WCTE
WORLD CONFERENCE ON TIMBER ENGINEERING
2010

EFFECT OF SURFACE TREATMENTS ON THE DURABILITY OF STRUCTURAL BONDED TIMBER JOINTS

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ABSTRACT: In this study, the effects of four surface treatments (flame ionization, corona discharge, γ-glycidoxypropyltrimethoxysilane – GPMS and hydroxymethylated resorcinol – n-HMR) on three timbers (maritime pine, iroko and European oak) were evaluated through contact angle measurements (Dynamic Contact Angle Analysis using the Wilhelmy plate method) and compressive lap-shear tests involving weathered and non-weathered epoxy-bonded specimens. The wettability tests showed that both flame ionization and corona discharge treatments increased the timber's surface free energy, with the corona leading to the greater increase, resting largely in its polar component. This treatment also tended to be less species specific, less susceptible to variation, and tended to last the longest. From the pull-off tests results, it was concluded that both flame and corona produced, at least for pine, an increase in the short-term adhesion strength that may translate into a durability enhancement for bonded joints. Once the shear tests are completed, further conclusions will be made about the effect of the treatments on the long-term bonded joint durability.

KEYWORDS: Timber, surface pre-treatments, epoxy, structural bonded joints, durability

1 INTRODUCTION

Adhesive bonding technology has played an essential role in the development and growth of the rehabilitation and repair of timber structures in recent years. The advantages of this method in comparison to traditional repair techniques are many, but one major remaining concern is the durability of both the adhesive and resultant adhesion to the timber. Although high initial bond strengths are relatively easy to achieve, obtaining good bond durability is comparatively more difficult. The ability of a joint to maintain satisfactory long-term performance, often in severe environments, is therefore an important requirement of a structural adhesive joint [1].

Additional bonding schemes (*e.g.*, primary and/or physical bonds that are less susceptible to degradation) can be used to improve durability. These include the use of primers, adhesion promoters and other surface treatments. Despite the extra cost associated with them, their use is of particular value where structural bonds may be subjected to repeated wetting and drying [2]. These agents are quite common in the aerospace, automotive and plastics industries, where they are used to develop highly durable bonds to metals, advanced composites, ceramics and plastics [3]. However, such treatments are virtually nonexistent in the timber industry, since water-based, polar timber adhesives as phenolics, resorcinolics, and aminoplastic resins perform quite well on timber. Nonetheless, epoxy adhesives are an exception because they develop dry bonds to timber that are as strong as the timber itself, but once they are exposed to repeated water soaking and drying cycles, the epoxy bonds delaminate and fail to meet requirements for structural timber adhesives intended for exterior exposure [4].

The proposed paper discusses the approach adopted, describes the test programme, and discusses the results obtained.

2 MATERIALS AND METHODS

2.1 SURFACE THERMODYNAMICS

The effects of two surface treatments, corona and flame, were evaluated quantitatively through contact angle measurements made using the Wilhelmy Plate technique. The treatments were performed on three different timbers (maritime pine – *Pinus pinaster* Ait.; iroko – *Milicia excelsa* (Welw.) CC Berg.; European oak – *Quercus robur* L.).

The test specimens had the following approximate dimensions: 60 mm in length (along the grain), 20 mm in width and 3.5 mm in thickness. The test specimens were

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