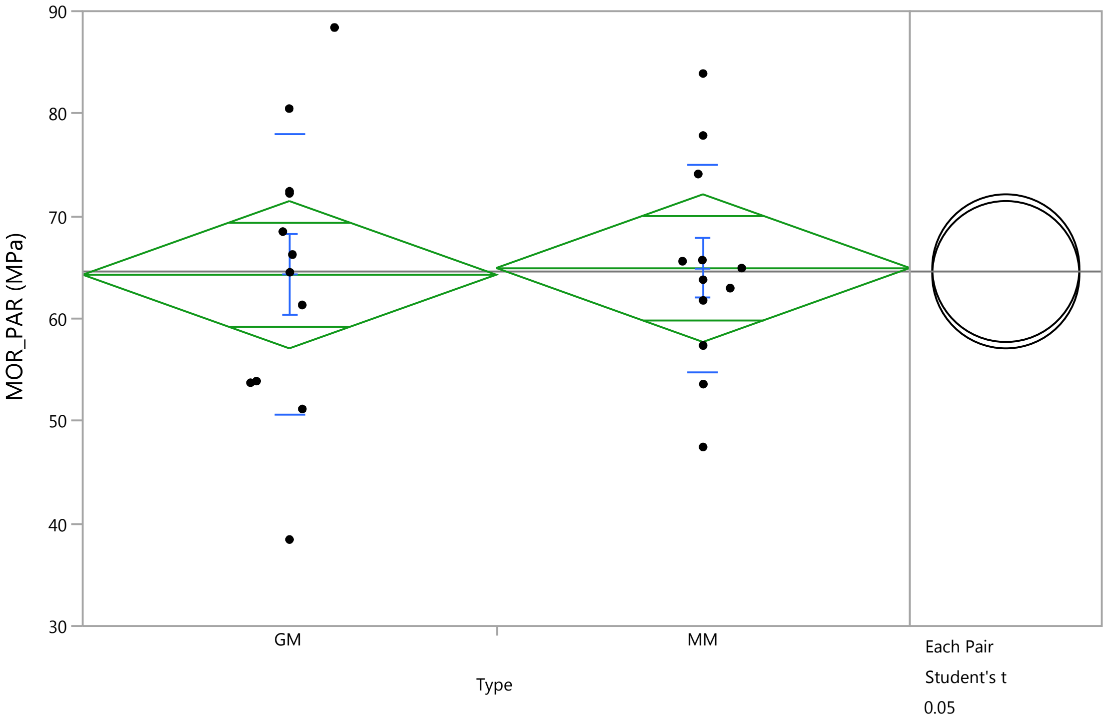
LSD Threshold Matrix

Abs(Dif)-LSD

	GM	MM
GM	-4.8822	-3.1945
MM	-3.1945	-4.8822

Positive values show pairs of means that are significantly different.

Oneway Analysis of MOR_PAR By Type



Oneway Anova

Summary of Fit

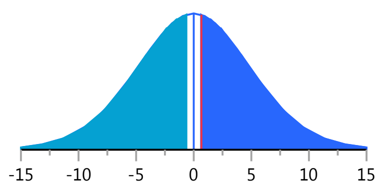
Rsquare	0.000782
Adj Rsquare	-0.04464
Root Mean Square Error	12.02481
Mean of Response	64.60308
Observations (or Sum Wgts)	24

t Test

MM-GM

Assuming equal variances

Difference	0.644	t Ratio	0.131253
Std Err Dif	4.909	DF	22
Upper CL Dif	10.825	Prob > |t|	0.8968
Lower CL Dif	-9.537	Prob > t	0.4484
Confidence	0.95	Prob < t	0.5516



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Type	1	2.4910	2.491	0.0172	0.8968
Error	22	3181.1138	144.596		
C. Total	23	3183.6048			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
GM	12	64.2809	3.4713	57.082	71.480
MM	12	64.9252	3.4713	57.726	72.124

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
GM	12	64.2809	13.6935	3.9530	55.580	72.981
MM	12	64.9252	10.0837	2.9109	58.518	71.332

Means Comparisons

Comparisons for each pair using Student's t

Oneway Analysis of MOR_PAR By Type

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
2.07387	0.05

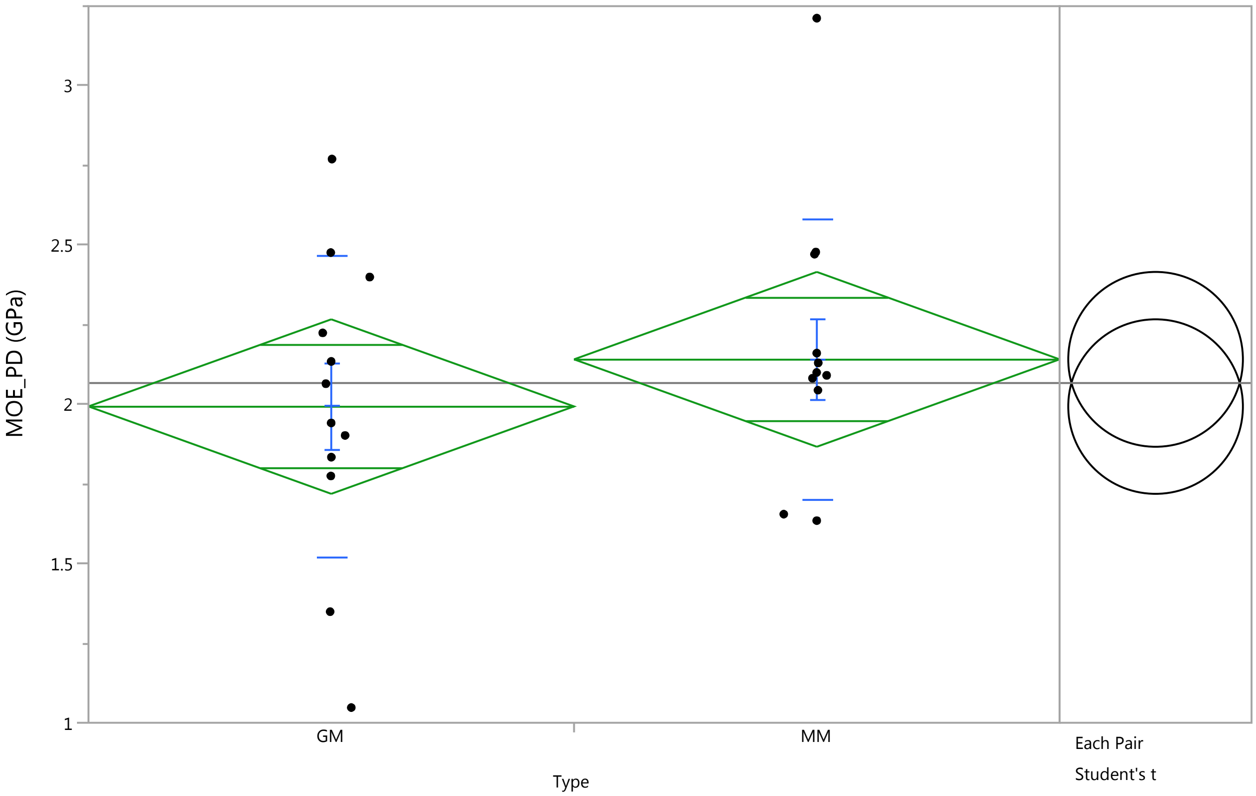
LSD Threshold Matrix

Abs(Dif)-LSD

	MM	GM
MM	-10.181	-9.537
GM	-9.537	-10.181

Positive values show pairs of means that are significantly different.

Oneway Analysis of MOE_PD By Type



Oneway Anova

Summary of Fit

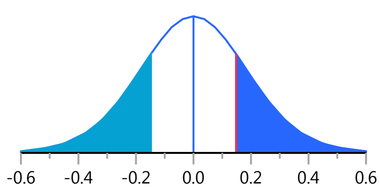
Rsquare	0.027672
Adj Rsquare	-0.01652
Root Mean Square Error	0.45779
Mean of Response	2.067083
Observations (or Sum Wgts)	24

t Test

MM-GM

Assuming equal variances

Difference	0.14788	t Ratio	0.791276
Std Err Dif	0.18689	DF	22
Upper CL Dif	0.53547	Prob > |t|	0.4372
Lower CL Dif	-0.23971	Prob > t	0.2186
Confidence	0.95	Prob < t	0.7814



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Type	1	0.1312169	0.131217	0.6261	0.4372
Error	22	4.6105857	0.209572		
C. Total	23	4.7418025			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
GM	12	1.99314	0.13215	1.7191	2.2672
MM	12	2.14103	0.13215	1.8670	2.4151

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
GM	12	1.99314	0.474214	0.13689	1.6918	2.2944
MM	12	2.14103	0.440755	0.12723	1.8610	2.4211

Oneway Analysis of MOE_PD By Type

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
2.07387	0.05

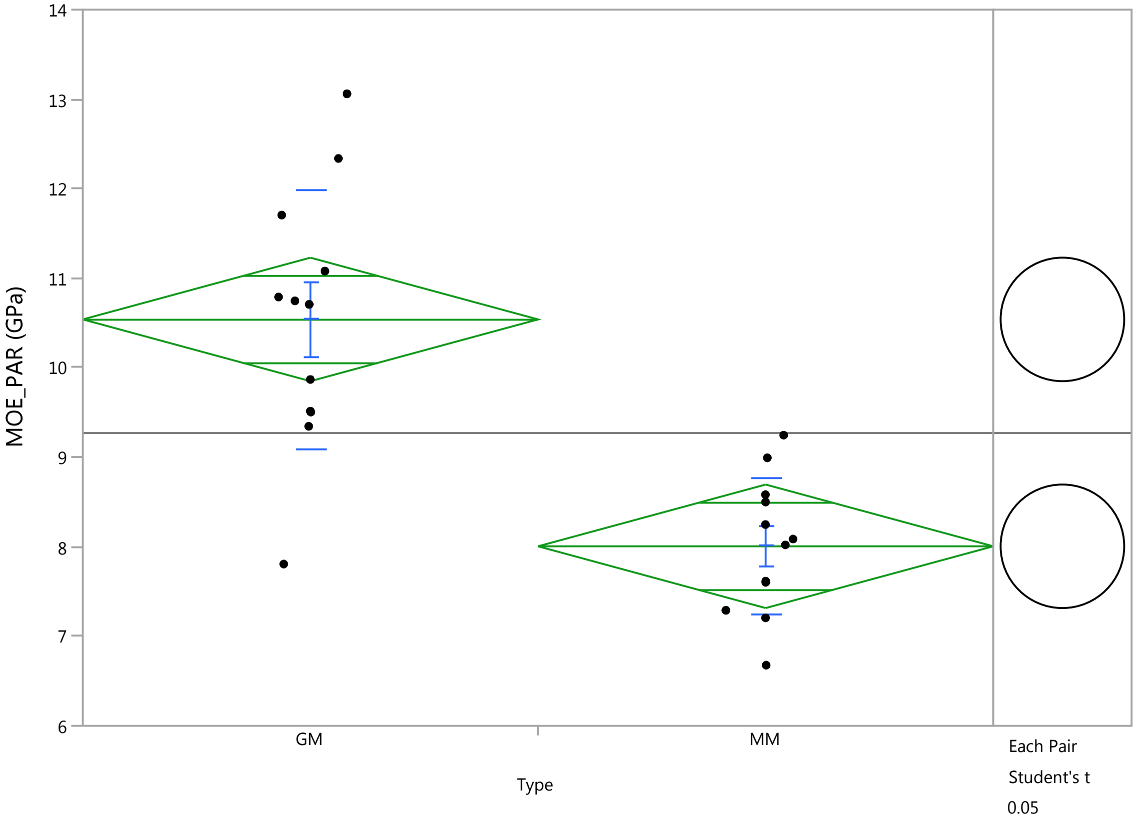
LSD Threshold Matrix

Abs(Dif)-LSD

	MM	GM
MM	-0.38759	-0.23971
GM	-0.23971	-0.38759

Positive values show pairs of means that are significantly different.

Oneway Analysis of MOE_PAR By Type



Oneway Anova

Summary of Fit

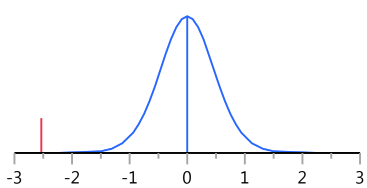
Rsquare	0.568535
Adj Rsquare	0.548923
Root Mean Square Error	1.152473
Mean of Response	9.272375
Observations (or Sum Wgts)	24

t Test

MM-GM

Assuming equal variances

Difference	-2.5332	t Ratio	-5.38415
Std Err Dif	0.4705	DF	22
Upper CL Dif	-1.5575	Prob > |t|	<.0001*
Lower CL Dif	-3.5090	Prob > t	1.0000
Confidence	0.95	Prob < t	<.0001*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Type	1	38.503120	38.5031	28.9891	<.0001*
Error	22	29.220259	1.3282		
C. Total	23	67.723379			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
GM	12	10.5390	0.33269	9.8490	11.229
MM	12	8.0058	0.33269	7.3158	8.696

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
GM	12	10.5390	1.44067	0.41589	9.6236	11.454
MM	12	8.0058	0.76214	0.22001	7.5215	8.490

Oneway Analysis of MOE_PAR By Type

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
2.07387	0.05

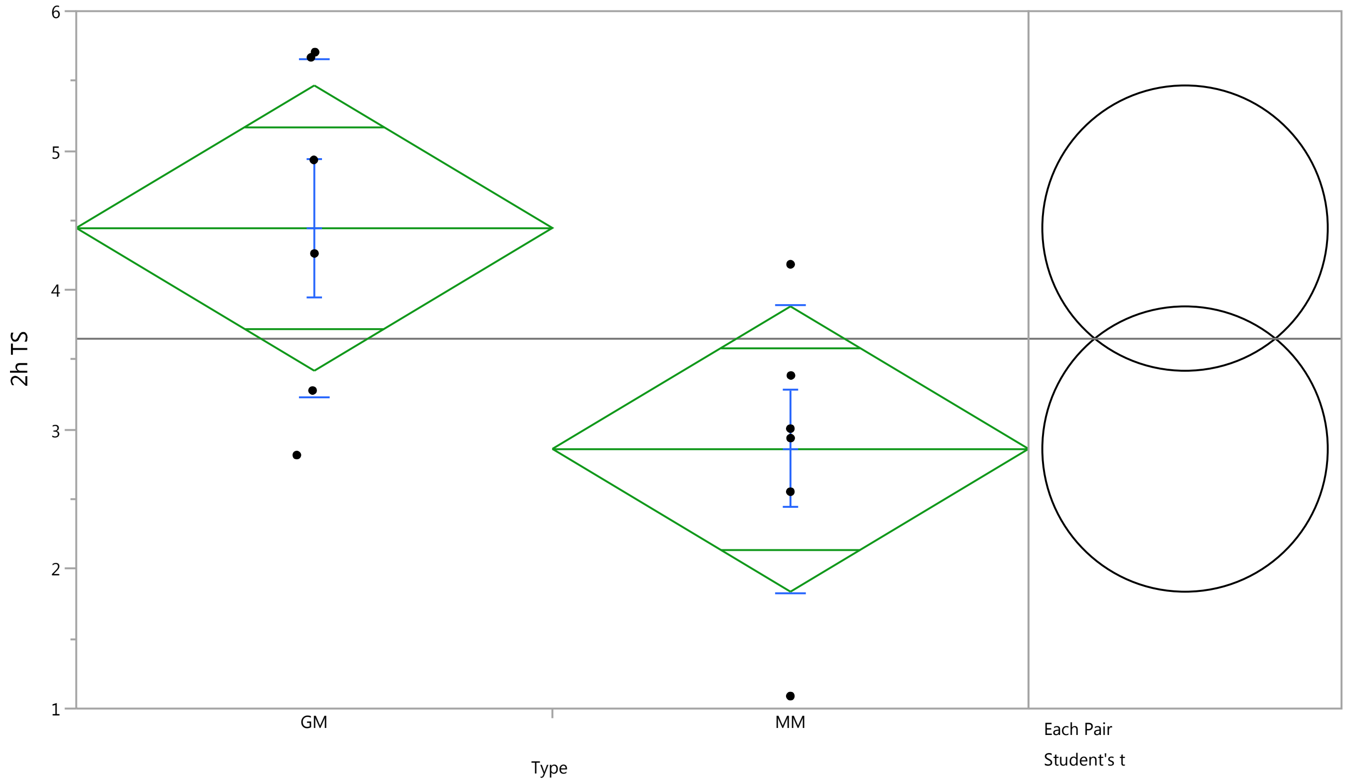
LSD Threshold Matrix

Abs(Dif)-LSD

	GM	MM
GM	-0.9757	1.5575
MM	1.5575	-0.9757

Positive values show pairs of means that are significantly different.

