

Embedment Parallel to the Grain Strength of the *Schizolobium amazonicum* Herb Wood Specie

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Abstract Wood is one of the main raw materials used by man in several uses. It can be used in furniture and package industries, and also in components for building construction. For all these purposes, it is necessary to know the physical and mechanical properties of wood specie being used. Brazilian Code ABNT NBR 7190:1997, in its Annex B, presents methods for determining wood mechanical properties, among them the embedment parallel to grain. This property is important because it relates to the design of bolted and nailed joints in timber structures. This research aims to the experimental determination of embedment strength parallel to grain strength for *Schizolobium amazonicum* Herb, a wood specie recently used for structural purposes. Results showed that embedment strength for *Schizolobium amazonicum* Herb wood specie is lower when compared with traditional tropical essences, but sufficient for some structural applications.

Keywords Embedment strength, Mechanical properties, Structural members, Specific gravity, *Schizolobium amazonicum*

1. Introduction

Wood is a natural material and its species present different values of physical and mechanical properties, influenced by factors as: tree age, grain direction, moisture content [1-3]. Researches about physical and mechanical properties are developed with the aim of providing subsidies for better use of wood industry, civil construction among other sectors that can get it as a raw material [4, 5].

Wood can be used as structural material such in bridges, roofs, footbridges, among others, since their physical and mechanical properties are known, aiming development a design according to Standard Codes, as example Brazilian Standard Code ABNT NBR 7190:1997 [6-10].

This research was realized with *Schizolobium amazonicum* Herb wood specie (called also Paricá), wood specie from Amazonian Forest Region [11]. Physical and mechanical properties of this wood have been studied in recent yers with the purpose dissolving its use as na alternative material in relation to other species used in Brazil, such as *Pinus* and *Eucalyptus* genus [12, 13].

Brazilian Standard Code ABNT NBR 7190:1997 [10] presents the recommendations for design of connections in timber structures using metal pins (nails or bolts). The parameters used for breaking a connection are embedment of the bolt in the wood or bending of the metal pin [14].

In case of embedment of the pin in the wood, Brazilian Standard Code ABNT NBR 7190:1997 [10] presentes the experimental procedure to tests on specimens to determination this mechanical property. If it is not possible to carry out the tests on specimens, the Brazilian Standard Code [10] recommends that the value of the embedment strength parallel to the grain (f_{e0}) be equal to the compressive strength parallel to the grain (f_{c0}).

Embedment parallel to grain strength is essential in evaluation of structural joints, but it's necessary to observe that some related problems can occur during procedures of nailing or bolting [11-17]. Molina et al [18] carried out tests to determine embedment strength of *Pinus elliotti* and *Eucaliptus saligna*.

This research aims to determine, in an experimental way, embedment strength parallel to grain strength for *Schizolobium amazonicum* wood specie, from Amazonian Forest Region.

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2. Material and Methods

Tests were carried out in Wood and Timber Structures Laboratory (LaMEM), Structural Engineering Department (SET), São Carlos Engineering School (EESC), São Paulo University (USP) and Department of Civil Engineering (DECiv), Federal University of São Carlos (UFSCar).

For this research was used *Schizolobium amazonicum* wood specie from trees planted forests in Legal Reserve of Northern Region of Brazil (Fig.1). Were prepared 18 specimens (Fig. 2), in the Standard condition of moisture content (12%), according to ABNT NBR 7190: 1997 [10]. The tests specimens occurred in the universal testing machine AMSLER with load capacity of 250 kN. Were used metal dowel with diameter of 10 mm.

According to ABNT NBR 7190:1997 [10], the embedment strength of wood (f_e) is provided by the ratio between the load that causes the residual specific deformation of 2‰ ($F_{e2‰}$) (determined graphically, Fig. 3) and square cross-section area of the specimen (A).

$$f_e = \frac{F_{e2}}{A} \quad (1)$$



Figure 1. Members of *Schizolobium amazonicum* wood specie for preparation of specimens

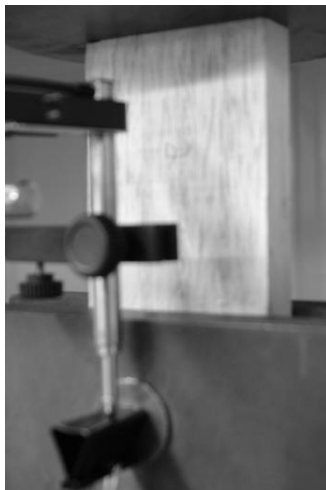


Figure 2. Standard specimen for determination embedment strength of *Schizolobium amazonicum* wood specie in test

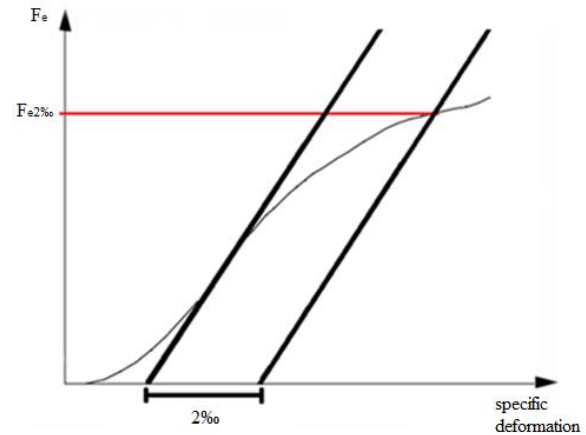


Figure 3. Embedment load vs. specific deformation to $F_{e2‰}$ determination [15]

3. Results

Table 1 presents the average values of embedment strength (x_m), standard deviation (Sd), coefficient of variation (CV) and maximum (Max) and minimum (Min) values found from the Standard tests.

Table 1. Embedment parallel to the grain strength of *Schizolobium amazonicum* wood specie [MPa]

Statistical parameters	Values
x_m	17
Sd	2.45
CV [%]	15
Max	20
Min	13

Schizolobium amazonicum wood specie is classified as strength class C20 of dicotyledonous according to the Brazilian Standard Code ABNT NBR 7190:1997 [17, 19].

Average value of the embedment parallel to the grain strength of the *Schizolobium amazonicum* was lower to 20 MPa. According to ABNT NBR 7190:1997 [10], embedment parallel to the grain strength can be equal to compression parallel to the grain strength, which for *Schizolobium amazonicum* Herb is close to 20 MPa [13, 15, 18].

Embedment parallel to the grain strength found to *Schizolobium amazonicum* wood specie is lower compared to wood of *Pinus* genus [14, 15].

The low average value of the embedment parallel to the grain strength of *Schizolobium amazonicum* wood specie is due to the low density of wood, approximately equal to 0.28 g/cm³ [18].

4. Conclusions

Schizolobium amazonicum wood specie present low average value of embedment parallel to the grain strength, even the wood specie being classified as C20 of the dycotiledons. More researches about mechanical and physical properties of the wood from Amazonian Forest Region are very important due to variability of wood properties.

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