Determinition of physical properties of *Eucalyptus cloeziana* sp. wood in different dimensions

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**Abstract**—The *Eucalyptus* belongs to the family Mirtaceae and has about 600 species with several varieties and hybrids, besides having different types of cells that adapt to perform specific functions. The objective of this study was to evaluate the physical properties of *Eucalyptus Cloeziana* wood, specifically, apparent density, basic density, moisture content, total volumetric retractability and anisotropy factor. The wood of this species was cut into three different sizes of species according to the current Brazilian standard, the old Brazilian standard and the French standard. The values found were similar to those found in studies of other researchers, which shows a data concordance for the *Eucalyptus Cloeziana* species.

**Keywords**—Density, Forest Biomass, Retratibility.

I. INTRODUCTION

Planted forests represent an essential role in the industrial supply of wood, which shows effectiveness in replacing timber from natural forests. The favor of this scenario occurs due to the rapid growth of plantations, forest yield and technologies applied in the forestry sector [1]. The Brazilian forestry is based on the cultivation and management of some species, mainly of the genus *Eucalyptus* that represents more than 70% of the planted forest areas, in the year 2015 corresponded to approximately 5,630,000 hectares [2].

The species *Eucalyptus Cloeziana* is widely applied in the civil, furniture, energy, pulp and paper sector, this way is increasingly consolidated in the industry in Brazil [3]. In addition, this tree has a rapid growth, easy management and develops in a wide variety of habitats. *Eucalyptus* wood has a heterogeneous structure due to variations in anatomical elements, which implies the determination of existing variation patterns for better application [4].

*Eucalyptus* belongs to the family Mirtaceae and has around 600 species with several varieties and hybrids, besides having different types of cells that adapt to perform specific functions. The variations existing in the chemical, physical and anatomical compositions of wood among the species are remarkable, such differences may also be present within the same species, especially as a function of age, genetic and environmental factors [5].

Among the physical properties of wood, the specific mass, one of the main parameters of application, determines the final quality and the performance of raw material in industrial and technological processes, since it is directly related to most of the other properties, as well as the cellular composition of wood [6].

The basic density of wood and the relationship between Mass and volume are directly associated with moisture content, instability of dimensions and durability [7]. The present study aimed to determine the physical properties of *Eucalyptus Cloeziana* wood from Diamantina-Minas Gerais, specifically regarding apparent density, basic density, moisture content, retratibility Volume and the anisotropy factor.

II. MATERIALS AND METHOD

The procedures for the determination of physical properties followed the standard ABNT NBR 7190/1997 (adapted) [12]. The wood of the species *Eucalyptus Cloeziana*, object of study, from the region of Diamantina-Minas Gerais was cut in three different sizes of species (Fig. 1). The dimensions were in accordance with the current Brazilian standard ABNT NBR 7190/1997 (5cm x 3cm x 2cm), the Brazilian standard NBR 7190:1982 (3cm x 2cm x 2cm), and the French Norm (5cm x 2cm x 1cm) [13].
To calculate the factors associated with the physical properties of Eucalyptus Cloeziana Wood, the initial mass and the measurements of the sides of the cross section, length and width of 50 species were determined for the three different sizes. After measurements, saturation of the species was performed (Fig. 2). The wood samples were completely submerged in water around 90 days, and during this period, the water was changed weekly and the mass was verified to accompany the progression of saturation. This procedure was performed for the determination of saturated mass and volume.

Then all these bodies were subjected to a maximum temperature of 103 ± 2 ºC in a greenhouse for the calculation of the dry mass and volume. During drying, the masses were checked every 6 h until there was a variation between two consecutive measurements less than or equal to 0.5% of the last mass measured for all sizes of species, this fact occurred in the third weighing.

The calculation of densities and moisture contents were performed according to the following equations involving mass and volume (\(M_i = \) initial mass (g); \(M_o = \) dry mass (g); \(M_s = \) saturated mass (g); \(V_i = \) initial Volume (cm³); \(V_s = \) saturated Volume (cm³)).

- **Aparent Density (g/cm³):**
  \[
  D_{ap} = \frac{M_i}{V_i}
  \]

- **Basic Density (g/cm³):**
  \[
  D_b = \frac{M_o}{V_s}
  \]

- **Moisture Content (%):**
  \[
  U = \frac{M_i - M_o}{M_o} \times 100
  \]

- **Maximum moisture content (%):**
  \[
  U_{max} = \frac{M_s - M_o}{M_o} \times 100
  \]

The calculation of total volumetric retratibility and the anisotropy factor of wood were defined from the following expressions, noting that some were determined in an analogous way. (\(R_v = \) Total Volumetric Retratibility (%); \(V_s = \) Saturated Volume of moisture (cm³); \(V_o = \) Absolutely dry Volume (cm³); \(L_t (Sat) = \) Saturated Tangential length (cm); \(L_t (dry) = \) Tangential Length...
The figures found in this order, 0.603; 0.600 and 0.541, are excellent around the desired average moisture content and, therefore, it is important to obtain little variability in drying defects, which can cause warings and fendilhings and, therefore, it is important to obtain little variability around the desired average moisture content. The moisture content is defined as the relationship between the amount of water and the mass contained in the wood, with this, the ideal percentage depends on the application of the raw material. The tables below show the values found were very similar for the three different types of species (Table 2).

| Samples | Moisture Content (%) | Maximum Moisture Content (%) |
|---------|----------------------|------------------------------|
| 5cm x 3cm x 2cm<sup>1</sup> | 14.547 | 89.672 |
| 3cm x 2cm x 2cm<sup>2</sup> | 14.966 | 100.950 |
| 5cm x 2cm x 1cm<sup>3</sup> | 14.036 | 113.866 |

<sup>1</sup>ABNT NBR 7190/1997; <sup>2</sup>NBR 7190:1982; <sup>3</sup>French norm

The woody materials have a large amount of water that, most of the time, it is necessary to remove before the use of raw material. The high moisture content of the wood is characterized as one of the factors that causes drying defects, which can cause warings and fendilhings and, therefore, it is important to obtain little variability around the desired average moisture content. The moisture content is defined as the relationship between the
The determination of the physical properties of wood allows the proper use of this raw material, in addition to preserving future problems in structural projects, making furniture, among others. The values found were similar to the studies of other researchers, which shows a data concordance for the Eucalyptus Cloeziana species. Finally, through this study, it was perceived the importance of this raw material in the present day, since it has a wide purpose and the physical properties of these materials confirms the possibility of use in various sectors.

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