Oneway Analysis of 2h TS By Type



Oneway Anova

Summary of Fit

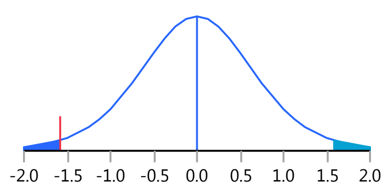
Rsquare	0.373009
Adj Rsquare	0.31031
Root Mean Square Error	1.124949
Mean of Response	3.652717
Observations (or Sum Wgts)	12

t Test

MM-GM

Assuming equal variances

Difference	-1.5842	t Ratio	-2.43909
Std Err Dif	0.6495	DF	10
Upper CL Dif	-0.1370	Prob > |t|	0.0349*
Lower CL Dif	-3.0313	Prob > t	0.9825
Confidence	0.95	Prob < t	0.0175*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Type	1	7.528752	7.52875	5.9492	0.0349*
Error	10	12.655102	1.26551		
C. Total	11	20.183854			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
GM	6	4.44480	0.45926	3.4215	5.4681
MM	6	2.86063	0.45926	1.8373	3.8839

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
GM	6	4.44480	1.21373	0.49550	3.1711	5.7185
MM	6	2.86063	1.02854	0.41990	1.7812	3.9400

Oneway Analysis of 2h TS By Type

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
2.22814	0.05

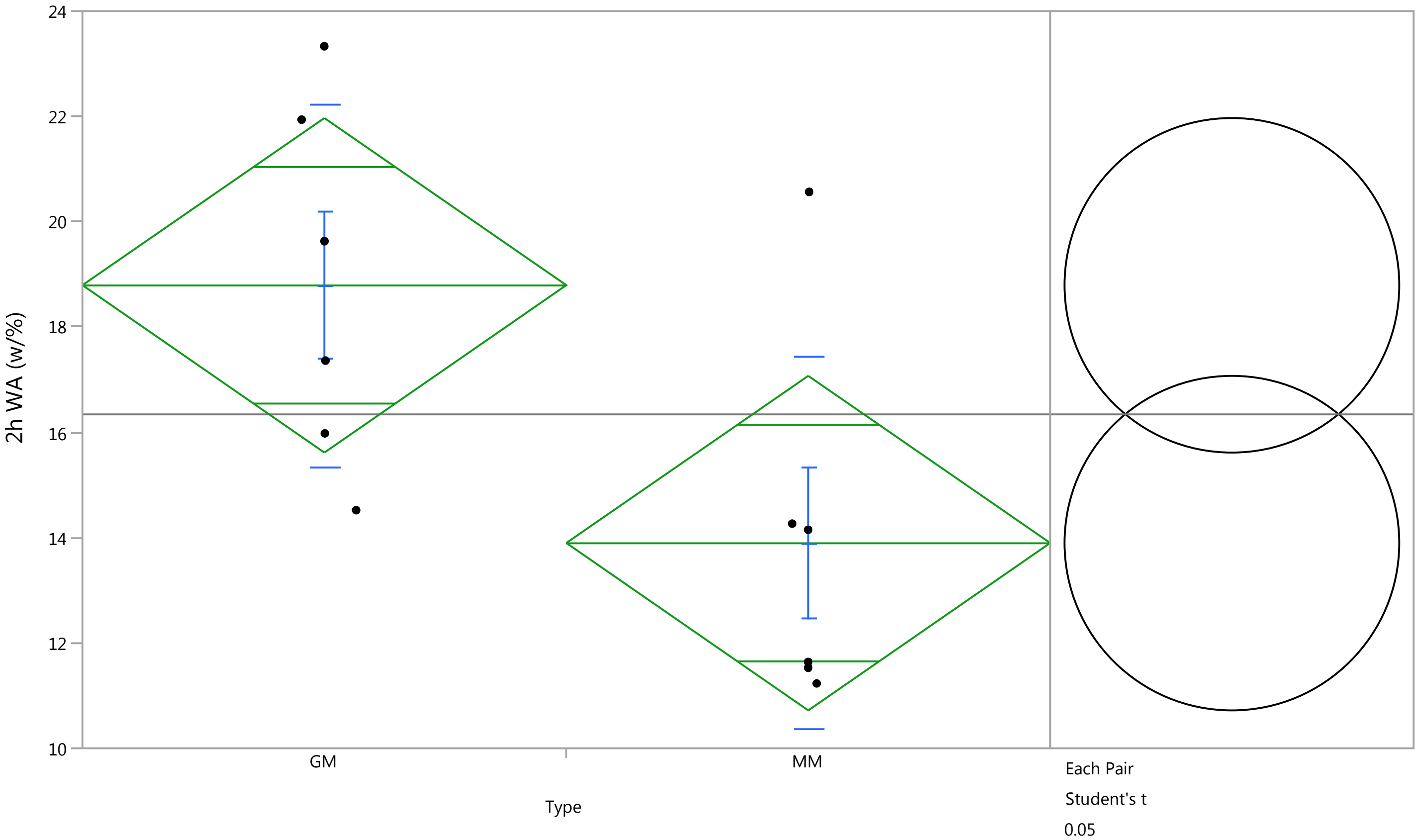
LSD Threshold Matrix

Abs(Dif)-LSD

	GM	MM
GM	-1.4472	0.1370
MM	0.1370	-1.4472

Positive values show pairs of means that are significantly different.

Oneway Analysis of 2h WA By Type



Oneway Anova

Summary of Fit

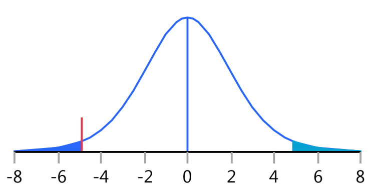
Rsquare	0.371099
Adj Rsquare	0.308208
Root Mean Square Error	3.491466
Mean of Response	16.34512
Observations (or Sum Wgts)	12

t Test

MM-GM

Assuming equal variances

Difference	-4.8967	t Ratio	-2.42914
Std Err Dif	2.0158	DF	10
Upper CL Dif	-0.4052	Prob > |t|	0.0355*
Lower CL Dif	-9.3881	Prob > t	0.9822
Confidence	0.95	Prob < t	0.0178*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Type	1	71.93203	71.9320	5.9007	0.0355*
Error	10	121.90334	12.1903		
C. Total	11	193.83537			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
GM	6	18.7935	1.4254	15.617	21.969
MM	6	13.8968	1.4254	10.721	17.073

Std Error uses a pooled estimate of error variance

Oneway Analysis of 2h WA By Type

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
GM	6	18.7935	3.44684	1.4072	15.176	22.411
MM	6	13.8968	3.53553	1.4434	10.186	17.607

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
2.22814	0.05

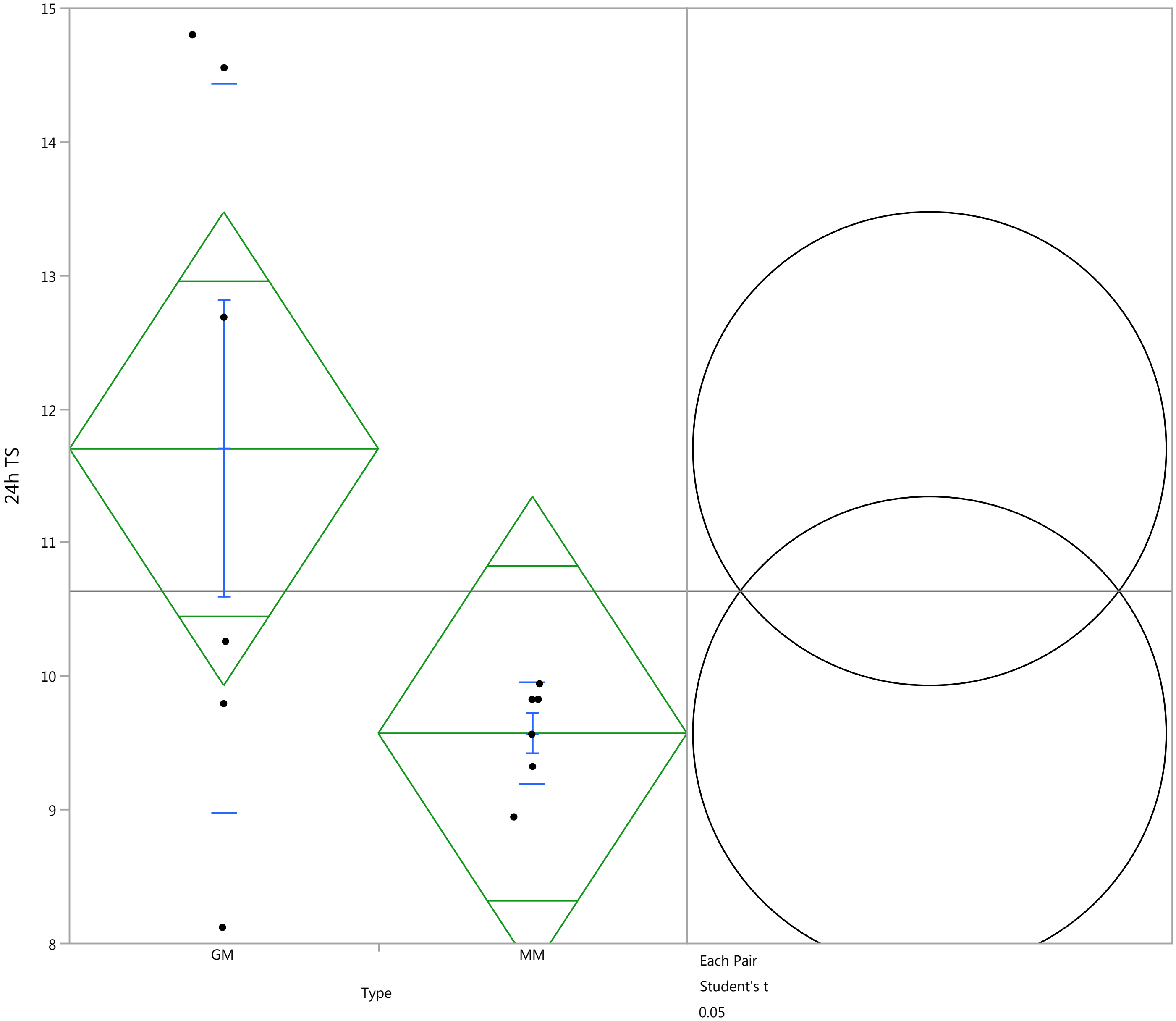
LSD Threshold Matrix

Abs(Dif)-LSD

	GM	MM
GM	-4.4915	0.4052
MM	0.4052	-4.4915

Positive values show pairs of means that are significantly different.

Oneway Analysis of 24h TS By Type



Oneway Anova

Summary of Fit

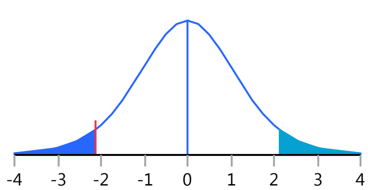
Rsquare	0.263877
Adj Rsquare	0.190264
Root Mean Square Error	1.948459
Mean of Response	10.63808
Observations (or Sum Wgts)	12

t Test

MM-GM

Assuming equal variances

Difference	-2.1299	t Ratio	-1.89333
Std Err Dif	1.1249	DF	10
Upper CL Dif	0.3766	Prob > |t|	0.0876
Lower CL Dif	-4.6364	Prob > t	0.9562
Confidence	0.95	Prob < t	0.0438*



Oneway Analysis of 24h TS By Type

Oneway Anova

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Type	1	13.609209	13.6092	3.5847	0.0876
Error	10	37.964907	3.7965		
C. Total	11	51.574117			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
GM	6	11.7030	0.79545	9.9306	13.475
MM	6	9.5731	0.79545	7.8007	11.346

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
GM	6	11.7030	2.72926	1.1142	8.8388	14.567
MM	6	9.5731	0.37965	0.1550	9.1747	9.972

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
2.22814	0.05

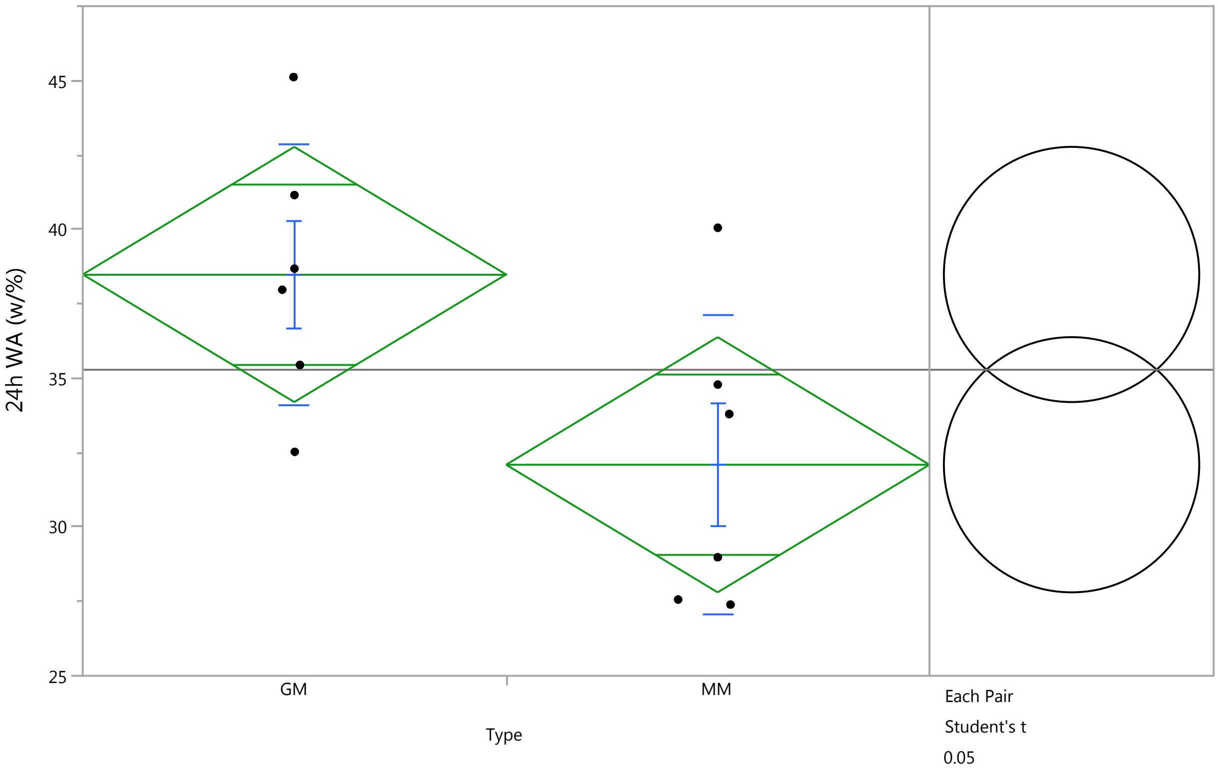
LSD Threshold Matrix

Abs(Dif)-LSD

	GM	MM
GM	-2.5065	-0.3766
MM	-0.3766	-2.5065

Positive values show pairs of means that are significantly different.

Oneway Analysis of 24h WA By Type



Oneway Anova

Summary of Fit

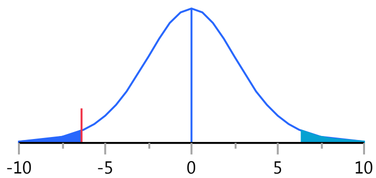
Rsquare	0.355294
Adj Rsquare	0.290823
Root Mean Square Error	4.711654
Mean of Response	35.28823
Observations (or Sum Wgts)	12

t Test

MM-GM

Assuming equal variances

Difference	-6.386	t Ratio	-2.34754
Std Err Dif	2.720	DF	10
Upper CL Dif	-0.325	Prob > |t|	0.0408*
Lower CL Dif	-12.447	Prob > t	0.9796
Confidence	0.95	Prob < t	0.0204*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Type	1	122.34107	122.341	5.5109	0.0408*
Error	10	221.99683	22.200		
C. Total	11	344.33790			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
GM	6	38.4812	1.9235	34.195	42.767
MM	6	32.0953	1.9235	27.809	36.381

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
GM	6	38.4812	4.38588	1.7905	33.879	43.084
MM	6	32.0953	5.01632	2.0479	26.831	37.360

Means Comparisons

Oneway Analysis of 24h WA By Type

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
2.22814	0.05

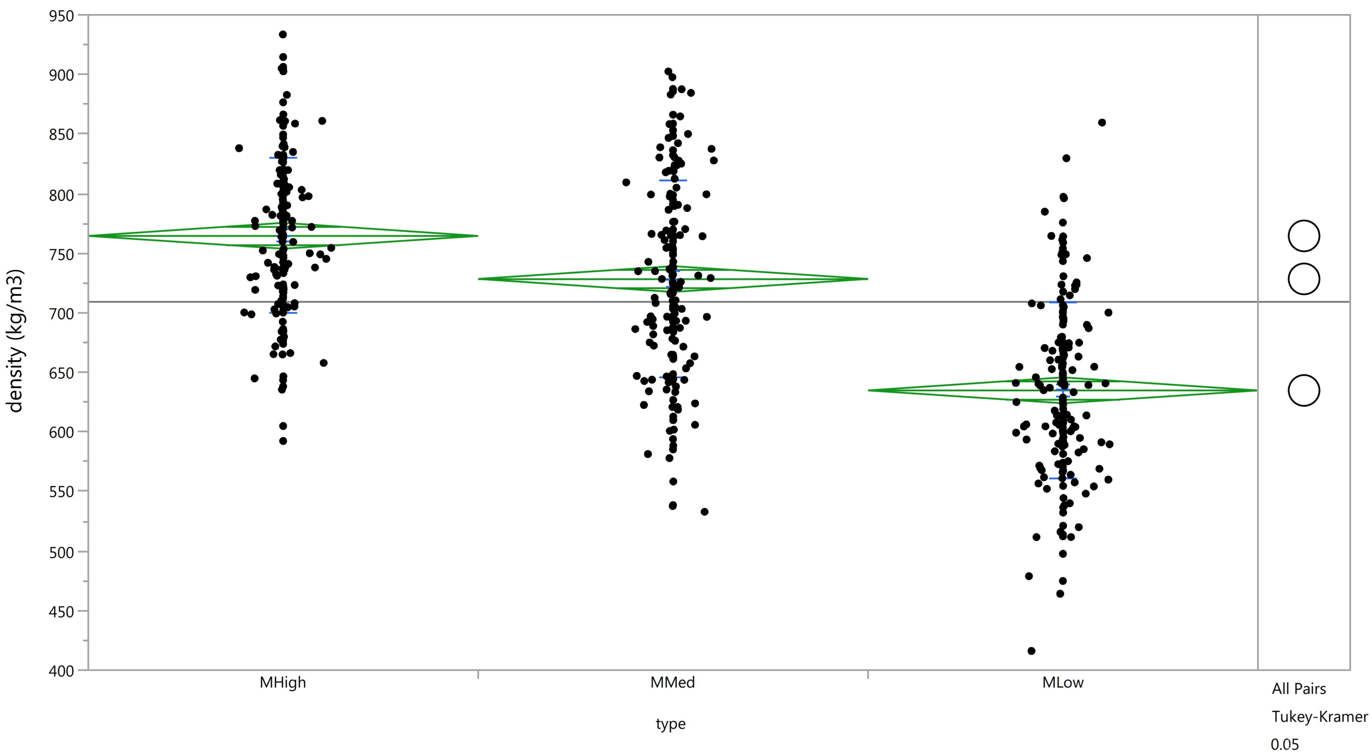
LSD Threshold Matrix

Abs(Dif)-LSD

	GM	MM
GM	-6.0611	0.3248
MM	0.3248	-6.0611

Positive values show pairs of means that are significantly different.

