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Rehabilitation of timber structures – Preparation and environmental service condition effects on the bulk performance of epoxy adhesives

João Custódio [a,*], James Broughton [b], Helena Cruz [c]

[a] Laboratório Nacional de Engenharia Civil – LNEC, Departamento de Materiais, Av. Brasil, 101, 1700-066 Lisboa, Portugal
[b] Joining Technology Research Centre, School of Technology, Oxford Brookes University – OBU, Wheatley Campus, Oxford OX33 1HX, United Kingdom
[c] Laboratório Nacional de Engenharia Civil – LNEC, Departamento de Estruturas, Av. Brasil, 101, 1700-066 Lisboa, Portugal

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ABSTRACT

Epoxy adhesives have been used for many years in the rehabilitation of timber structures and are currently the most appropriate adhesive type for on-site operations. However, because they exhibit excellent initial joint strength when tested in standard climate conditions, there has not been a major concern about their service durability. In order to contribute to the ongoing discussion on the reliability of these adhesives, a study was conducted to evaluate the effect of environmental service conditions on the durability of four commercial two-component structural epoxy adhesives, as well as the effect that the type of mixing, curing and post-curing conditions, as well as the presence of moisture have on the adhesives viscoelastic properties. It was found that the preparation conditions, cure schedule and moisture have a significant effect on the performance of the bulk adhesives. Moreover, it was found that under ambient conditions there is potential for under-cure or slow progression of cure for the epoxy adhesive products typically employed in these applications, which in turn can compromise the durability of a bonded joint.

1. Introduction

Rehabilitation systems involving structural adhesives represent an efficient method for the repair and/or reinforcement of both new and existing timber members. These systems minimise disturbance to the building and to its occupants during the intervention. This is achieved by taking advantage of a number of factors including: low volume of replaced materials; none or small increase of the rehabilitated element weight; ease and speed of installation with minimum personnel and plant requirements; versatility to suit the unique situation for every repair; the potential for introducing "like-to-like" timber species and grades; completed work that is structurally efficient, conservationally acceptable and aesthetically pleasing [1,2]. Yet, despite these advantages, when compared with traditional methods and materials, they are perceived as being more expensive than the latter and, in general, they are only used by small-specialized companies who are prepared to deviate from, or add to, traditional carpentry techniques to exploit the benefits associated with these methods [3].

Epoxy adhesives have been used for many years in the repair and strengthening of timber structures, on their one or in conjunction with steel plates, rods or fibre reinforced polymer composite materials. Thus, are currently the most appropriate adhesive type for on-site operations, since they do not require high pressure during their application and curing and they can be reasonably tolerant with regard to bond-line thickness variation. Unlike other traditional generic adhesive types, epoxy adhesive families can also be produced to cure under a wide variety of ambient conditions – an essential requirement for on-site use [4].

Structural epoxy adhesives are generally used in service conditions equivalent to service classes 1 and 2 (EN1995-1:2004) [1]. Many studies have shown them to exhibit excellent initial joint strength when tested in standard climate conditions, which may explain a lack of concern regarding their service durability. It is this lack of knowledge that led certain authors to develop research studies to address high service temperature effects on their performance. The results from those studies clearly showed that the performance of an adhesive is severely influenced by service temperature, and its immediate effects may be critical for structural safety [5–9]. Since the effect that the preparation method, application environment and service conditions have on the performance and durability of epoxy adhesives specifically used in rehabilitation/restoration systems involving bonded-in rods has not been completely addressed in the scientific community, this paper discusses a test programme that was developed to assess the effect that type of mixing, curing and post-curing temperature, water and environmental service conditions have on the adhesives' viscoelastic properties.

* Corresponding author. Tel.: +351 218443246; fax: +351 218443023.
E-mail address: jcustodio@lnec.pt (J. Custódio).

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