Cable-stayed timber footbridge with two towers

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Summary

This paper presents design aspects of cable-stayed timber footbridge with two towers of 6,10 m, 45 m long, located in Brotas, São Paulo, Brazil, built by the Municipality of this city, whose project was prepared by members of the Wood and Timber Structures Laboratory, Department of Structural Engineering, São Carlos Engineering School, São Paulo University. The structure of the cable-stayed timber footbridge consists of foundation and support made of concrete; principal beams in *Eucalyptus citriodora* CCA-treated in an autoclave poles; deck made of *Mezilaurus itauba* pieces, with the painting process against biological demand. Brazilian Standard Code to timber structures design NBR7190 presents all the guidelines for design of this structure. The cable-stayed timber footbridge shows the feasibility of using wood reforestation, particularly the species used in the main parts, as an excellent structural material, which has low energy consumption, optimum ratio strength/weight and durability when treated.

Keywords: Timber footbridge, stayed footbridge, planted forests, *Eucalyptus citriodora*.

1. Introduction

The Parque dos Saltos is the postcard of Brotas, municipality of São Paulo, Brazil, and reveals important environmental and tourism. Located in the urban area of the city, is crossed by a river that forms falls and rapids, where events are held periodically bound to practice adventure sports such as rafting and canoeing championships. The area is also of historical and architectural importance as it houses a building of a former power plant, currently disabled.

The crossing by pedestrians over the river enables hereby guyed wooden walkway, a second alternative walk this recreation area. The first alternative was possible river crossing through a metal suspension footbridge built next to power plant also for the workers to access the service site. Before disabling the generation of electricity and the subsequent transformation of the region into a public viewing area, there was a need to open up paths to allow access to various parts of the park. In this context the walkway was built, and the city opted for wood construction.

This paper presents aspects of the design and implementation of the cable-stayed footbridge wood Parque dos Saltos, comprising two towers of 6.10 m high, 45 m long, two side spans of 10 m. The footbridge was built with oversight of the Department of Planning of the City of Brotas, whose project was prepared by members of the Laboratory of Wood and Timber Structures, Department of Structural Engineering, School of Engineering of São Carlos, University of São Paulo.

The connections of this footbridge follow the trend of using appropriate elements of the industrialization process for timber structures. The wood used in the superstructure of *Eucalyptus citriodora* from planted forests and underwent CCA preservative treatment process for vacuum-pressure autoclave to ensure greater longevity insect repelling the attack. The wood *Mezifaurus itauba*, used on the board in the form of sawn pieces, was obtained from certified forest area and went through the process of painting in order to have a longer life.

2. Materials and Methods

The structure of the cable-stayed footbridge designed in wood Laboratory of Wood and Timber Structures consists of foundation and basis for support made of reinforced concrete, the pieces from *Eucalyptus citriodora* CCA treated in autoclave: two main towers with two masts each 36 cm in diameter and 6.10 m in height; locking the mast 30 cm in diameter and 2.6 m in length; stringers diameter of 30 cm with 10 me 7.5 m in length; beams 30 cm in diameter and 3.4 m in length; support the railing with 12 cm diameter and 2 m in length; banister railing about 12 cm in diameter and 5 m in length; closing the umbrella body with 8 cm diameter and 2 m long. The tray was made of sawn *Mezifaurus itauba* gauge 4 x 16 x 280 cm receiving painting process. The Dywidag steel bar 15 mm in diameter. Metal parts and special connections: plates, threaded rods, bolts, nails, steel bars galvanized and painted with fire.

3. Design

3.1 Geometrical characteristics of the footbridge

The structure of the footbridge shown in Figures 1-4 was designed as stayed structural system with two towers, two masts per tower. The structure of the central footbridge with stretch span of 25 m was designed with double stringers of 7.5 m and 10 m in length attached to tower. The side spans with span of 10 m were also designed with double stringers 10 m in length. Four out of every mast stays, two for each side, and you are one of the external is docked in the cradle supporting the footbridge to avoid tipping the tower to the inside of the river. The foundation was executed in reinforced concrete, whose masts were set: the foundation blocks.