Oneway Analysis of density By type



Oneway Anova

Summary of Fit

Rsquare	0.354504
Adj Rsquare	0.352099
Root Mean Square Error	73.95237
Mean of Response	709.2106
Observations (or Sum Wgts)	540

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
type	2	1612891.6	806446	147.4589	<.0001*
Error	537	2936828.1	5469		
C. Total	539	4549719.8			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
MHigh	180	764.522	5.5121	753.69	775.35
MMed	180	728.306	5.5121	717.48	739.13
MLow	180	634.803	5.5121	623.98	645.63

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
MHigh	180	764.522	64.8698	4.8351	754.98	774.06
MMed	180	728.306	82.2540	6.1309	716.21	740.40
MLow	180	634.803	73.7092	5.4940	623.96	645.64

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2.35023	0.05

Oneway Analysis of density By type

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

HSD Threshold Matrix

Abs(Dif)-HSD

	MHigh	MMed	MLow
MHigh	-18.32	17.90	111.40
MMed	17.90	-18.32	75.18
MLow	111.40	75.18	-18.32

Positive values show pairs of means that are significantly different.

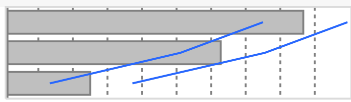
Connecting Letters Report

Level				Mean
MHigh	A			764.52239
MMed		B		728.30617
MLow			C	634.80311

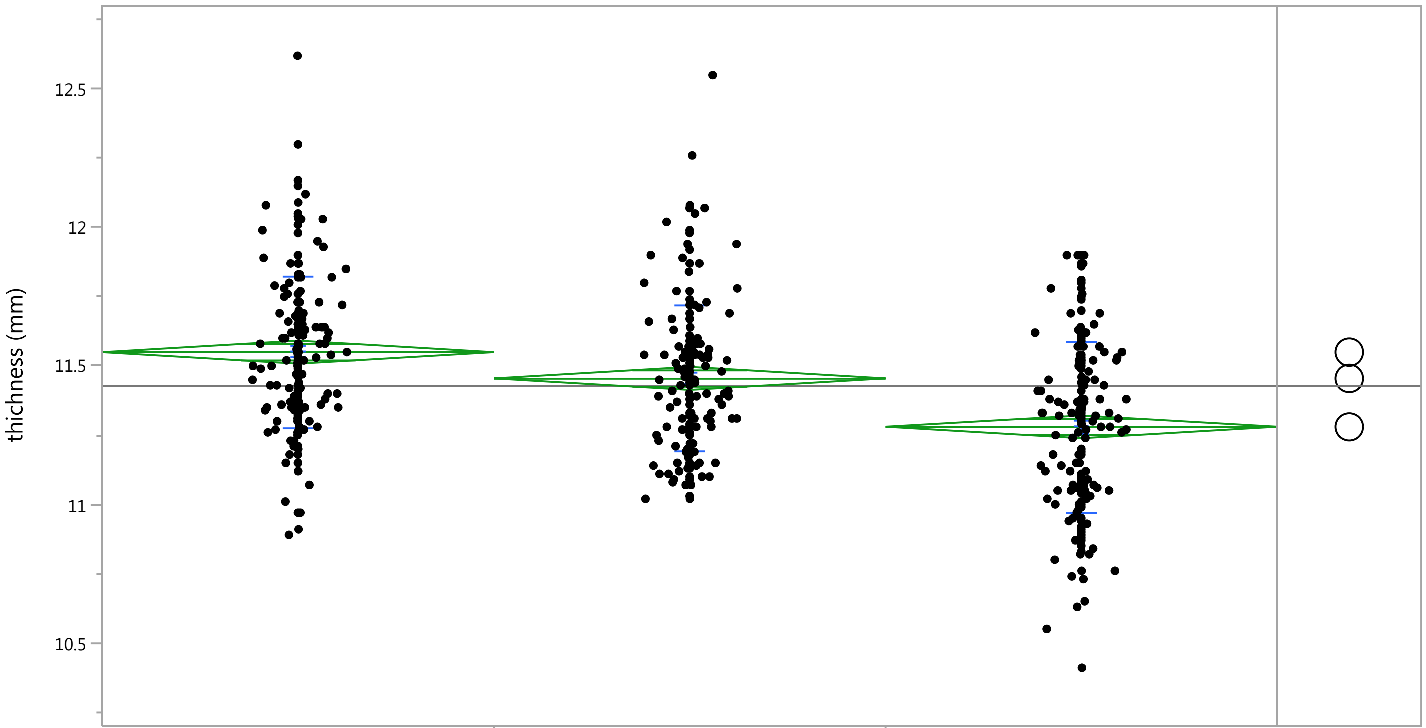
Levels not connected by same letter are significantly different.

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
MHigh	MLow	129.7193	7.795265	111.3986	148.0399	<.0001*
MMed	MLow	93.5031	7.795265	75.1824	111.8237	<.0001*
MHigh	MMed	36.2162	7.795265	17.8956	54.5369	<.0001*



Oneway Analysis of thichness By type



Oneway Anova

Summary of Fit

Rsquare	0.136083
Adj Rsquare	0.132865
Root Mean Square Error	0.282319
Mean of Response	11.4282
Observations (or Sum Wgts)	540

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
type	2	6.741980	3.37099	42.2937	<.0001*
Error	537	42.801177	0.07970		
C. Total	539	49.543158			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
MHigh	180	11.5499	0.02104	11.509	11.591
MMed	180	11.4547	0.02104	11.413	11.496
MLow	180	11.2801	0.02104	11.239	11.321

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
MHigh	180	11.5499	0.274369	0.02045	11.510	11.590
MMed	180	11.4547	0.262177	0.01954	11.416	11.493
MLow	180	11.2801	0.308379	0.02299	11.235	11.325

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2.35023	0.05

Oneway Analysis of thichness By type

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

HSD Threshold Matrix

Abs(Dif)-HSD

	MHigh	MMed	MLow
MHigh	-0.06994	0.02528	0.19989
MMed	0.02528	-0.06994	0.10467
MLow	0.19989	0.10467	-0.06994

Positive values show pairs of means that are significantly different.

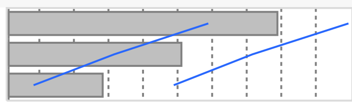
Connecting Letters Report

Level				Mean
MHigh	A			11.549889
MMed		B		11.454667
MLow			C	11.280056

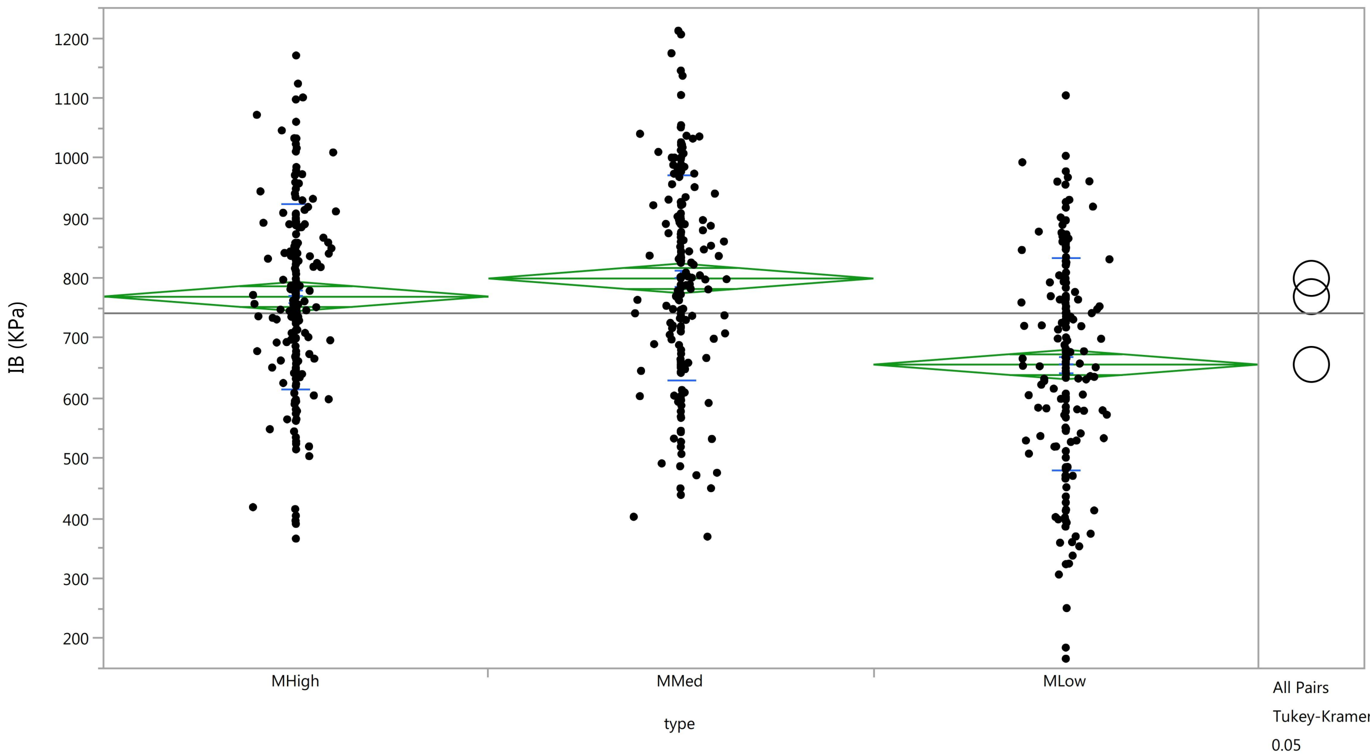
Levels not connected by same letter are significantly different.

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
MHigh	MLow	0.2698333	0.0297591	0.1998927	0.3397740	<.0001*
MMed	MLow	0.1746111	0.0297591	0.1046705	0.2445517	<.0001*
MHigh	MMed	0.0952222	0.0297591	0.0252816	0.1651628	0.0042*



Oneway Analysis of IB By type



Oneway Anova

Summary of Fit

Rsquare	0.120372
Adj Rsquare	0.117096
Root Mean Square Error	167.3471
Mean of Response	741.6883
Observations (or Sum Wgts)	540

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
type	2	2057966	1028983	36.7428	<.0001*
Error	537	15038718	28005		
C. Total	539	17096685			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
MHigh	180	769.281	12.473	744.78	793.78
MMed	180	799.624	12.473	775.12	824.13
MLow	180	656.159	12.473	631.66	680.66

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
MHigh	180	769.281	154.863	11.543	746.50	792.06
MMed	180	799.624	170.440	12.704	774.56	824.69
MLow	180	656.159	176.019	13.120	630.27	682.05

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2.35023	0.05

Oneway Analysis of IB By type

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

HSD Threshold Matrix

Abs(Dif)-HSD

	MMed	MHigh	MLow
MMed	-41.46	-11.11	102.01
MHigh	-11.11	-41.46	71.66
MLow	102.01	71.66	-41.46

Positive values show pairs of means that are significantly different.

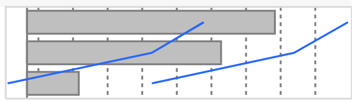
Connecting Letters Report

Level			Mean
MMed	A		799.62444
MHigh	A		769.28111
MLow		B	656.15944

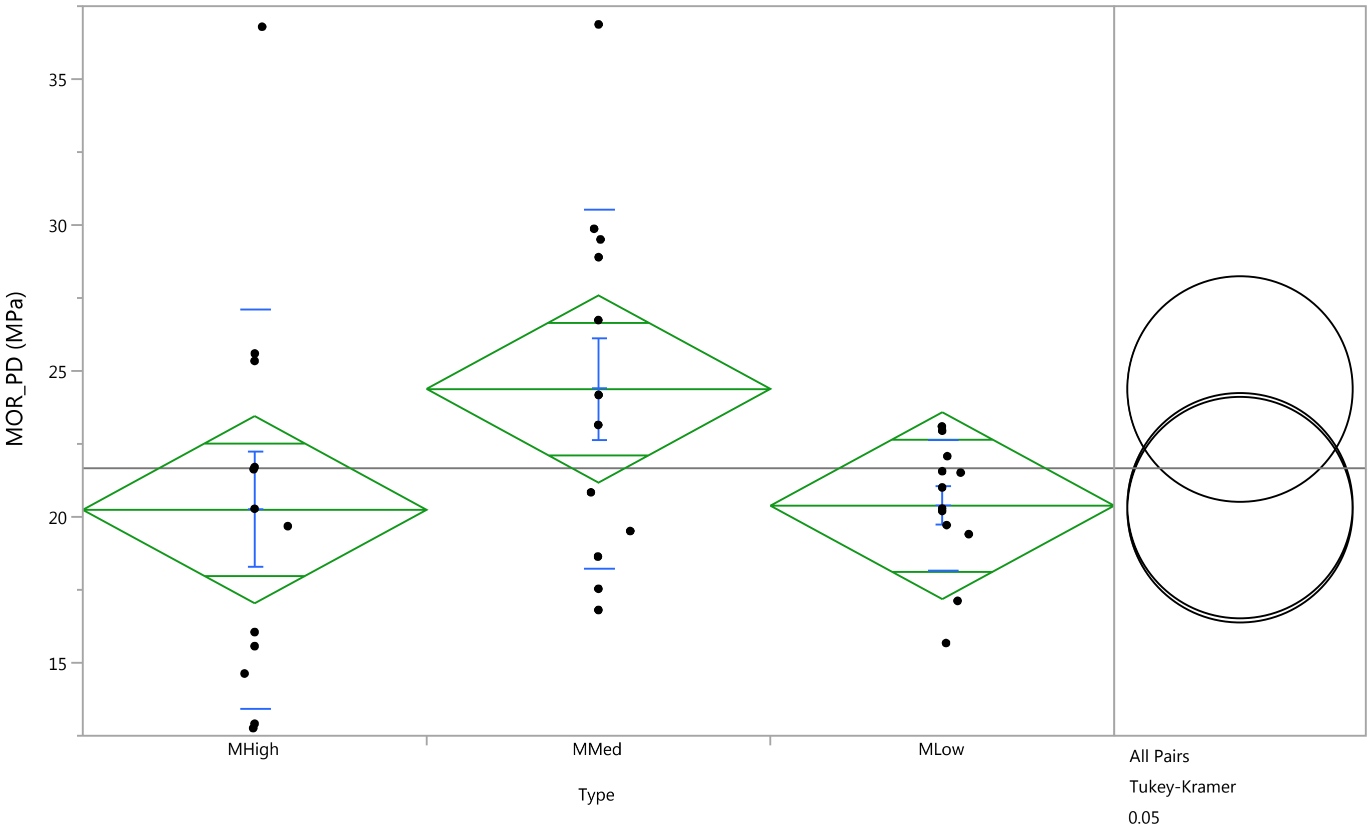
Levels not connected by same letter are significantly different.

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
MMed	MLow	143.4650	17.63994	102.007	184.9229	<.0001*
MHigh	MLow	113.1217	17.63994	71.664	154.5795	<.0001*
MMed	MHigh	30.3433	17.63994	-11.115	71.8012	0.1986



Oneway Analysis of MOR_PD By Type



Oneway Anova

Summary of Fit

Rsquare	0.118782
Adj Rsquare	0.065375
Root Mean Square Error	5.452765
Mean of Response	21.6707
Observations (or Sum Wgts)	36

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Type	2	132.2556	66.1278	2.2241	0.1241
Error	33	981.1773	29.7326		
C. Total	35	1113.4330			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
MHigh	12	20.2464	1.5741	17.044	23.449
MMed	12	24.3801	1.5741	21.178	27.583
MLow	12	20.3856	1.5741	17.183	23.588

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
MHigh	12	20.2464	6.83321	1.9726	15.905	24.588
MMed	12	24.3801	6.13049	1.7697	20.485	28.275
MLow	12	20.3856	2.21863	0.6405	18.976	21.795

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2.45379	0.05

Oneway Analysis of MOR_PD By Type

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

HSD Threshold Matrix

Abs(Dif)-HSD

	MMed	MLow	MHigh
MMed	-5.4623	-1.4678	-1.3286
MLow	-1.4678	-5.4623	-5.3231
MHigh	-1.3286	-5.3231	-5.4623

Positive values show pairs of means that are significantly different.

