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A Different Approach to Classic Structural Reinforcements Using Recycled Synthetic Materials

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Abstract

The aim of this paper was to test viable alternatives to classic materials used as reinforcements, like: steel, fiber reinforced polymers or carbon fiber reinforced polymers, in order to produce cheaper and more eco-friendly structural elements with similar or better behavior under service.
PET straps and bonded polyester yarn straps are some of the most used materials in the packaging industry, with remarkable tensile strength almost similar to steel bands and are easily recycled, therefore came the idea that those materials could be used as reinforcements instead of steel or other materials providing an economical and more eco-friendly alternative.
Experimental research was made to see if these straps provide the necessary pull-out resistance as they are imbedded in the structural element, in order to add the needed extra flexural strength.
Four point bending test on glue laminated timber beams reinforced with these straps were also conducted to see actual improvements over standard non-reinforced beams.
As supposed, significant improvement on the flexural behavior of the tested elements were observed proving that these straps are a viable alternative over standard reinforcements for lightweight and economical structural elements with a lower carbon footprint, with no increased fabrication costs.

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1. Introduction

When we think of reinforcements we think of steel, and even though steel is easily recycled the recycling process is relatively complex and requires a lot of energy. A more economical and greener solution would be to try to replace these rebars with synthetic materials witch are cheaper and their fabrication has a lower carbon footprint.

Macrosynthetic fibers [1] are starting to gain popularity and prove to be a great alternative to steel, with improved behavior in concrete elements, mostly because of the protection that the concrete offers against UV rays, but still have a long way to go until mass usage [2].

Although these fibers are mostly used as structural reinforcements in concrete beams, their use is not limited to that since lighter materials are gaining popularity in the last decades, we are referring to glue laminated timber witch is a sustainable and more eco-friendly alternative and can also be reinforced with steel or synthetic strap like materials in order to increase their bending strength.

This paper describes the experimental results performed at the Laboratory of Structural Engineering of the Technical University of Cluj-Napoca regarding the possibility of using synthetic straps as structural reinforcements in glue laminated timber beams.

2. Experimental campaign

Experiments regarding the pullout resistance of synthetic strap reinforcements from glue laminated timber were made and also four point bending tests on these reinforced beams. All the tests and preparation for these tests described in this paper were performed strictly following the guidelines given in the EN 408-2010 [3] and EN 338:2003[4].

2.1. Pull out resistance of synthetic straps

In order to provide real strength increases the reinforcements and the reinforced material must be structurally tied together and for that mater pullout tests were made on three types of synthetic straps:

- PET (*Polythene Terephthalate*) straps
- Glue bonded polyester straps
- PP (*Polypropylene*) coated polyester straps.

These tests were made using a LLOYD Instruments LS100 Plus tensile force tester, under a 10mm/min steady pull. The test subjects were composed of one 50 cm long straps glued between two 30 cm long 14x2 cm C18 graded spruce boards. MUF (*Melamine-ureoformaldehyde)* glue was applied; witch is commonly used for glulam elements.

Fig. 1 From left to right PET, glue bonded polyester and PP coated polyester straps

Results were interesting and proved that only the first two types of synthetic stripes provided the needed friction and proved to be the best choices for the following tests [5].

As seen in Fig. 3 the Polypropylene coating made the third strap slippery and had the worst behavior possible, therefore concluding that it is not usable as a structural reinforcement.