

# Maritime Pine Stress-Laminated Timber Bridges: Losses of Prestress Forces and Flexural Behavior

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## Abstract

This article presents a study on stress-laminated timber bridges. The technique is useful for the rehabilitation and construction of bridges. It consists of a series of timber planks placed side by side and compressed transversely with high-strength steel prestressing bars. A prototype of this kind of structure was built in the Department of Civil Engineering at the University of Coimbra. The prototype, a stress-laminated timber bridge deck with butt joints, was 6 m long, 2.7 m wide, and 0.20 m thick. The experimental program was developed with two main objectives: to study the evolution of the prestress value applied to the structure and to observe the bridge structural behavior under the effect of loads simulating the action of a standard vehicle. Practical difficulties and/or limitations and potentialities of the system when maritime pine is used as the timber material are also discussed. This article reports the experimental program and the results, with emphasis on the tension losses in the prestressed steel bars.

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A growing interest in wooden structures has recently reappeared in Portugal. As a consequence, new research projects have been carried out. The applications of timber in bridges have also been investigated (Dias et al. 2011). For example, the technique of timber-concrete composite slabs was studied at the University of Coimbra, and the results of such work have been published by Dias et al. (2007a, 2007b). Another possibility that has been studied is the use of Portuguese maritime pine in stress-laminated timber slabs. The use of this technique in the construction and rehabilitation of bridges has been used since the mid-1970s, when it was introduced in Canada. In this respect, works by Ritter (1990) and Ritter et al. (1991) are important. Oliva and Dimakis (1988) have also studied stress-laminated timber bridges by constructing a bridge for laboratory tests, giving them information for constructing a prototype bridge on-site. Dahl et al. (2006) presented a study on the evaluation of stress-laminated bridge decks based on full-scale tests. More recently, Gutkowski et al. (2007, 2008) have carried out a study on an innovative timber bridge technology applied to skew decks. Gentry et al. (2007) reported a study on a stress-laminated deck bridge that was left with no maintenance for 15 years; nevertheless, after this period, the bridge was in good condition.

The stress-laminated technique consists of a series of timber planks placed side by side between supports of the

bridge and compressed transversely with high-strength prestressing steel bars. A prototype of this kind of structure was built in the Department of Civil Engineering at the University of Coimbra.

The experimental program was developed with two main objectives: to study the time evolution of the prestress applied to the structure and to verify the bridge structural behavior under the action of loads simulating the action of a vehicle. It also helped to clarify the practical difficulties and/or limitations and potentialities of the system when the most common national structural timber is used as the raw material. This article reports the experimental program carried out to monitor the tension losses in the prestressed steel bars and the flexural tests of the slab.

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