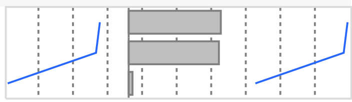
Connecting Letters Report

Level		Mean
MMed	A	24.380142
MLow	A	20.385592
MHigh	A	20.246367

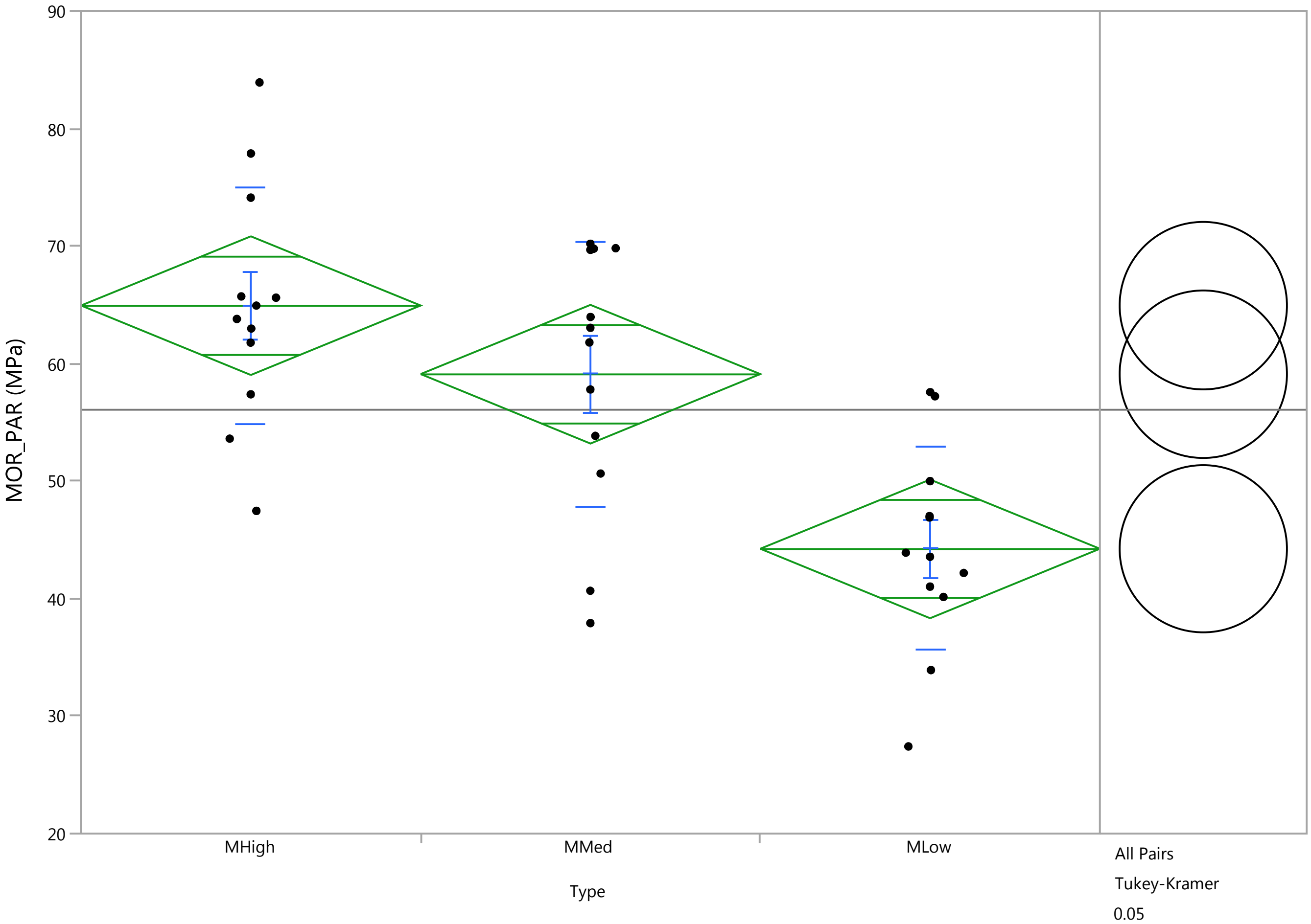
Levels not connected by same letter are significantly different.

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
MMed	MHigh	4.133775	2.226082	-1.32857	9.596123	0.1673
MMed	MLow	3.994550	2.226082	-1.46780	9.456898	0.1871
MLow	MHigh	0.139225	2.226082	-5.32312	5.601573	0.9978



Oneway Analysis of MOR_PAR By Type



Oneway Anova

Summary of Fit

Rsquare	0.450389
Adj Rsquare	0.417079
Root Mean Square Error	10.05069
Mean of Response	56.08271
Observations (or Sum Wgts)	36

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Type	2	2731.7278	1365.86	13.5212	<.0001*
Error	33	3333.5376	101.02		
C. Total	35	6065.2654			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
MHigh	12	64.9252	2.9014	59.022	70.828
MMed	12	59.0897	2.9014	53.187	64.993
MLow	12	44.2332	2.9014	38.330	50.136

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
MHigh	12	64.9252	10.0837	2.9109	58.518	71.332
MMed	12	59.0897	11.2801	3.2563	51.923	66.257
MLow	12	44.2332	8.6097	2.4854	38.763	49.704

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Oneway Analysis of MOR_PAR By Type

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2.45379	0.05

HSD Threshold Matrix

Abs(Dif)-HSD

	MHigh	MMed	MLow
MHigh	-10.068	-4.233	10.624
MMed	-4.233	-10.068	4.788
MLow	10.624	4.788	-10.068

Positive values show pairs of means that are significantly different.

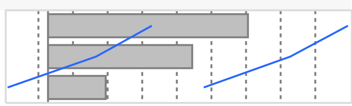
Connecting Letters Report

Level			Mean
MHigh	A		64.925242
MMed	A		59.089725
MLow		B	44.233175

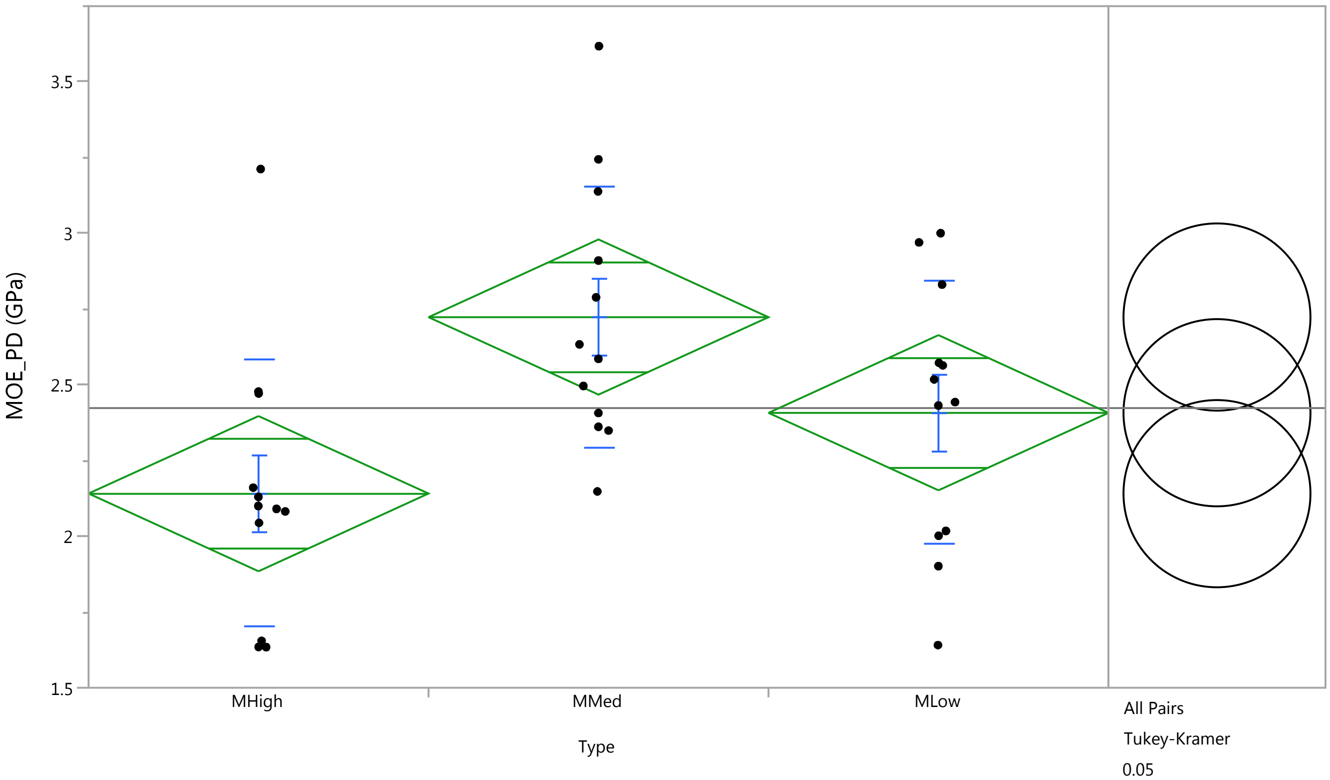
Levels not connected by same letter are significantly different.

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
MHigh	MLow	20.69207	4.103175	10.6237	30.76042	<.0001*
MMed	MLow	14.85655	4.103175	4.7882	24.92490	0.0027*
MHigh	MMed	5.83552	4.103175	-4.2328	15.90387	0.3414



Oneway Analysis of MOE_PD By Type



Oneway Anova

Summary of Fit

Rsquare	0.245282
Adj Rsquare	0.199541
Root Mean Square Error	0.436053
Mean of Response	2.423992
Observations (or Sum Wgts)	36

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Type	2	2.0392614	1.01963	5.3625	0.0096*
Error	33	6.2746949	0.19014		
C. Total	35	8.3139562			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
MHigh	12	2.14103	0.12588	1.8849	2.3971
MMed	12	2.72333	0.12588	2.4672	2.9794
MLow	12	2.40762	0.12588	2.1515	2.6637

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
MHigh	12	2.14103	0.440755	0.12723	1.8610	2.4211
MMed	12	2.72333	0.433167	0.12504	2.4481	2.9985
MLow	12	2.40762	0.434199	0.12534	2.1317	2.6835

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2.45379	0.05

Oneway Analysis of MOE_PD By Type

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

HSD Threshold Matrix

Abs(Dif)-HSD

	MMed	MLow	MHigh
MMed	-0.43682	-0.12112	0.14548
MLow	-0.12112	-0.43682	-0.17022
MHigh	0.14548	-0.17022	-0.43682

Positive values show pairs of means that are significantly different.

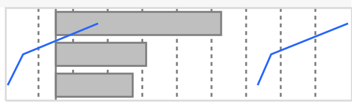
Connecting Letters Report

Level			Mean
MMed	A		2.7233250
MLow	A	B	2.4076250
MHigh		B	2.1410250

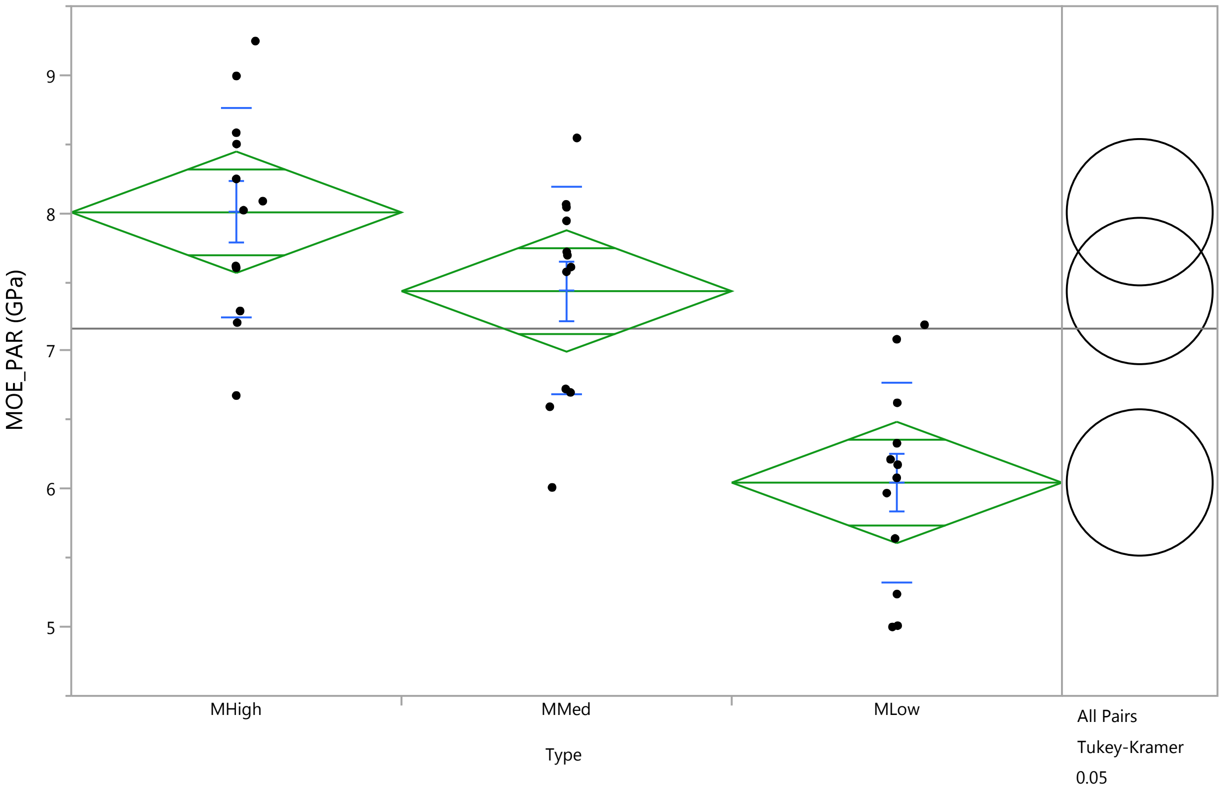
Levels not connected by same letter are significantly different.

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
MMed	MHigh	0.5823000	0.1780179	0.145481	1.019119	0.0069*
MMed	MLow	0.3157000	0.1780179	-0.121119	0.752519	0.1941
MLow	MHigh	0.2666000	0.1780179	-0.170219	0.703419	0.3051



Oneway Analysis of MOE_PAR By Type



Oneway Anova

Summary of Fit

Rsquare	0.568905
Adj Rsquare	0.542778
Root Mean Square Error	0.747951
Mean of Response	7.162508
Observations (or Sum Wgts)	36

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Type	2	24.362813	12.1814	21.7746	<.0001*
Error	33	18.461234	0.5594		
C. Total	35	42.824047			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
MHigh	12	8.00577	0.21591	7.5665	8.4450
MMed	12	7.43500	0.21591	6.9957	7.8743
MLow	12	6.04676	0.21591	5.6075	6.4860

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
MHigh	12	8.00577	0.762141	0.22001	7.5215	8.4900
MMed	12	7.43500	0.752365	0.21719	6.9570	7.9130
MLow	12	6.04676	0.728959	0.21043	5.5836	6.5099

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2.45379	0.05

Oneway Analysis of MOE_PAR By Type

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

HSD Threshold Matrix

Abs(Dif)-HSD

	MHigh	MMed	MLow
MHigh	-0.7493	-0.1785	1.2097
MMed	-0.1785	-0.7493	0.6390
MLow	1.2097	0.6390	-0.7493

Positive values show pairs of means that are significantly different.

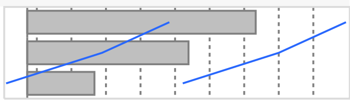
Connecting Letters Report

Level			Mean
MHigh	A		8.0057667
MMed	A		7.4350000
MLow		B	6.0467583

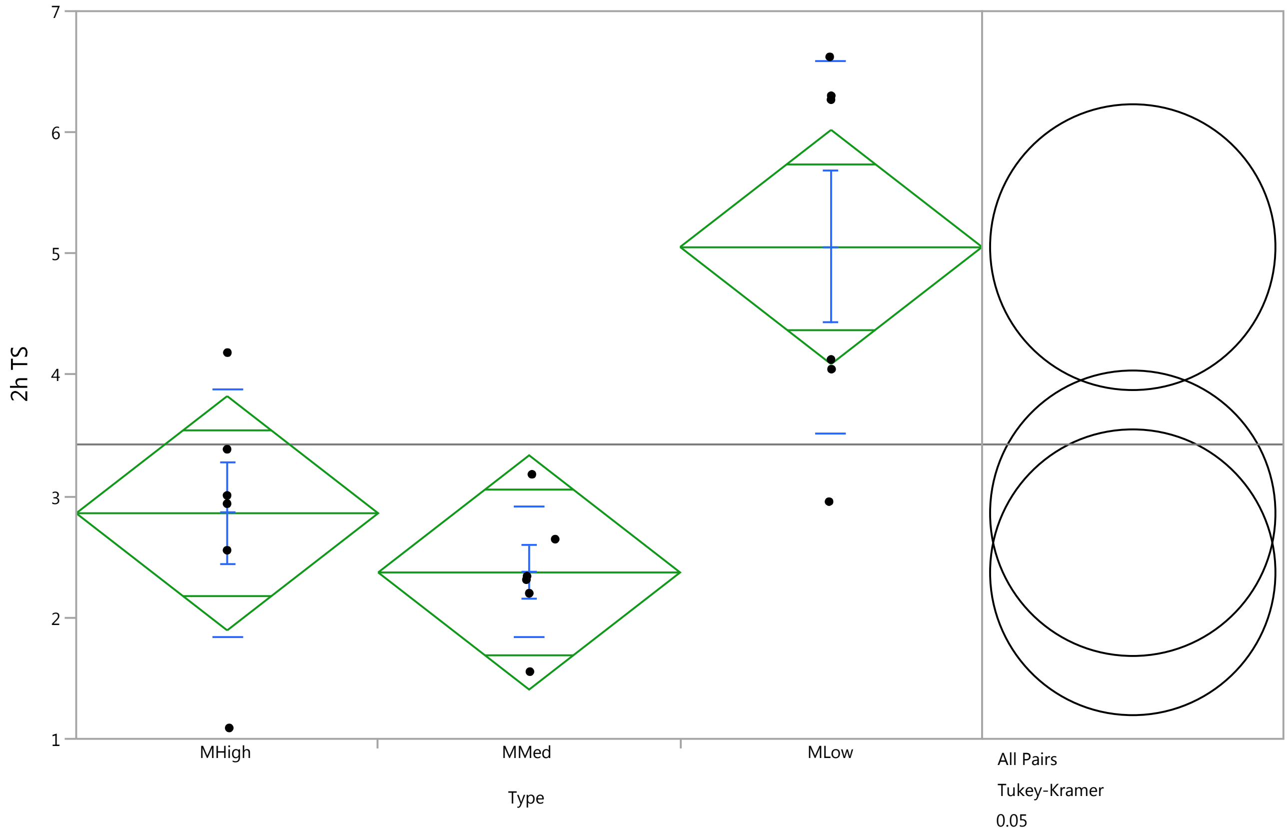
Levels not connected by same letter are significantly different.

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
MHigh	MLow	1.959008	0.3053499	1.20974	2.708274	<.0001*
MMed	MLow	1.388242	0.3053499	0.63898	2.137508	0.0002*
MHigh	MMed	0.570767	0.3053499	-0.17850	1.320033	0.1636



Oneway Analysis of 2h TS By Type



Oneway Anova

Summary of Fit

Rsquare	0.569729
Adj Rsquare	0.51236
Root Mean Square Error	1.110431
Mean of Response	3.429306
Observations (or Sum Wgts)	18

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Type	2	24.490669	12.2453	9.9309	0.0018*
Error	15	18.495846	1.2331		
C. Total	17	42.986516			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
MHigh	6	2.86063	0.45333	1.8944	3.8269
MMed	6	2.37262	0.45333	1.4064	3.3389
MLow	6	5.05467	0.45333	4.0884	6.0209

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
MHigh	6	2.86063	1.02854	0.41990	1.7812	3.9400
MMed	6	2.37262	0.53532	0.21854	1.8108	2.9344
MLow	6	5.05467	1.53451	0.62646	3.4443	6.6650

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2.59747	0.05

Oneway Analysis of 2h TS By Type

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

HSD Threshold Matrix

Abs(Dif)-HSD

	MLow	MHigh	MMed
MLow	-1.6653	0.5288	1.0168
MHigh	0.5288	-1.6653	-1.1772
MMed	1.0168	-1.1772	-1.6653

Positive values show pairs of means that are significantly different.

