ABSTRACT: Wood connections must be considered as key points in the safety of timber structures. The use of structural elements of roundwood from reforestation in Brazil has grown in recent years due to the research that had been conducted at universities, in order to make it a sustainable material more competitive relative to other materials used as structural function. However the joining of the structural elements of roundwood timber, are usually more difficult to be made than the connections made in sawn planks. In some cases, the raw timber connections have to be sawed by hand to facilitate and ensure that the connections will fit and work properly. This is a major problem and results in the resistance against the use of roundwood in construction, in which the work of preparing the connections is carried out by hand and depends upon the expertise of the construction site’s carpenter, which in some cases can result in less efficient and poor quality connections. With the aim to promote more efficient use of the joints connecting the structural elements of roundwood timber, the purpose of this paper is to present the main types of connections used in these structural and construction systems.

KEYWORDS: sustainable buildings; structural systems; roundwood treated; connections between structural elements; reforestation.

1 INTRODUCTION

The joints, also known as connections, should be considered as key points in the safety of timber structures. The use of structural elements from reforestation roundwood in Brazil has grown in recent years because of research conducted at universities, in order to make it a sustainable material more competitive relative to other materials used as structural function in construction, BRITO (2010) [2]. However, connections to the structural elements of roundwood construction are usually more difficult to manufacturing than connections with sawn timber. In some cases part of roundwood needs to be cut manufacture artisanal to facilitate the connection and guarantee the best performance among the structural connections. This is the major problem in the resistance of using roundwood to build in Brazil. The process of implementing the connections is made by artisanal methods and troublesome enough, often with only carpenter’s practice work. Generally the building without adequate knowledge cases problems as low effectiveness connections. This kind of thing happens because as they don’t know or don’t have the procedures to follow, they execute based on their practice, instead of technical methods and as a consequence, they do it improperly. In order to promote more efficient use of the connections between the structural elements of roundwood, specially those from reforested wood, the goal of this article is to present the main usual types of connections used in structural systems and construction commonly used in Brazil for the elaboration of structural design of projects with this material, BRITO (2010) [2].

2 TYPES OF JOINTS FOR ROUNDWOOD

In the search, we categorized the main varieties of connections with roundwood for structural elements, each corresponding to its function, such as notches in the wood, wooden dowel, threaded rods with washers and nuts, dowel nut, steel plate external fixed with screws, steel plate internal fixed with screws, galvanized perforated steel plate and nailed, steel straps woven into, steel rings with threaded rods fixed with washers and nuts, steel connectors for structures mixed roundwood and concrete, details on the interface of the timber structure with masonry, Connections log home walls, connections in parts compressed, connections to bases of columns and other, CALIL & BRITO (2010) [3].

2.1 NOTCHES IN THE WOOD

The links are slots types of connections frequently adopted for beam-column system in Brazil, and is a fitting concave at the top of the column and sometimes with the addition of fixed vertical bar of galvanized steel or wooden dowel to prevent separation of parts, fig. 1.

Figure 1: Connection with the notch at the top of the piece. Fonte: CALIL & BRITO (2010) [3].
According to NBR 7190:1997 [1], the connections of pieces of wood can be made by means of metal pins, wooden pegs and or connectors.

2.2 THREADED RODS, WASHERS AND NUTS
Connections using threaded steel rods attached with washers and nuts on the extremities have been widely used in structural connections between elements in roundwood in Brazil, figure 2.

2.3 DOWEL NUT
This type of connection is a system with threaded steel bar, metal pin. In a transverse hole passing through the axis of the beam near the column connects the metal pin that has a female threaded hole compatible with the thread diameter of the steel bar to fix it, figure 3.

2.4 STEEL CONNECTORS FOR STRUCTURES MIXED ROUNDWOOD AND CONCRETE
In structures mixed roundwood and concrete, to ensure adequate adhesion of the concrete structural element of wood, facilities are required connectors bolted steel with epoxy adhesive into holes in roundwood, figure 4.

2.5 CONNECTIONS IN PARTS COMPRESSED
The compressed parts may be simple or compound. They may be present in parts of trusses, bracing systems, as well as isolated columns or porches. Figure 5 shows examples of amendments in parts compressed axially, BRITO (2010)[2].

2.6 CONNECTIONS TO BASES OF COLUMNS
The bases of the columns can be either the pin-block foundation, or be installed on steel base plates. In the case of direct strung the pieces of wood preservative treatment must be due to the use class 5. As for the cases of setting the piece in base plates recommendations gap between a certain piece of wood and the base, preventing moisture buildup, figure 6, BRITO (2010) [2].

3 CONCLUSIONS
The LaMEM is one of the most important research laboratories of wooden structures in Brazil in recent years has held several lines of theoretical and experimental research of structural elements and connections between structural elements with roundwood, especially from reforestation, as species of eucalyptus and pine. In May 2010, Eng. Civil Leandro Dussarrat Brito, presented the dissertation of master "Recommendations for the design and construction of structures of roundwood from reforestation", directed by teacher Dr. Carlito Calil Junior in the Department of Structural Engineering School of Engineering of São Carlos University of São Paulo, with a scholarship funded by the Montana Química SA. The chapter 4 of the dissertation deals with the connections between structural elements in roundwoods structures. Therefore, the purpose of this article is to present briefly, a literature reference review of some major types of connections, between structural elements common to roundwood used in Brazil as suggestions in the application of models in design and construction with this material. The aim of this study is to guide students and professionals in civil engineering and architecture, presenting some of the most appropriate models of connections in order to provide enough information to help them to choose the most convenient structural construction systems that use reforestation’s roundwood.

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