Preliminary testing of timber consolidants applied by impregnation

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Abstract

This paper presents the initial laboratory work developed with the aim of consolidating timber that has been subjected to the action of rot fungi, by impregnation with polymeric products. This technique has been largely used in restoration of works of art but not so much in civil engineering.

Indeed, structural wooden elements in buildings are often subjected to degradation by rot fungi due to the accidental presence of water from various causes such as deficiencies in plumbing, broken tiles, clogging of guttering or degradation of exterior masonry. In these situations the question arises about which repair action to take: replace the whole element? Replace only the damaged part by inserting prosthesis? Maintain the damaged element, strengthening or consolidating it? The option of maintaining in the building the original (even though deteriorated) timber has been gaining more and more importance, because the loss of the element contributes to the loss of its historical identity. Consolidation by impregnation falls within this context, thus justifying deeper studies.

The laboratorial work, developed using degraded maritime pine (*Pinus pinaster*) specimens, is presented. The test-specimens were prepared in the laboratory, to reach different decay levels by varying the exposure time to brown-rot fungi (*Coniophora puteana*). Three commercial low-viscosity products, specific for the impregnation of timber deteriorated by rot fungi, were tested: two epoxy-based and one acrylic. The efficiency of these products was assessed through compression tests parallel to the grain and hardness tests, involving both impregnated and non impregnated wood. Their influence, when applied to degraded timber, on its water absorption behavior was also tested.

1. INTRODUCTION

The process of consolidating degraded timber by impregnation consists on forcing a specific fluid material to penetrate it, which when hardened will give it back integrity and promote an improvement of the physical and mechanical characteristics [1, 2, 3]. The efficiency of the impregnation results from the depth achieved, the nature of the product employed and its permanence on the cells and cellular walls of the material [4]. In the past, it was common practice to replace degraded timber in buildings with elements of the same or other material, but in the future the option of maintaining the original timber, even if deteriorated, will gain importance. As a matter of fact extensive replacement of elements not only is expensive but it is often also unnecessary, it changes the aspect of the structure, it disrupts the normal use of the building and it results in a loss of historical identity [5, 6]. Consolidation of timber through impregnation of polymeric products is a technique already widely applied in the conservation and restoration of works of art but not so in civil engineering. Notwithstanding the large number of application in practical cases, quantitative data on the effect of strengthening by consolidants are still very much unavailable [5].

In what concerns the conservation and restoration areas, before the development of synthetic materials a great number of other materials, such as animal glues and natural resins, were already used as consolidants, each one of them with their own drawbacks [1, 7]. Thermo-hardening synthetic resins, such as epoxy and methyl methacrylate, were first used as consolidants for deteriorated timber in middle of the XX century [2], with the limitation of its irreversibility, among others [1, 2]. The researchers' interest then turned to thermoplastic polymers whose application was reversible, easily penetrated the micro-porosity of the timber and enhanced the strength the degraded timber [1].

Among the thermoplastic products polyvinyl butyral (Butvar®) and acrylic resin (Acryloid® or