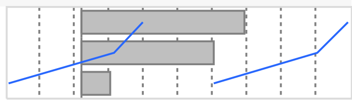
Connecting Letters Report

Level			Mean
MLow	A		5.0546667
MHigh		B	2.8606333
MMed		B	2.3726167

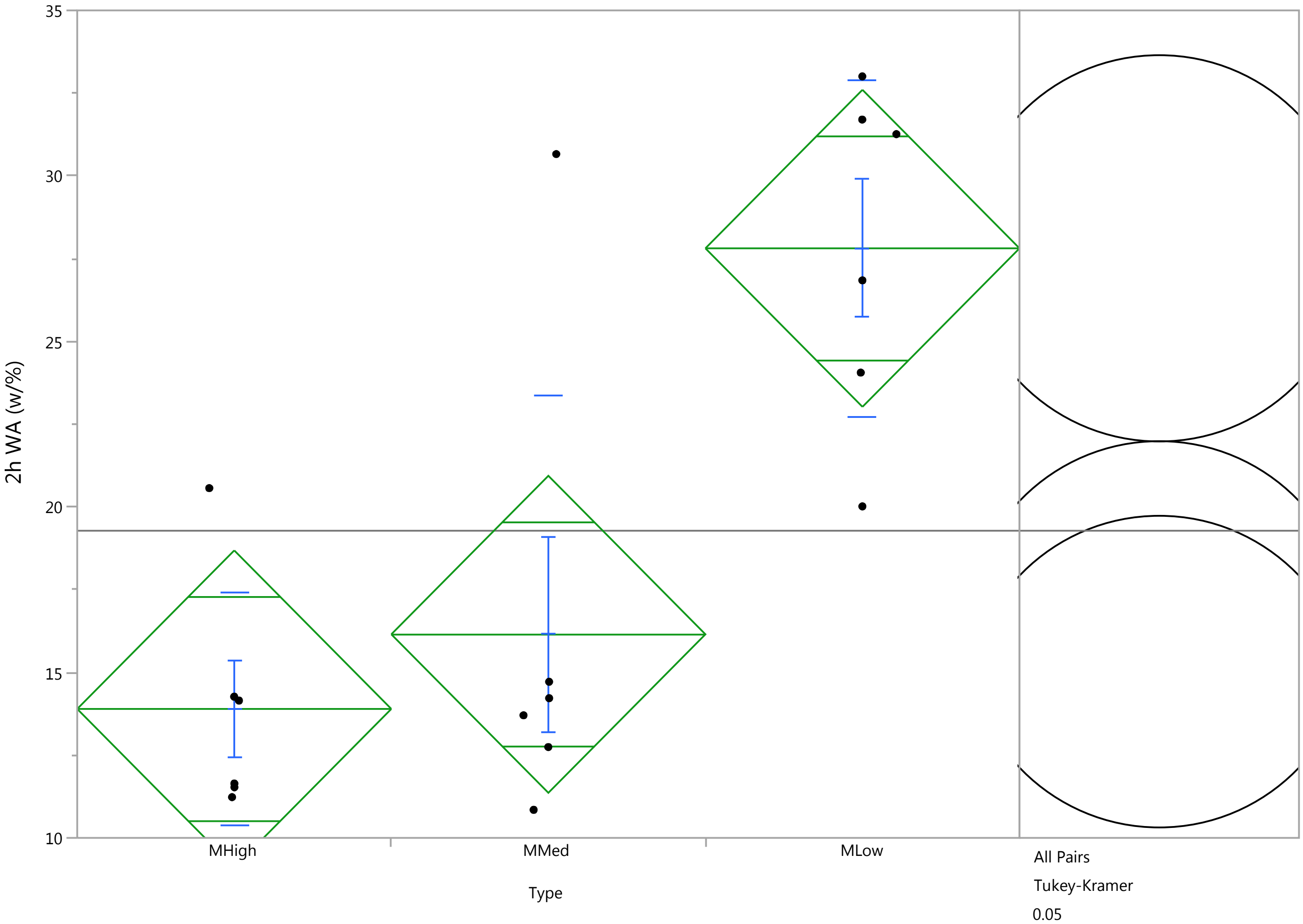
Levels not connected by same letter are significantly different.

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
MLow	MMed	2.682050	0.6411075	1.01679	4.347308	0.0022*
MLow	MHigh	2.194033	0.6411075	0.52878	3.859291	0.0099*
MHigh	MMed	0.488017	0.6411075	-1.17724	2.153274	0.7317



Oneway Analysis of 2h WA By Type



Oneway Anova

Summary of Fit

Rsquare	0.595798
Adj Rsquare	0.541904
Root Mean Square Error	5.503525
Mean of Response	19.28687
Observations (or Sum Wgts)	18

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Type	2	669.6895	334.845	11.0551	0.0011*
Error	15	454.3318	30.289		
C. Total	17	1124.0213			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
MHigh	6	13.8968	2.2468	9.108	18.686
MMed	6	16.1495	2.2468	11.360	20.938
MLow	6	27.8144	2.2468	23.025	32.603

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
MHigh	6	13.8968	3.53553	1.4434	10.186	17.607
MMed	6	16.1495	7.23861	2.9552	8.553	23.746
MLow	6	27.8144	5.09597	2.0804	22.466	33.162

Means Comparisons

Oneway Analysis of 2h WA By Type

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2.59747	0.05

HSD Threshold Matrix

Abs(Dif)-HSD

	MLow	MMed	MHigh
MLow	-8.2534	3.4116	5.6642
MMed	3.4116	-8.2534	-6.0007
MHigh	5.6642	-6.0007	-8.2534

Positive values show pairs of means that are significantly different.

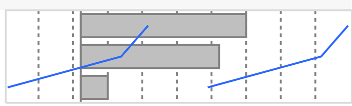
Connecting Letters Report

Level			Mean
MLow	A		27.814383
MMed		B	16.149450
MHigh		B	13.896783

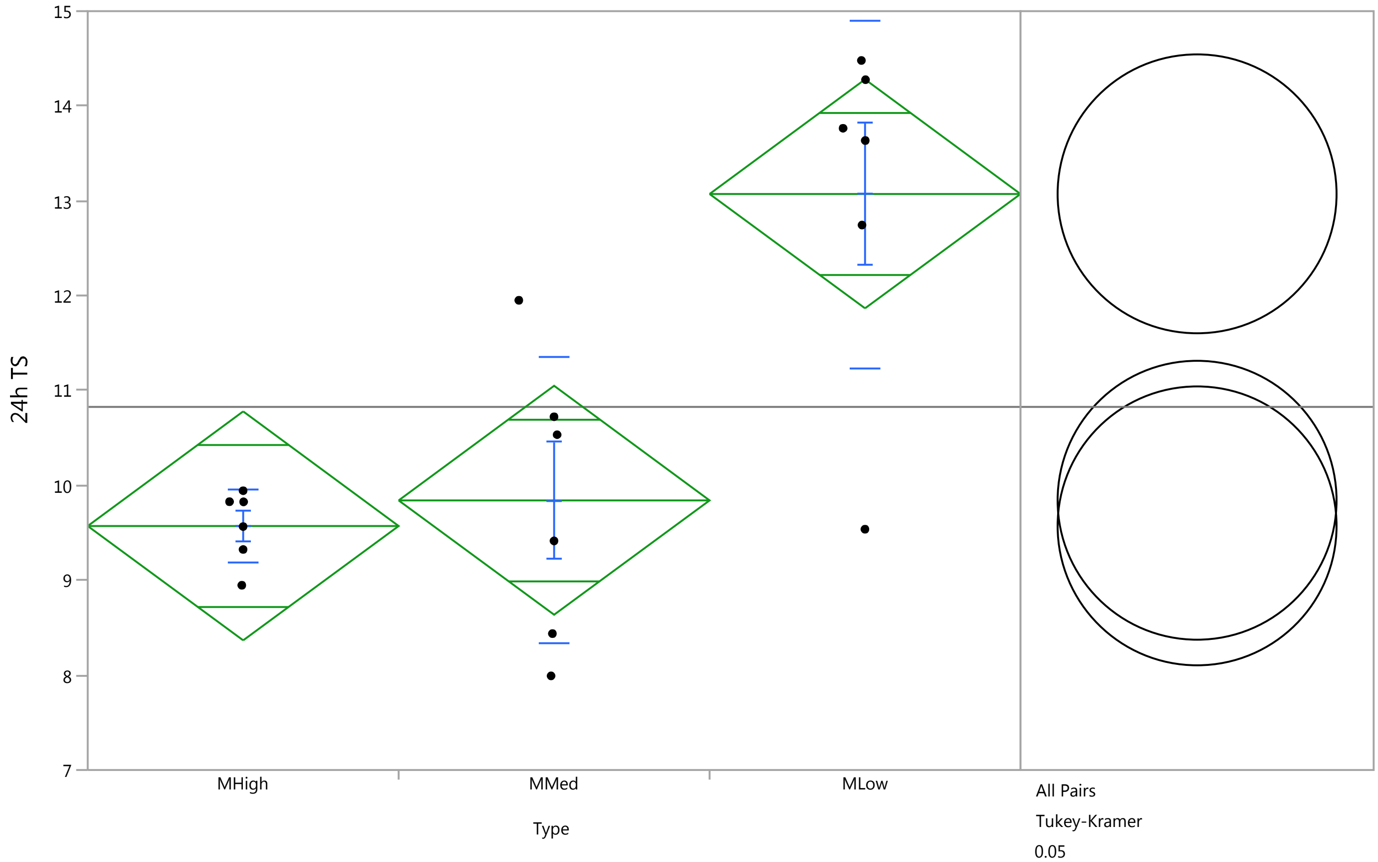
Levels not connected by same letter are significantly different.

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
MLow	MHigh	13.91760	3.177462	5.66424	22.17096	0.0015*
MLow	MMed	11.66493	3.177462	3.41157	19.91830	0.0060*
MMed	MHigh	2.25267	3.177462	-6.00070	10.50603	0.7620



Oneway Analysis of 24h TS By Type



Oneway Anova

Summary of Fit

Rsquare	0.612235
Adj Rsquare	0.560533
Root Mean Square Error	1.386448
Mean of Response	10.82983
Observations (or Sum Wgts)	18

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Type	2	45.524827	22.7624	11.8416	0.0008*
Error	15	28.833567	1.9222		
C. Total	17	74.358394			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
MHigh	6	9.5731	0.56601	8.367	10.780
MMed	6	9.8429	0.56601	8.636	11.049
MLow	6	13.0735	0.56601	11.867	14.280

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
MHigh	6	9.5731	0.37965	0.15499	9.175	9.972
MMed	6	9.8429	1.50203	0.61320	8.267	11.419
MLow	6	13.0735	1.83480	0.74905	11.148	14.999

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Oneway Analysis of 24h TS By Type

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2.59747	0.05

HSD Threshold Matrix

Abs(Dif)-HSD

	MLow	MMed	MHigh
MLow	-2.0792	1.1515	1.4212
MMed	1.1515	-2.0792	-1.8095
MHigh	1.4212	-1.8095	-2.0792

Positive values show pairs of means that are significantly different.

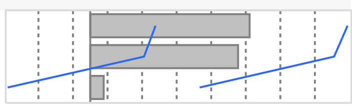
Connecting Letters Report

Level			Mean
MLow	A		13.073500
MMed		B	9.842850
MHigh		B	9.573133

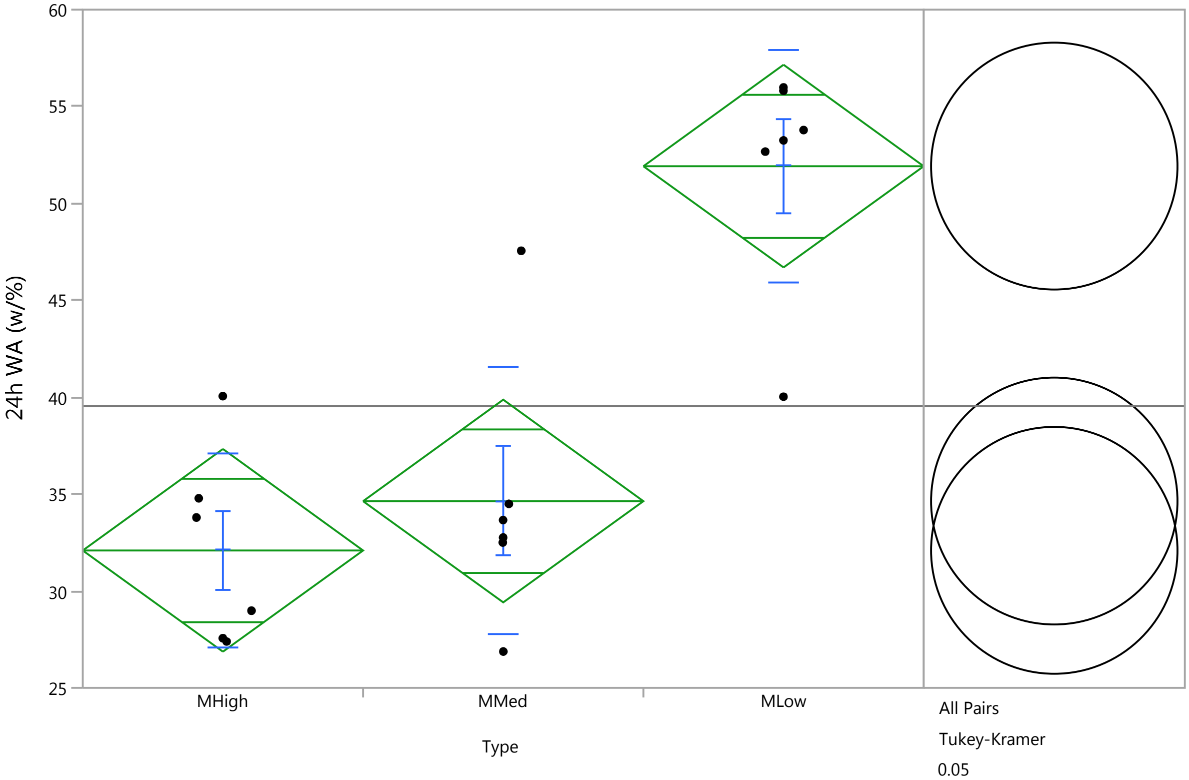
Levels not connected by same letter are significantly different.

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
MLow	MHigh	3.500367	0.8004661	1.42118	5.579554	0.0015*
MLow	MMed	3.230650	0.8004661	1.15146	5.309837	0.0029*
MMed	MHigh	0.269717	0.8004661	-1.80947	2.348904	0.9396



Oneway Analysis of 24h WA By Type



Oneway Anova

Summary of Fit

Rsquare	0.72075
Adj Rsquare	0.683516
Root Mean Square Error	6.006558
Mean of Response	39.55326
Observations (or Sum Wgts)	18

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Type	2	1396.7979	698.399	19.3576	<.0001*
Error	15	541.1812	36.079		
C. Total	17	1937.9791			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
MHigh	6	32.0953	2.4522	26.869	37.322
MMed	6	34.6403	2.4522	29.414	39.867
MLow	6	51.9242	2.4522	46.698	57.151

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
MHigh	6	32.0953	5.01632	2.0479	26.831	37.360
MMed	6	34.6403	6.87445	2.8065	27.426	41.855
MLow	6	51.9242	5.98454	2.4432	45.644	58.205

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2.59747	0.05

Oneway Analysis of 24h WA By Type

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

HSD Threshold Matrix

Abs(Dif)-HSD

	MLow	MMed	MHigh
MLow	-9.008	8.276	10.821
MMed	8.276	-9.008	-6.463
MHigh	10.821	-6.463	-9.008

Positive values show pairs of means that are significantly different.

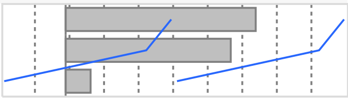
Connecting Letters Report

Level			Mean
MLow	A		51.924217
MMed		B	34.640300
MHigh		B	32.095250

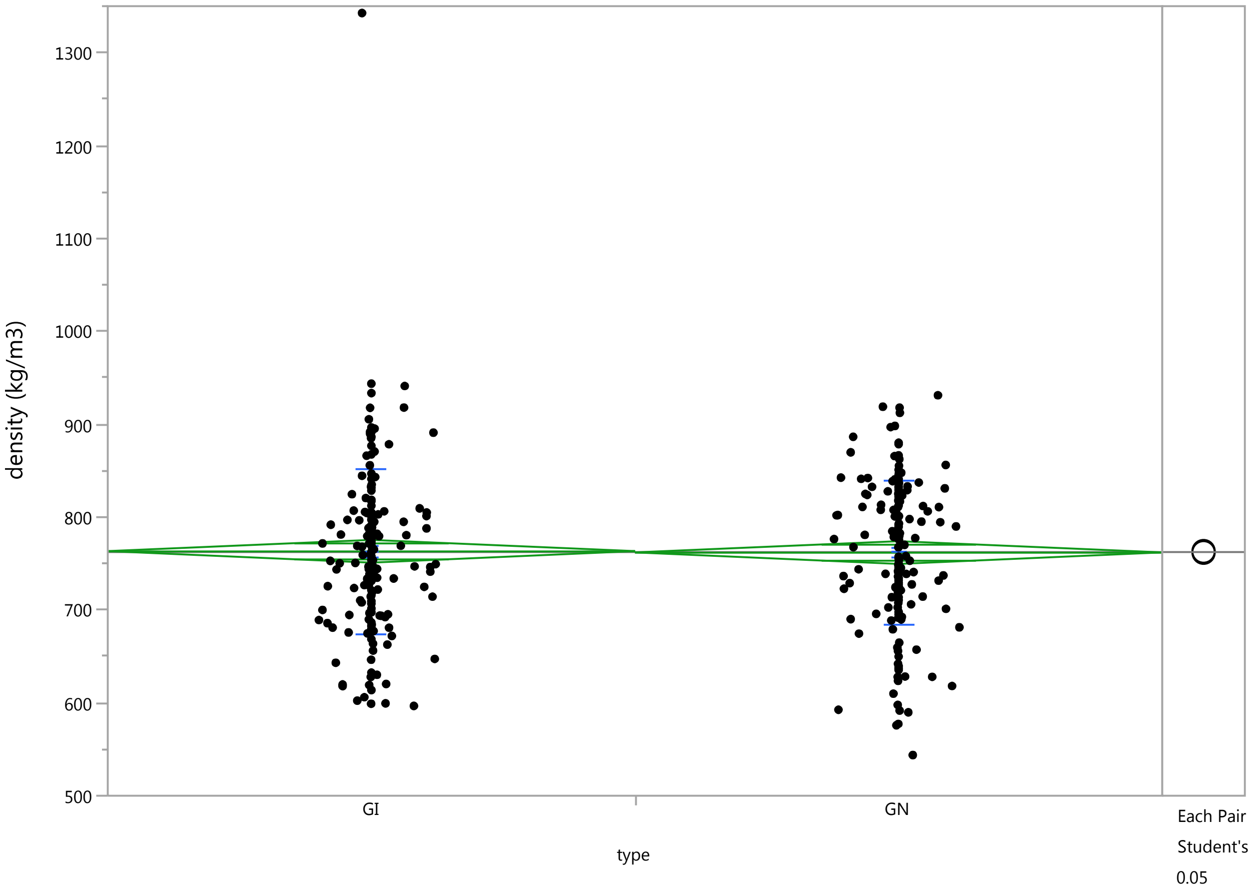
Levels not connected by same letter are significantly different.