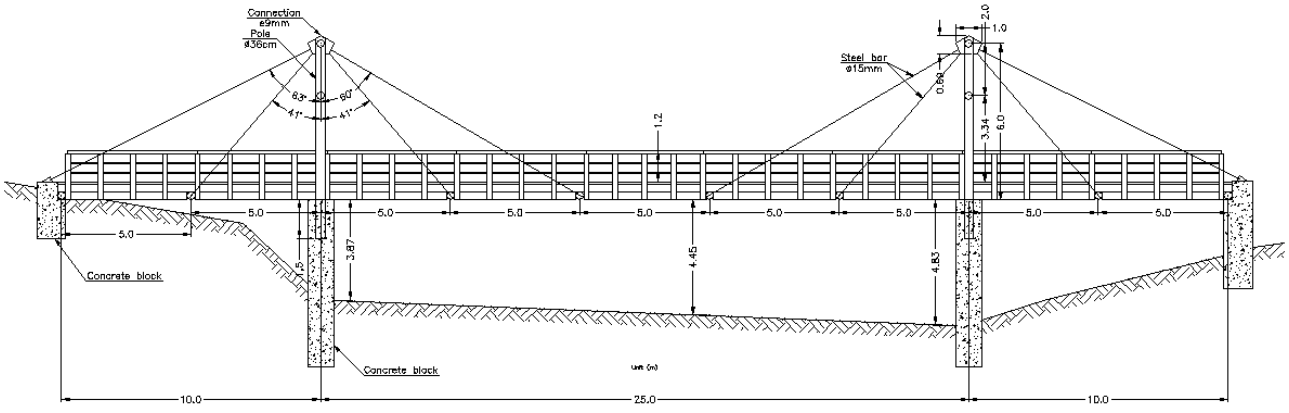

Fig. 1 Lateral view of the footbridge.

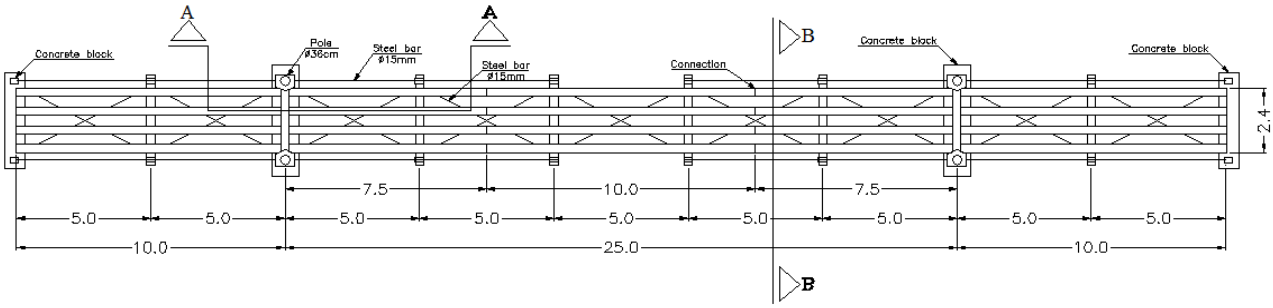

Fig. 2 Bottom view of the footbridge.

