

Selection of adhesives and quality control of structural repairs by bonding on site

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Abstract: Bonding on site has been used successfully for many years in the repair and strengthening of timber structures. However, there is still a lack of knowledge about its service durability, especially under high service temperature conditions. Not only the performance and durability of epoxy adhesives depend on their thermal stability but also on the preparation and application procedures followed on site, as confirmed by tests conducted by the authors to evaluate the effects of mixture ratios and curing conditions. This paper discusses a number of test methods that can be used for quality control of structural repair jobs involving bonding on site. Two studies conducted at LNEC where these methods were applied are presented: one concerning a structural intervention on a decorative suspended ceiling, the other concerning the selection of adhesives suitable for high service temperature conditions as expected in some roofs. DMA and FTIR analysis results are presented and their high potential for quality control during and after adhesive application is discussed.

1. Introduction

Epoxy adhesives have been used successfully for many years for the repair and strengthening of structures on site. These adhesives have good adhesion to a large variety of materials (wood, concrete, steel, FRP, GRP, etc.), cure at ambient temperature, don't require pressure during the cure process and exhibit low sensitivity to thickness variations of the glue line. However, because epoxy adhesives exhibit excellent initial joint strength when tested in standard climate conditions, there hasn't been a major concern about its service durability.

The lack of knowledge about the way in which fire and high service temperature affects the performance of epoxy adhesives lead recently to the development of research studies to address those concerns. Experimental and modelling work developed by the authors in previous studies clearly showed that the service temperature to which the timber structure is exposed dictates the temperature reached by the glue lines placed inside the bonded elements, despite the insulation provided by the timber cover (Cruz 2004 & 2005, Custódio 2006).

Although the heating effects on the long-term durability of glued joints require further investigation, the ("hot" tensile) tests performed so far with a range of commercial epoxy adhesives clearly show that its immediate effects may be critical for structural safety.

Selection of the adhesives for bonding on site should bear in mind the requirements of the job (viscosity, open time and close time, sensitivity to incorrect mixing or other possible mistakes) and the required performance (adhesion to the intended adherends, strength, stiffness, ductility, thermal stability).

Not only the performance and durability of adhesives depend on their intrinsic properties but also on the preparation and application procedures followed on site. On-site quality control of the intervention and regular monitoring of the joint should be made to ensure good service durability.

2. Test methods for adhesives selection and quality control

2.1 Selection of adhesives

Most commercial adhesives were developed for applications other than bonding timber. Generally they present too high stiffness and modest ductile behaviour. Moreover, information of their adhesion to timber products is not always available.

Adhesion tests are therefore required covering the specific adherends to be bonded and surface preparation methods considered. Pull-off tests are relatively easy to carry out and may help selecting the suitable adhesive and method of application.

Even when presenting working properties and strength and stiffness properties of the adhesive, rarely Product Data Sheets include quantitative information on its sensitivity to cure temperature and to service temperature – which may be highly relevant for certain applications and for certain regions.

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