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
MLow	MHigh	19.82897	3.467888	10.8212	28.83670	0.0001*
MLow	MMed	17.28392	3.467888	8.2762	26.29165	0.0005*
MMed	MHigh	2.54505	3.467888	-6.4627	11.55279	0.7476



Oneway Analysis of density By type



Oneway Anova

Summary of Fit

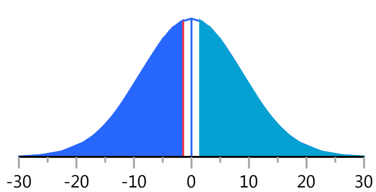
Rsquare	7.87e-5
Adj Rsquare	-0.00271
Root Mean Square Error	83.34964
Mean of Response	762.5301
Observations (or Sum Wgts)	360

t Test

GN-GI

Assuming equal variances

Difference	-1.475	t Ratio	-0.16786
Std Err Dif	8.786	DF	358
Upper CL Dif	15.804	Prob > |t|	0.8668
Lower CL Dif	-18.753	Prob > t	0.5666
Confidence	0.95	Prob < t	0.4334



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
type	1	195.7	195.75	0.0282	0.8668
Error	358	2487083.9	6947.16		
C. Total	359	2487279.6			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
GI	180	763.267	6.2125	751.05	775.49
GN	180	761.793	6.2125	749.58	774.01

Std Error uses a pooled estimate of error variance

Oneway Analysis of density By type

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
GI	180	763.267	88.8014	6.6189	750.21	776.33
GN	180	761.793	77.5154	5.7777	750.39	773.19

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
1.96661	0.05

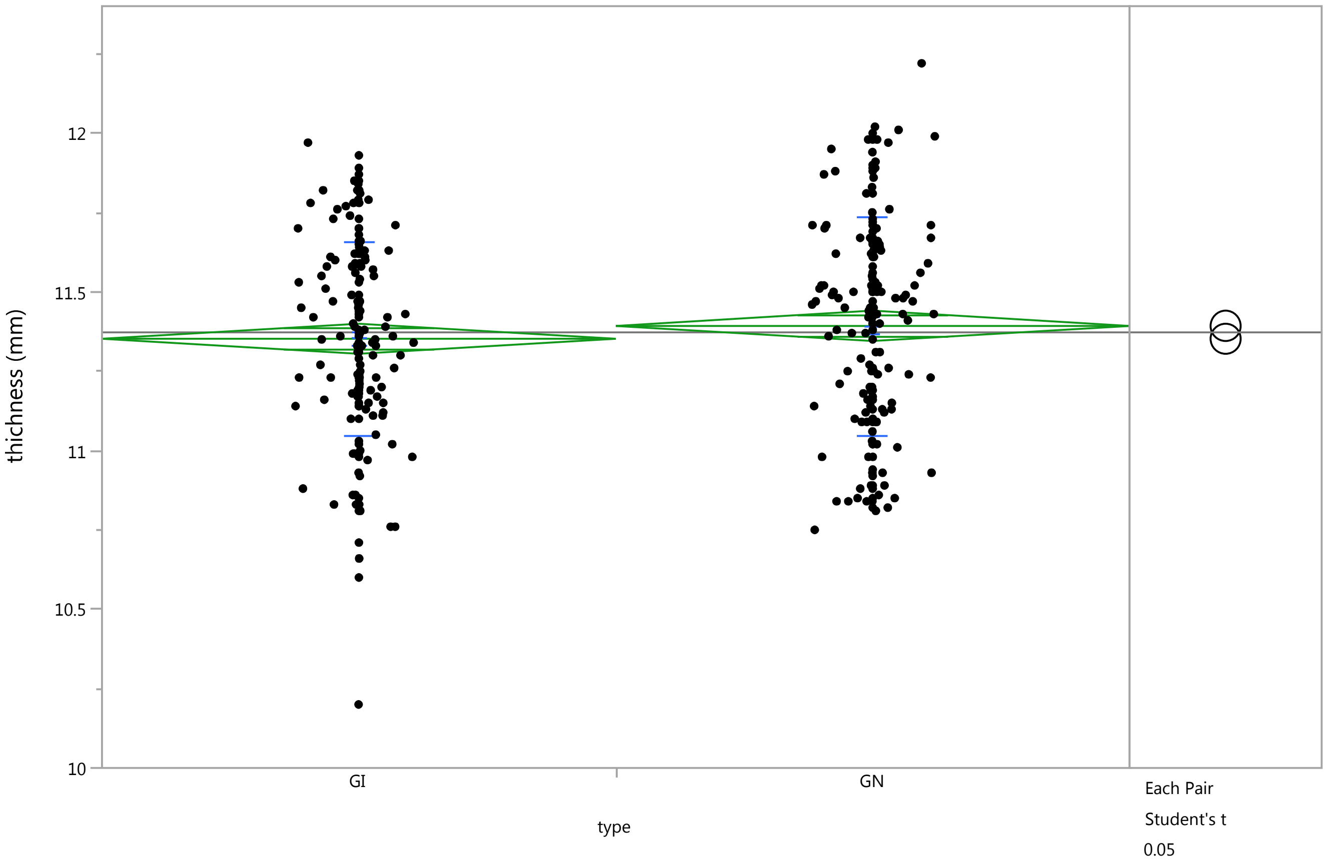
LSD Threshold Matrix

Abs(Dif)-LSD

	GI	GN
GI	-17.278	-15.804
GN	-15.804	-17.278

Positive values show pairs of means that are significantly different.

Oneway Analysis of thichness By type



Oneway Anova

Summary of Fit

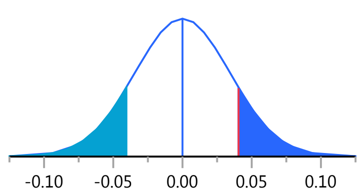
Rsquare	0.003863
Adj Rsquare	0.001081
Root Mean Square Error	0.326081
Mean of Response	11.37236
Observations (or Sum Wgts)	360

t Test

GN-GI

Assuming equal variances

Difference	0.04050	t Ratio	1.178287
Std Err Dif	0.03437	DF	358
Upper CL Dif	0.10810	Prob > |t|	0.2395
Lower CL Dif	-0.02710	Prob > t	0.1197
Confidence	0.95	Prob < t	0.8803



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
type	1	0.147623	0.147623	1.3884	0.2395
Error	358	38.065671	0.106329		
C. Total	359	38.213293			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
GI	180	11.3521	0.02430	11.304	11.400
GN	180	11.3926	0.02430	11.345	11.440

Std Error uses a pooled estimate of error variance

Oneway Analysis of thichness By type

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
GI	180	11.3521	0.305771	0.02279	11.307	11.397
GN	180	11.3926	0.345197	0.02573	11.342	11.443

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
1.96661	0.05

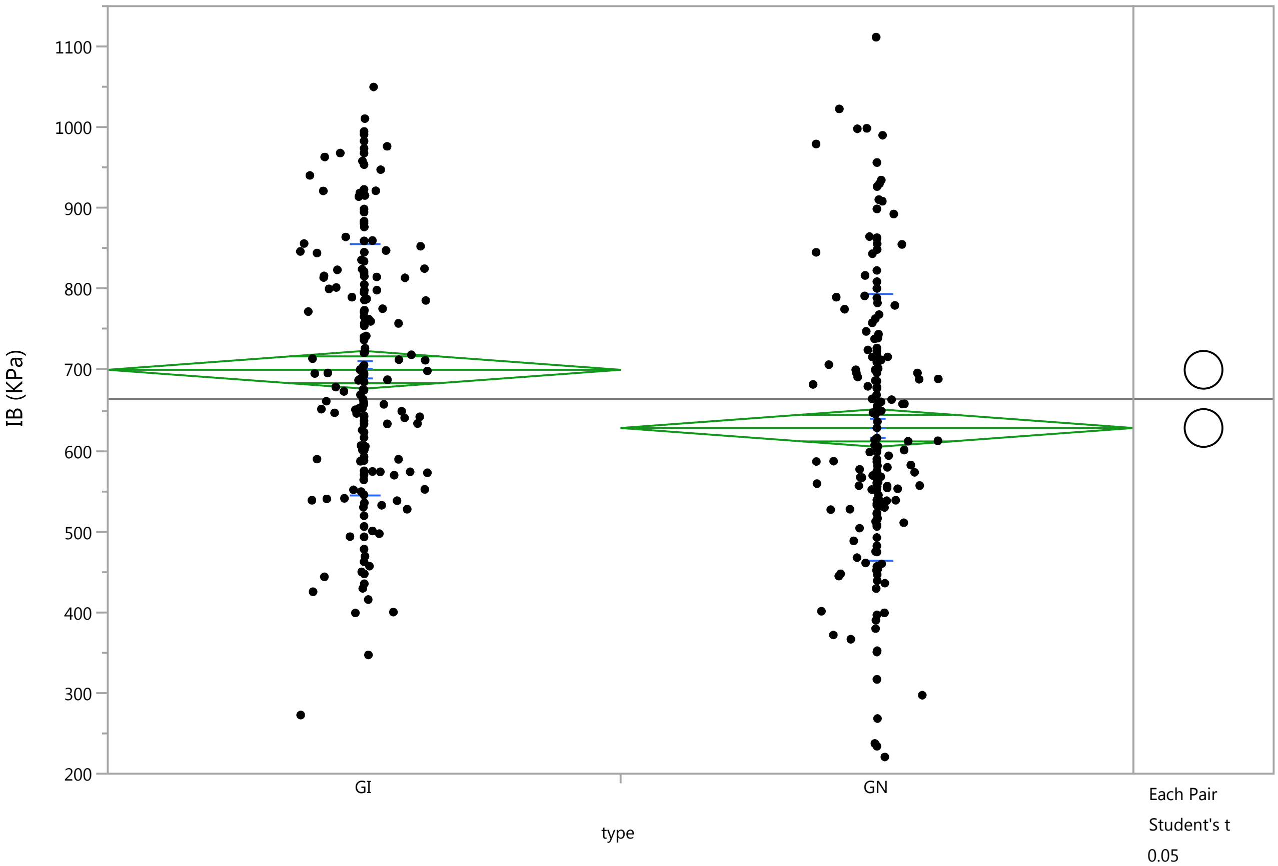
LSD Threshold Matrix

Abs(Dif)-LSD

	GN	GI
GN	-0.06760	-0.02710
GI	-0.02710	-0.06760

Positive values show pairs of means that are significantly different.

Oneway Analysis of IB By type



Oneway Anova

Summary of Fit

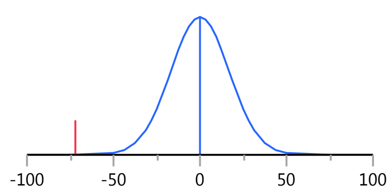
Rsquare	0.048655
Adj Rsquare	0.045997
Root Mean Square Error	159.8519
Mean of Response	663.9342
Observations (or Sum Wgts)	360

t Test

GN-GI

Assuming equal variances

Difference	-72.10	t Ratio	-4.27893
Std Err Dif	16.85	DF	358
Upper CL Dif	-38.96	Prob > |t|	<.0001*
Lower CL Dif	-105.24	Prob > t	1.0000
Confidence	0.95	Prob < t	<.0001*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
type	1	467849.7	467850	18.3093	<.0001*
Error	358	9147839.8	25553		
C. Total	359	9615689.5			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
GI	180	699.984	11.915	676.55	723.42
GN	180	627.884	11.915	604.45	651.32

Std Error uses a pooled estimate of error variance

Oneway Analysis of IB By type

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
GI	180	699.984	154.682	11.529	677.23	722.73
GN	180	627.884	164.860	12.288	603.64	652.13

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
1.96661	0.05

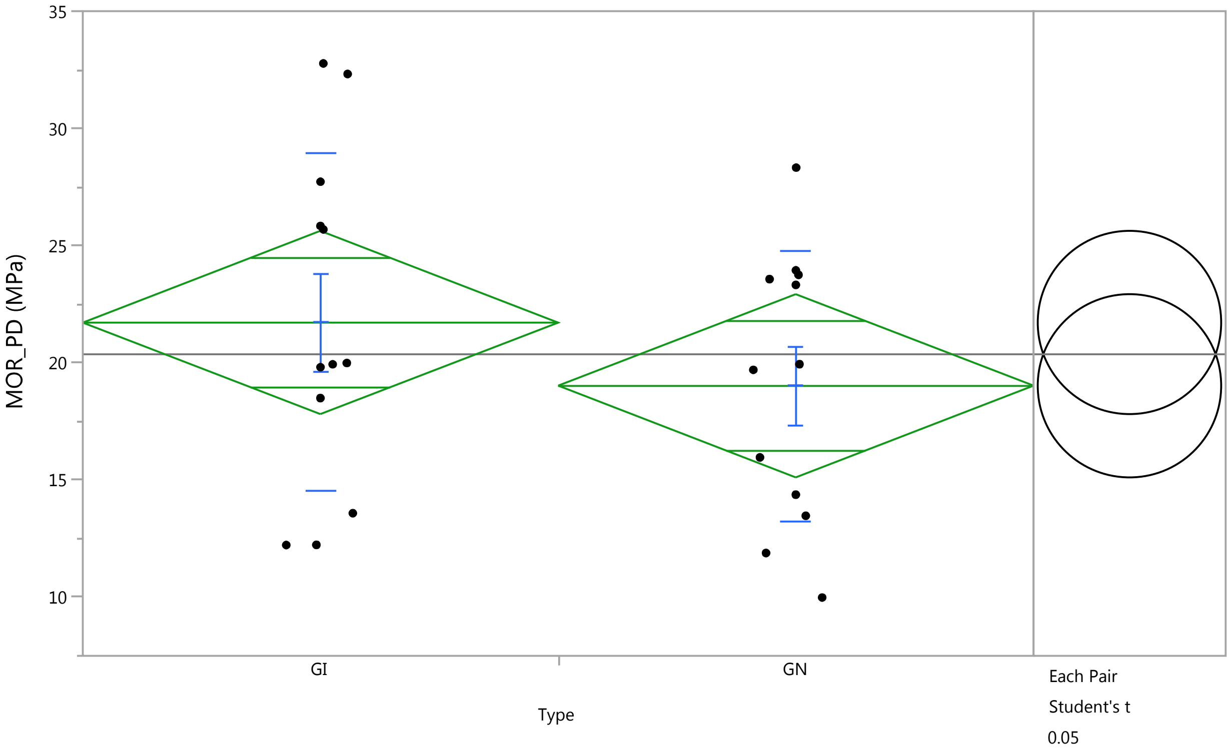
LSD Threshold Matrix

Abs(Dif)-LSD

	GI	GN
GI	-33.137	38.962
GN	38.962	-33.137

Positive values show pairs of means that are significantly different.