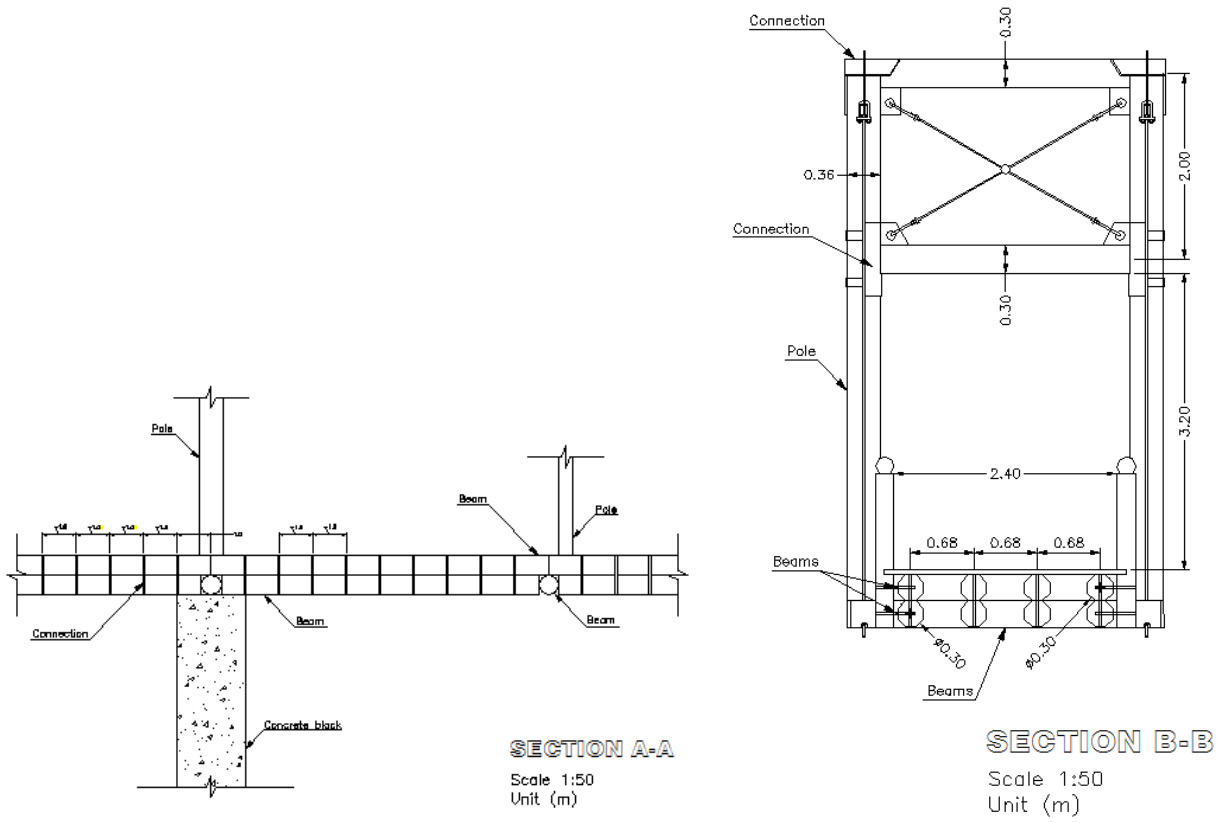

Fig. 3 Sections of the footbridge.

The connecting pieces, especially of the art in mast are designed in 3D graphical environment through the program AutoCAD®, in order to visualize how these parts would connection after finished, as shown in Figure 4.

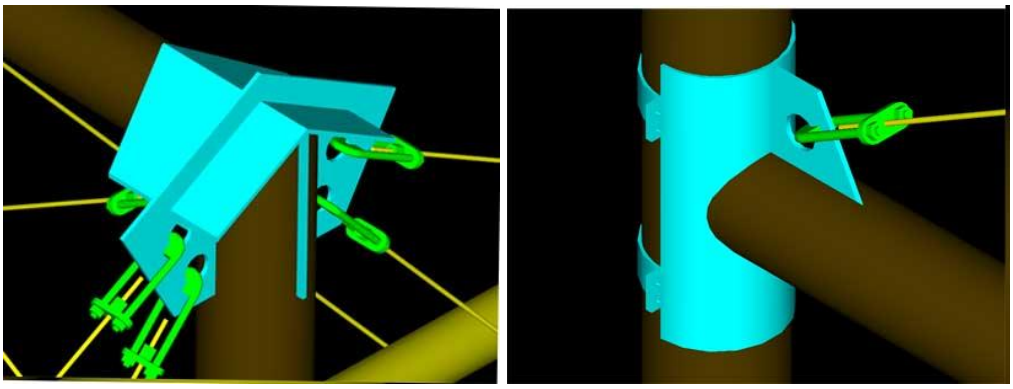

Fig. 4 Design of the footbridge links on the poles.

3.2 Actions

The building process contemplated situations loading in security checks, through the combinations given in standard Brazilian Actions and Security in Structures [1].

3.3 Structural analysis and design

The survey of efforts used in the preparation design were obtained through structural analysis program SAP2000® [2], based on finite element method. The secondary structural elements and were sized following the guidelines of the Brazilian Standard Design Timber Structures [3]. In Figure 5, for example, the removal of the efforts used in the design of the foundation.