Oneway Analysis of MOR_PD By Type



Oneway Anova

Summary of Fit

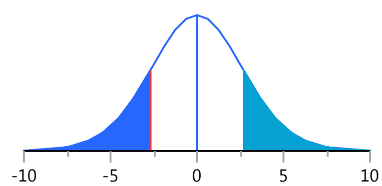
Rsquare	0.044503
Adj Rsquare	0.001072
Root Mean Square Error	6.528236
Mean of Response	20.36855
Observations (or Sum Wgts)	24

t Test

GN-GI

Assuming equal variances

Difference	-2.6978	t Ratio	-1.01226
Std Err Dif	2.6651	DF	22
Upper CL Dif	2.8293	Prob > |t|	0.3224
Lower CL Dif	-8.2250	Prob > t	0.8388
Confidence	0.95	Prob < t	0.1612



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Type	1	43.66956	43.6696	1.0247	0.3224
Error	22	937.59317	42.6179		
C. Total	23	981.26273			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
GI	12	21.7175	1.8845	17.809	25.626
GN	12	19.0196	1.8845	15.111	22.928

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
GI	12	21.7175	7.19649	2.0774	17.145	26.290
GN	12	19.0196	5.78327	1.6695	15.345	22.694

Means Comparisons

Oneway Analysis of MOR_PD By Type

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
2.07387	0.05

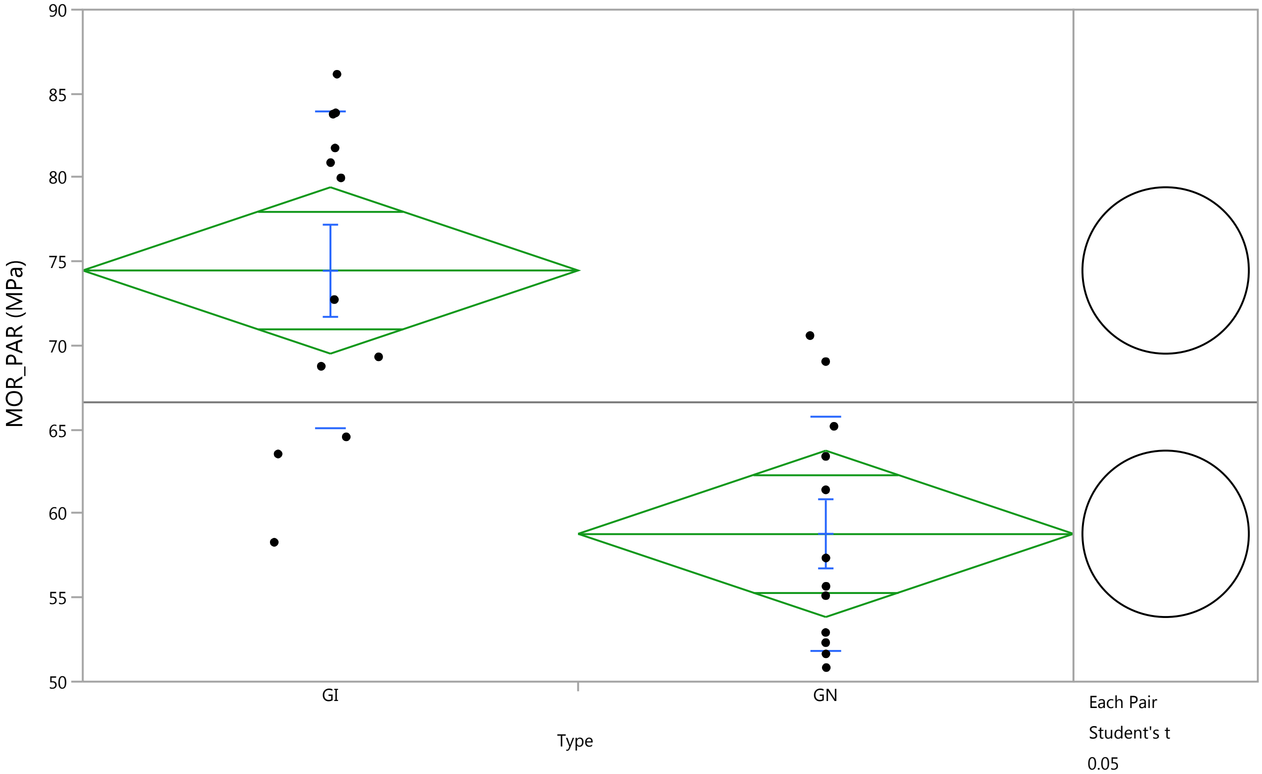
LSD Threshold Matrix

Abs(Dif)-LSD

	GI	GN
GI	-5.5272	-2.8293
GN	-2.8293	-5.5272

Positive values show pairs of means that are significantly different.

Oneway Analysis of MOR_PAR By Type



Oneway Anova

Summary of Fit

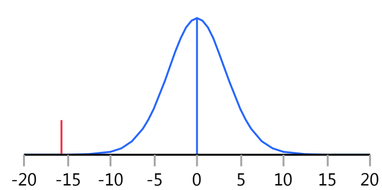
Rsquare	0.494624
Adj Rsquare	0.471653
Root Mean Square Error	8.276161
Mean of Response	66.63688
Observations (or Sum Wgts)	24

t Test

GN-GI

Assuming equal variances

Difference	-15.678	t Ratio	-4.64025
Std Err Dif	3.379	DF	22
Upper CL Dif	-8.671	Prob > |t|	0.0001*
Lower CL Dif	-22.685	Prob > t	0.9999
Confidence	0.95	Prob < t	<.0001*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Type	1	1474.8279	1474.83	21.5320	0.0001*
Error	22	1506.8863	68.49		
C. Total	23	2981.7142			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
GI	12	74.4760	2.3891	69.521	79.431
GN	12	58.7978	2.3891	53.843	63.753

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
GI	12	74.4760	9.42488	2.7207	68.488	80.464
GN	12	58.7978	6.93984	2.0034	54.388	63.207

Means Comparisons

Oneway Analysis of MOR_PAR By Type

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
2.07387	0.05

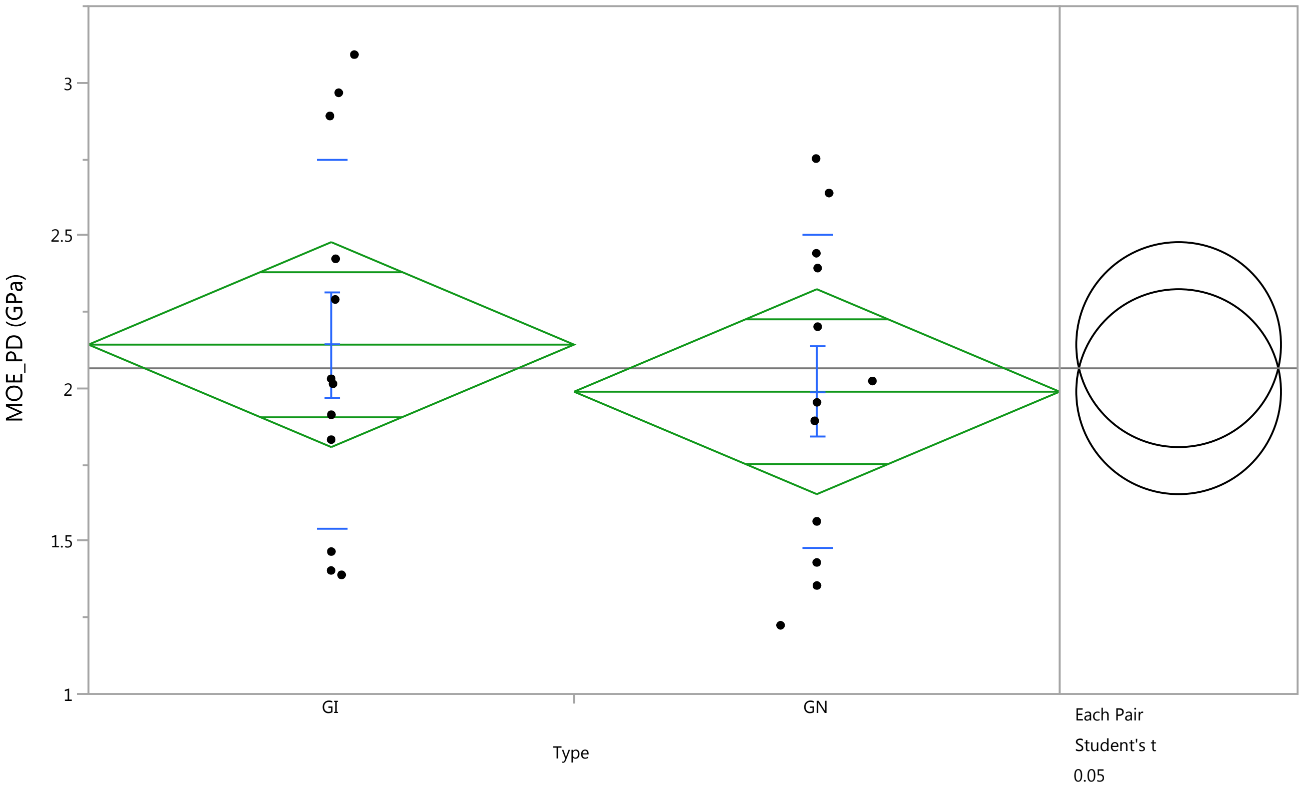
LSD Threshold Matrix

Abs(Dif)-LSD

	GI	GN
GI	-7.0071	8.6711
GN	8.6711	-7.0071

Positive values show pairs of means that are significantly different.

Oneway Analysis of MOE_PD By Type



Oneway Anova

Summary of Fit

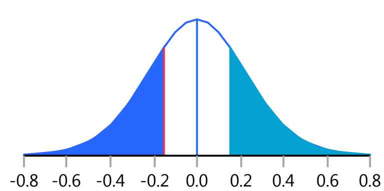
Rsquare	0.020102
Adj Rsquare	-0.02444
Root Mean Square Error	0.559831
Mean of Response	2.066004
Observations (or Sum Wgts)	24

t Test

GN-GI

Assuming equal variances

Difference	-0.15354	t Ratio	-0.67181
Std Err Dif	0.22855	DF	22
Upper CL Dif	0.32044	Prob > |t|	0.5087
Lower CL Dif	-0.62753	Prob > t	0.7456
Confidence	0.95	Prob < t	0.2544



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Type	1	0.1414503	0.141450	0.4513	0.5087
Error	22	6.8950441	0.313411		
C. Total	23	7.0364944			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
GI	12	2.14278	0.16161	1.8076	2.4779
GN	12	1.98923	0.16161	1.6541	2.3244

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
GI	12	2.14278	0.602132	0.17382	1.7602	2.5254
GN	12	1.98923	0.514062	0.14840	1.6626	2.3159

Oneway Analysis of MOE_PD By Type

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
2.07387	0.05

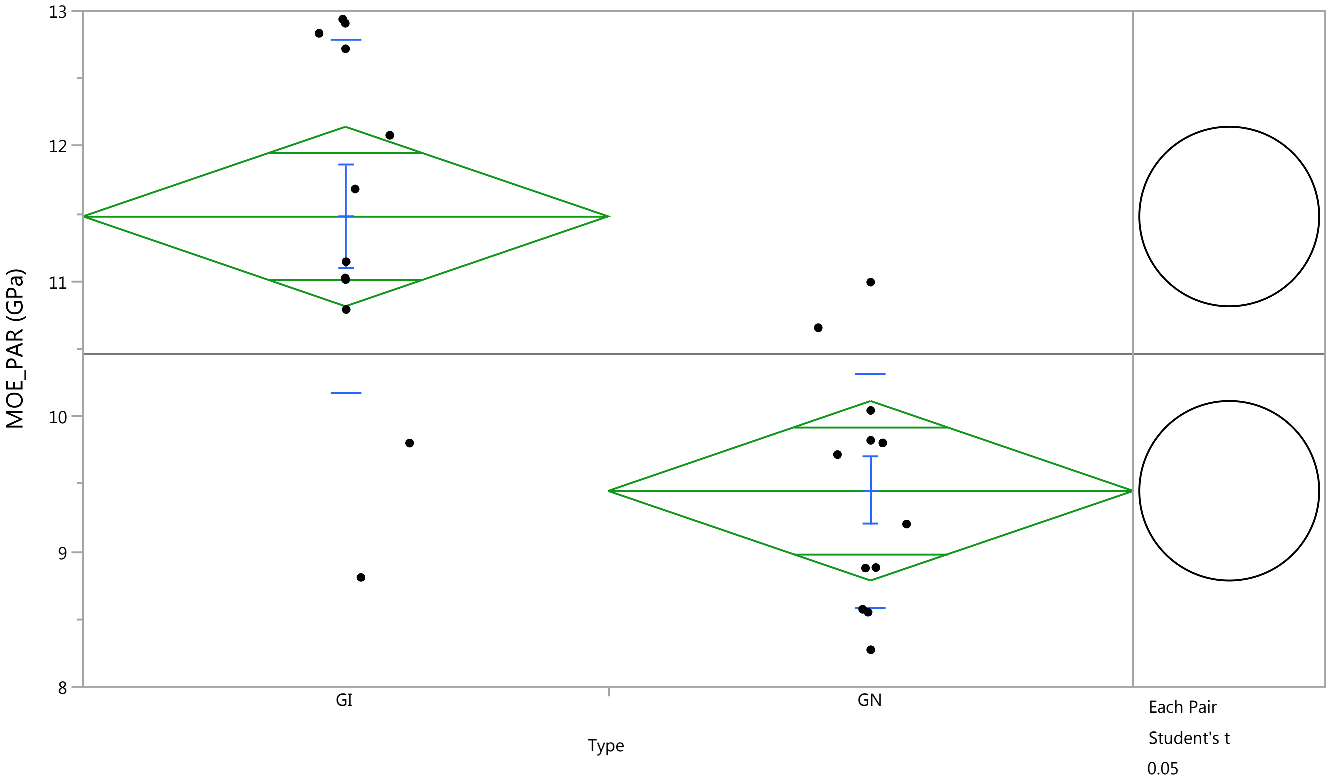
LSD Threshold Matrix

Abs(Dif)-LSD

	GI	GN
GI	-0.47398	-0.32044
GN	-0.32044	-0.47398

Positive values show pairs of means that are significantly different.

Oneway Analysis of MOE_PAR By Type



Oneway Anova

Summary of Fit

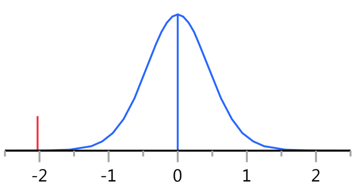
Rsquare	0.476886
Adj Rsquare	0.453108
Root Mean Square Error	1.109886
Mean of Response	10.46435
Observations (or Sum Wgts)	24

t Test

GN-GI

Assuming equal variances

Difference	-2.0292	t Ratio	-4.47837
Std Err Dif	0.4531	DF	22
Upper CL Dif	-1.0895	Prob > |t|	0.0002*
Lower CL Dif	-2.9689	Prob > t	0.9999
Confidence	0.95	Prob < t	<.0001*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Type	1	24.705713	24.7057	20.0558	0.0002*
Error	22	27.100637	1.2318		
C. Total	23	51.806350			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
GI	12	11.4790	0.32040	10.814	12.143
GN	12	9.4498	0.32040	8.785	10.114

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
GI	12	11.4790	1.31085	0.37841	10.646	12.312
GN	12	9.4498	0.86335	0.24923	8.901	9.998

Means Comparisons

Oneway Analysis of MOE_PAR By Type

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
2.07387	0.05

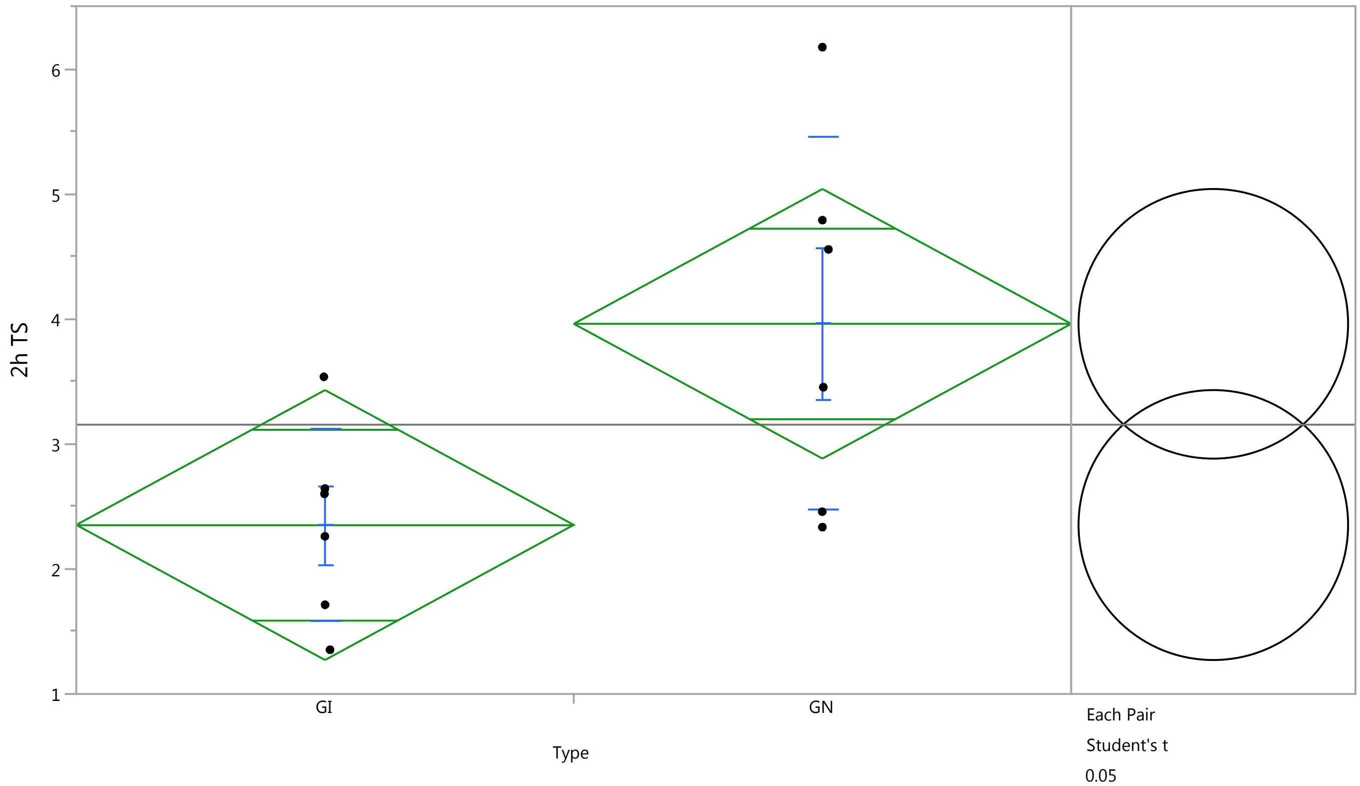
LSD Threshold Matrix

Abs(Dif)-LSD

	GI	GN
GI	-0.9397	1.0895
GN	1.0895	-0.9397

Positive values show pairs of means that are significantly different.