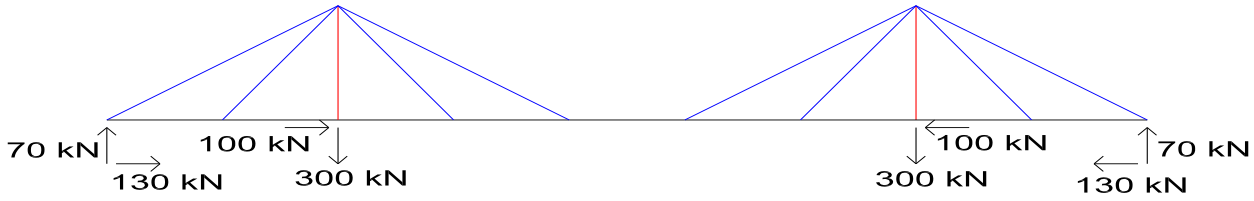

Fig. 5 Survey efforts used in the design of the foundation.

3.4 Footbridge constructed

In Figures 6-11 has photos of timber footbridge after construction. The execution of the footbridge was planned to allow the elements were made at ground level and positioned from the towers. After locking the two towers were set the stringers, the transversinas and stay. The horizontal rigidity of the footbridge is secured by bracing system of steel bars "X" set in the upper parts of the double stringers by means of bolts galvanized steel.

Fig. 6 Longitudinal view of the footbridge Parque dos Saltos, Brotas, SP.

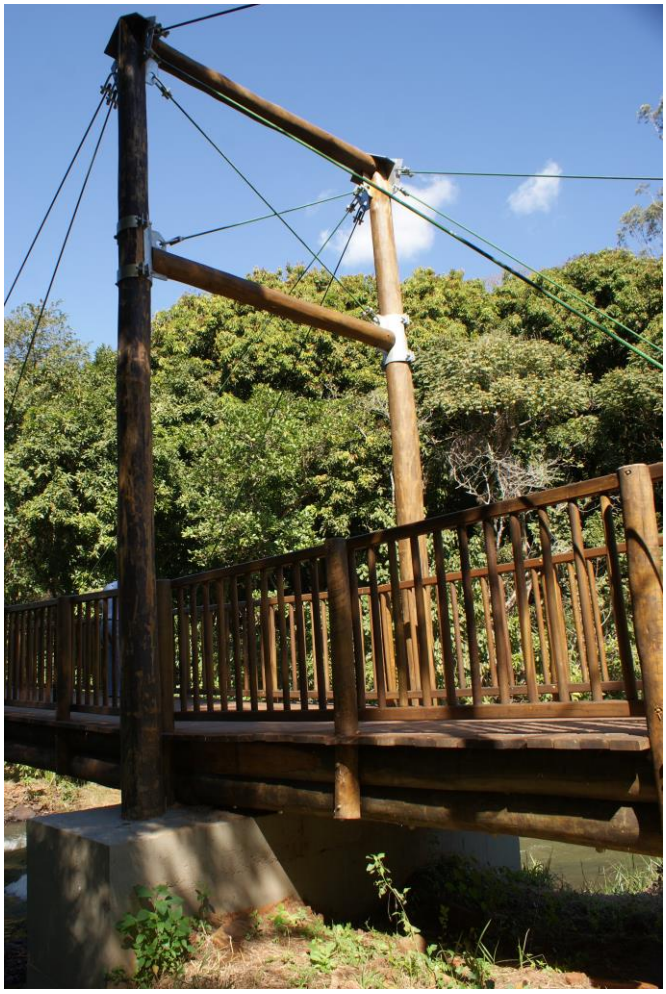

Fig. 7 Foundation block and a tower poles composing of the footbridge.

Fig. 8 Connects the poles of the footbridge.

Fig. 9 Connections are stayed the transversinas stringers and double pieces.

Fig. 10 Anchoring of you are in the cradle of external support.

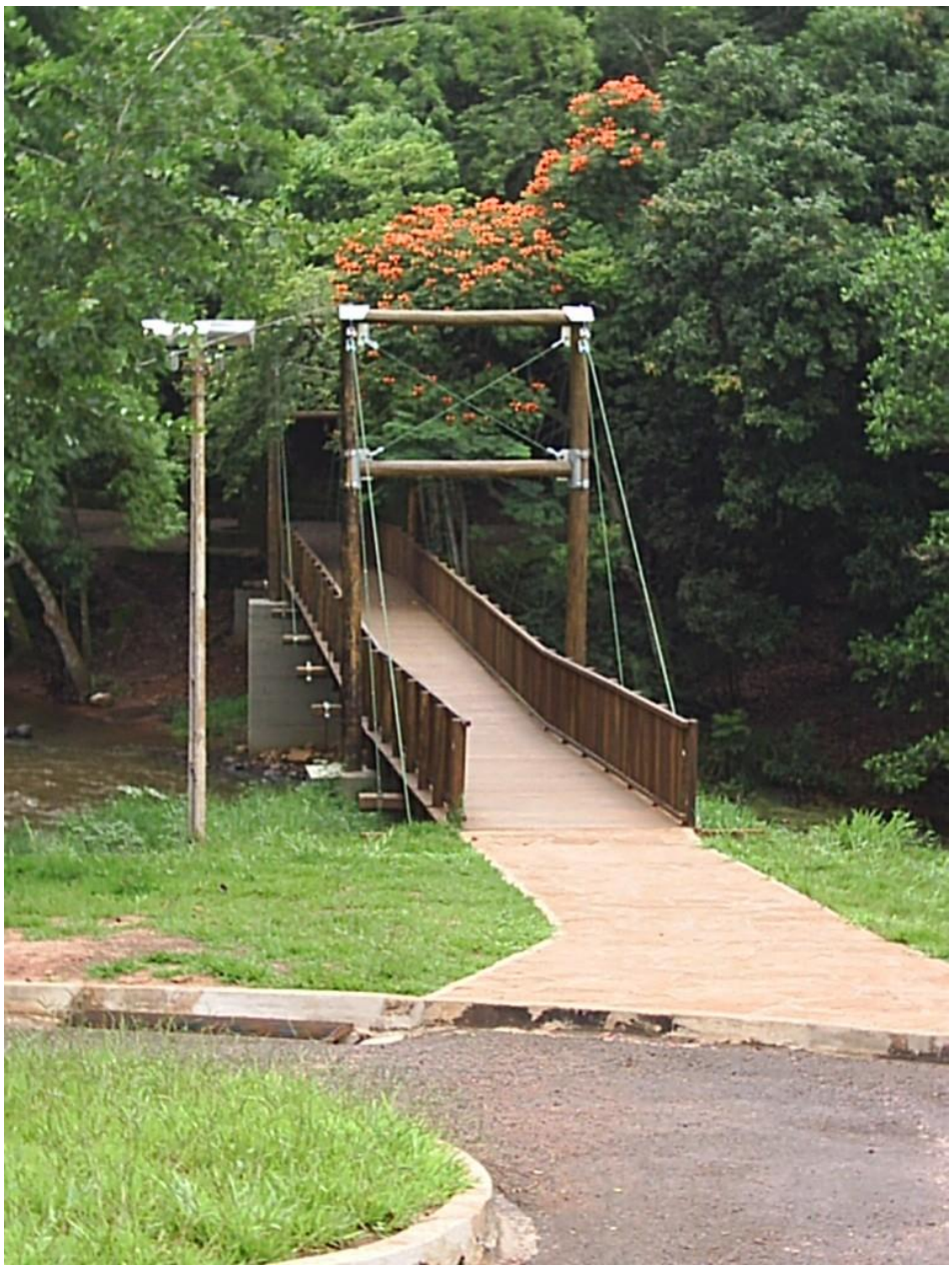

Fig. 11 Top view of the footbridge Parque dos Saltos, Brotas, SP.

4. Conclusions

The cable-stayed footbridge wood shows the feasibility of using wood from reforestation, renewable, particularly *Eucalyptus citriodora* as being an excellent structural material, which features low power consumption, great relationship weight / resistance and durability when treated.

The Brazilian Standard Design Timber Structures [3] presents all the concepts for the design and dimensioning of timber structures.

The structure was adequate to the environment, because the material used in the construction does not contrast with the proposal to the use of this public work. Undoubtedly, the wooden structures could be used in these projects.

5. References

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