Oneway Analysis of 2h TS By Type



Oneway Anova

Summary of Fit

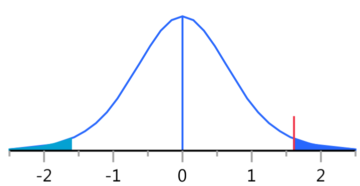
Rsquare	0.355915
Adj Rsquare	0.291506
Root Mean Square Error	1.185636
Mean of Response	3.155433
Observations (or Sum Wgts)	12

t Test

GN-GI

Assuming equal variances

Difference	1.60913	t Ratio	2.350723
Std Err Dif	0.68453	DF	10
Upper CL Dif	3.13435	Prob > |t|	0.0406*
Lower CL Dif	0.08391	Prob > t	0.0203*
Confidence	0.95	Prob < t	0.9797



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Type	1	7.767930	7.76793	5.5259	0.0406*
Error	10	14.057318	1.40573		
C. Total	11	21.825248			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
GI	6	2.35087	0.48403	1.2724	3.4294
GN	6	3.96000	0.48403	2.8815	5.0385

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
GI	6	2.35087	0.76986	0.31429	1.5429	3.1588
GN	6	3.96000	1.48956	0.60811	2.3968	5.5232

Oneway Analysis of 2h TS By Type

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
2.22814	0.05

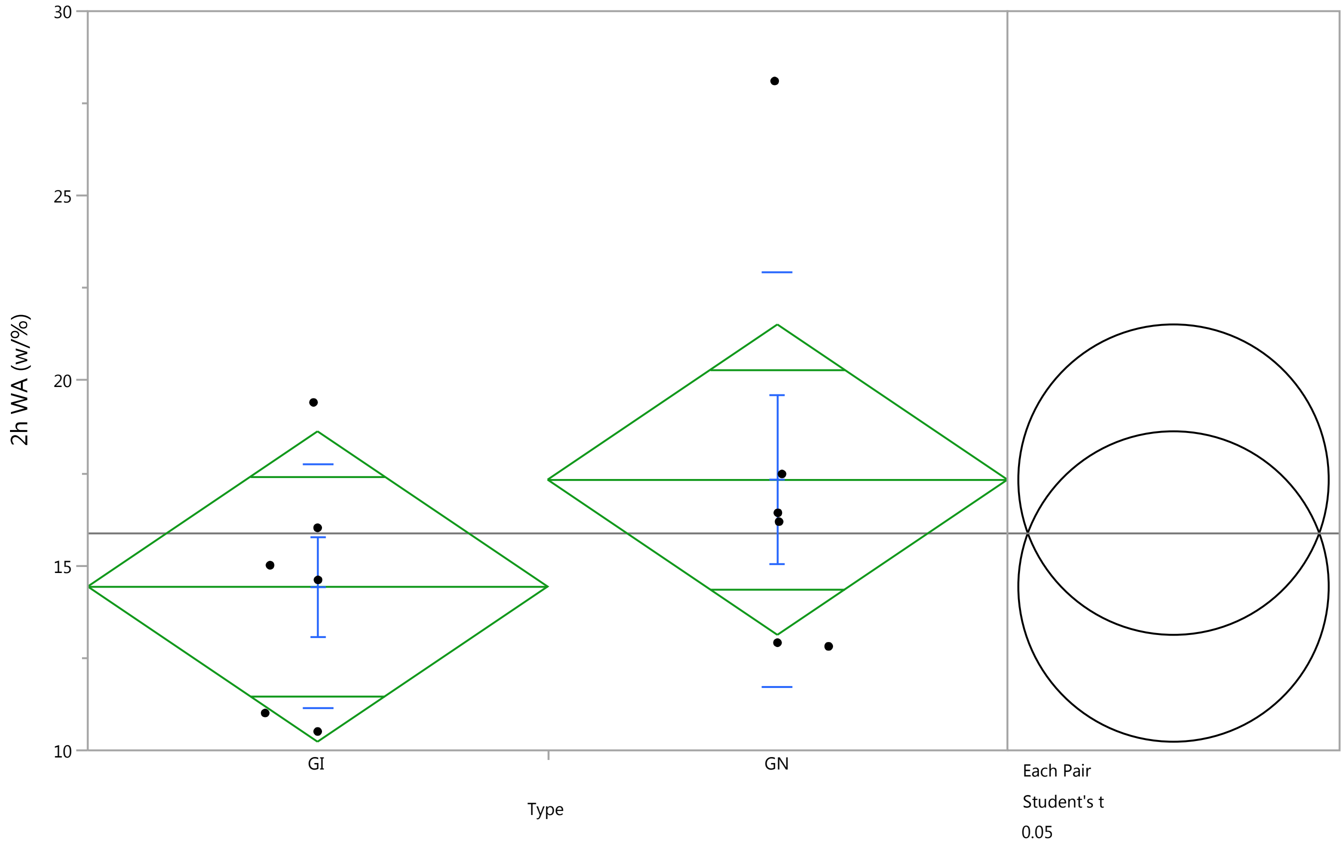
LSD Threshold Matrix

Abs(Dif)-LSD

	GN	GI
GN	-1.5252	0.0839
GI	0.0839	-1.5252

Positive values show pairs of means that are significantly different.

Oneway Analysis of 2h WA By Type



Oneway Anova

Summary of Fit

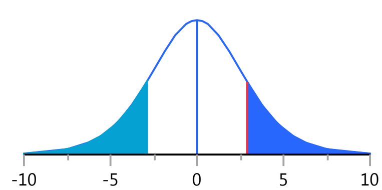
Rsquare	0.105343
Adj Rsquare	0.015877
Root Mean Square Error	4.615752
Mean of Response	15.87528
Observations (or Sum Wgts)	12

t Test

GN-GI

Assuming equal variances

Difference	2.8917	t Ratio	1.08511
Std Err Dif	2.6649	DF	10
Upper CL Dif	8.8295	Prob > |t|	0.3033
Lower CL Dif	-3.0461	Prob > t	0.1517
Confidence	0.95	Prob < t	0.8483



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Type	1	25.08608	25.0861	1.1775	0.3033
Error	10	213.05166	21.3052		
C. Total	11	238.13774			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
GI	6	14.4294	1.8844	10.231	18.628
GN	6	17.3211	1.8844	13.122	21.520

Std Error uses a pooled estimate of error variance

Oneway Analysis of 2h WA By Type

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
GI	6	14.4294	3.31080	1.3516	10.955	17.904
GN	6	17.3211	5.62574	2.2967	11.417	23.225

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
2.22814	0.05

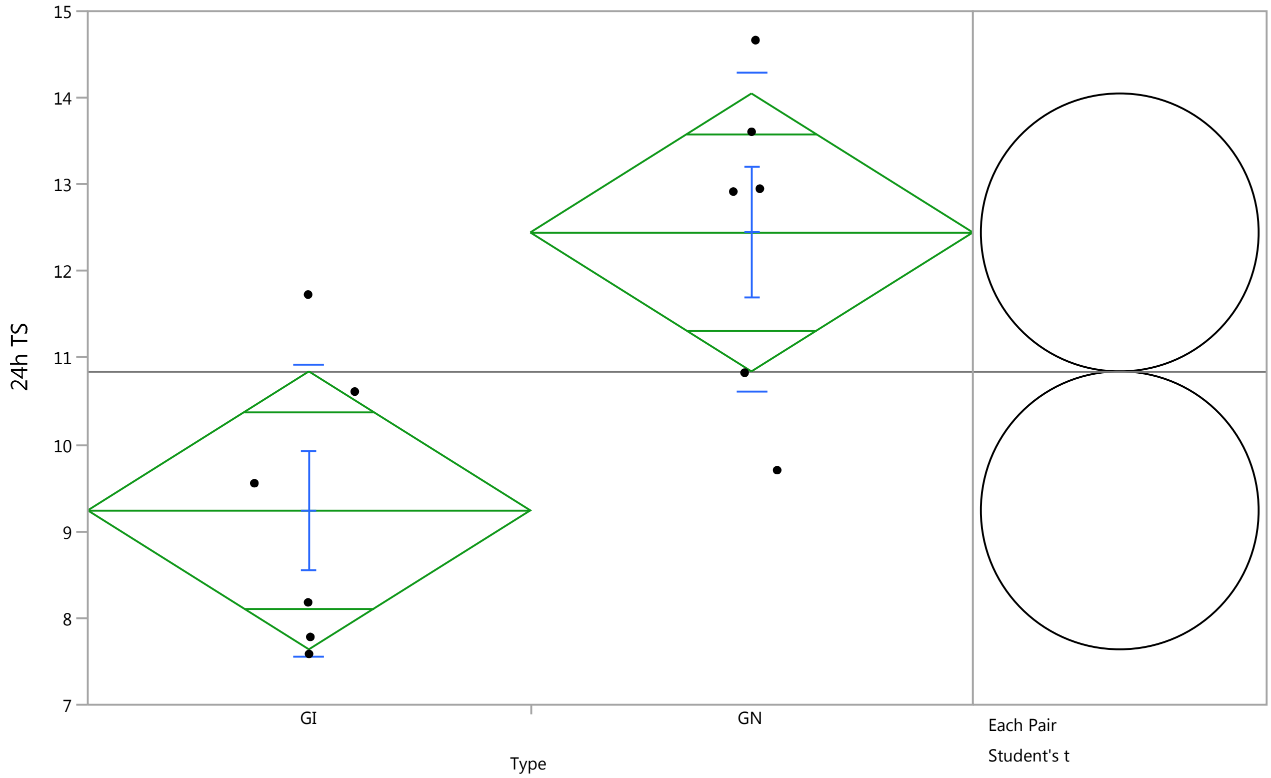
LSD Threshold Matrix

Abs(Dif)-LSD

	GN	GI
GN	-5.9378	-3.0461
GI	-3.0461	-5.9378

Positive values show pairs of means that are significantly different.

Oneway Analysis of 24h TS By Type



Oneway Anova

Summary of Fit

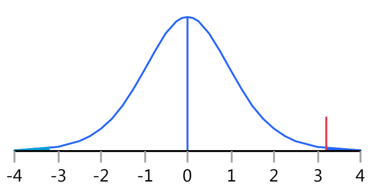
Rsquare	0.498172
Adj Rsquare	0.447989
Root Mean Square Error	1.762156
Mean of Response	10.84393
Observations (or Sum Wgts)	12

t Test

GN-GI

Assuming equal variances

Difference	3.20550	t Ratio	3.150737
Std Err Dif	1.01738	DF	10
Upper CL Dif	5.47237	Prob > |t|	0.0103*
Lower CL Dif	0.93863	Prob > t	0.0052*
Confidence	0.95	Prob < t	0.9948



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Type	1	30.825691	30.8257	9.9271	0.0103*
Error	10	31.051924	3.1052		
C. Total	11	61.877614			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
GI	6	9.2412	0.71940	7.638	10.844
GN	6	12.4467	0.71940	10.844	14.050

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
GI	6	9.2412	1.68359	0.68732	7.474	11.008
GN	6	12.4467	1.83736	0.75010	10.518	14.375

Oneway Analysis of 24h TS By Type

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
2.22814	0.05

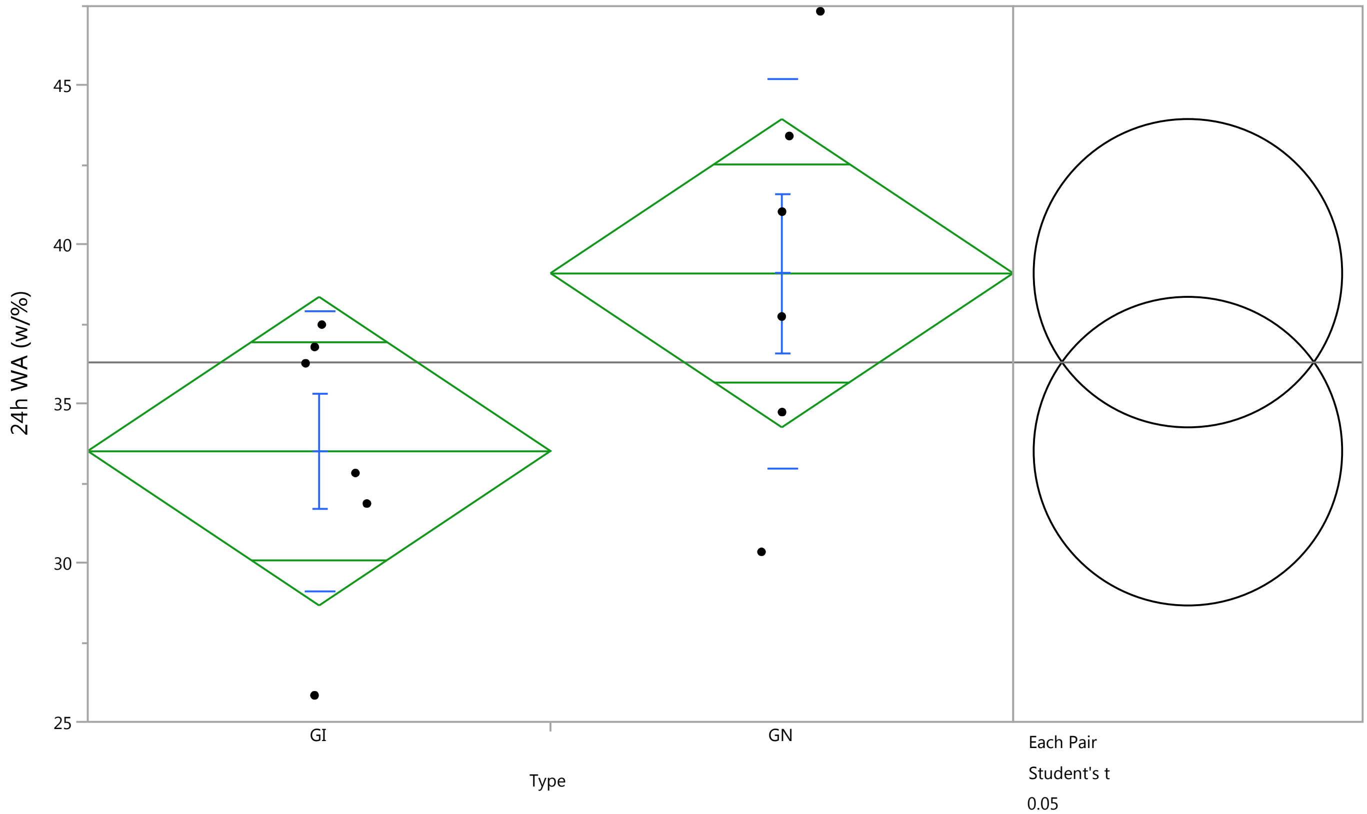
LSD Threshold Matrix

Abs(Dif)-LSD

	GN	GI
GN	-2.2669	0.9386
GI	0.9386	-2.2669

Positive values show pairs of means that are significantly different.

Oneway Analysis of 24h WA By Type



Oneway Anova

Summary of Fit

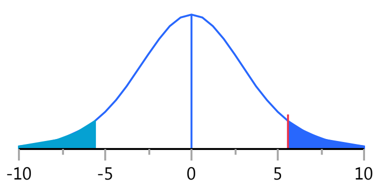
Rsquare	0.248284
Adj Rsquare	0.173112
Root Mean Square Error	5.330032
Mean of Response	36.30737
Observations (or Sum Wgts)	12

t Test

GN-GI

Assuming equal variances

Difference	5.593	t Ratio	1.817386
Std Err Dif	3.077	DF	10
Upper CL Dif	12.449	Prob > |t|	0.0992
Lower CL Dif	-1.264	Prob > t	0.0496*
Confidence	0.95	Prob < t	0.9504



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Type	1	93.83264	93.8326	3.3029	0.0992
Error	10	284.09243	28.4092		
C. Total	11	377.92507			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
GI	6	33.5111	2.1760	28.663	38.359
GN	6	39.1037	2.1760	34.255	43.952

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
GI	6	33.5111	4.38897	1.7918	28.905	38.117
GN	6	39.1037	6.12825	2.5018	32.672	45.535

Oneway Analysis of 24h WA By Type

Means Comparisons

Comparisons for each pair using Student's t

Confidence Quantile

t	Alpha
2.22814	0.05

LSD Threshold Matrix

Abs(Dif)-LSD

	GN	GI
GN	-6.8566	-1.2640
GI	-1.2640	-6.8566

Positive values show pairs of means that are significantly different.

Appendix D : Permission for reproduction for Figure 2, 3, 7

Gmail

Kunqian Zhang <polo.kq.zhang@gmail.com>

Image copyright request from a student.

Clark, Lynn G [EEOBS] <lgclark@iastate.edu>
To: Kunqian Zhang <polo.kq.zhang@gmail.com>

Mon, Jan 11, 2016 at 6:52 PM

Dear Polo,

Thanks for your message. You are welcome to use the Arthrostylidium sarmentosum image, which I took, and it is fine with me if you credit the BPG website with me as the photographer. I think the other image you want is the Phyllostachys sp. photo--I am not sure if I took that photo (I think not), but if you credit the website, that should be sufficient. Are these the two images you are referring to?

Best, Dr. Clark

From: Kunqian Zhang <polo.kq.zhang@gmail.com>
Sent: Monday, January 11, 2016 6:00 PM
To: Clark, Lynn G [EEOBS]
Subject: Image copyright request from a student.

Dear Dr. Clark,

I am Polo Zhang, a graduate student studying in Forestry Faculty in UBC, Vancouver, Canada. My project is about Bamboo OSB. I am writing my master thesis these days.

I've read a great article on your website:

http://www.eeob.iastate.edu/research/bamboo/bamboo.html.

Bamboo biodiversity - Iowa State University

www.eeob.iastate.edu

Home Bamboos Maps Characters Methods Keys Literature Collaborators Links. Bamboos. Bamboos (subfamily Bambusoideae) are among the broad-leaved grasses (Poaceae ...

Gmail

Kunqian Zhang <polo.kq.zhang@gmail.com>

Image copyright request from a student

Stephane Schroder <info@guaduabamboo.com> Thu, Jun 30, 2016 at 7:55 AM
To: Kunqian Zhang <polo.kq.zhang@gmail.com>

Hello Kunqian,

Thank you for contacting us. You can use the screenshot for your thesis no problem. Just mention www.guaduabamboo.com as the source.

Best regards and success,

P.S.: Subscribe to our Newsletter and receive updates about new product launches and special discounts!

Guadua Bamboo

CEO & Founder

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> On 30 jun. 2016, at 01:09, Kunqian Zhang <polo.kq.zhang@gmail.com> wrote:
>
> Dear Sir/Madam,
>
> I am Polo Zhang, a graduate student studying in Forestry Faculty in UBC, Vancouver, Canada. My project is about Bamboo OSB. I am writing my master thesis these days.
>
> I've found a video on your website quite useful. Thank you! Would you mind if I include one screenshot in my thesis with citation? Do you have any request on the reference? I am very happy to listen to your advice.