

## **Thermal stability of epoxy and polyurethane adhesives and bonded joints used in the rehabilitation of timber structures**

**João Custódio**

**Laboratório Nacional de Engenharia Civil, Lisboa, Portugal<sup>1</sup>**

**Helena Cruz**

**Laboratório Nacional de Engenharia Civil, Lisboa, Portugal**

**João Negrão**

**Faculdade de Ciências e Tecnologia da Universidade de Coimbra, Coimbra, Portugal**

**James Broughton**

**Joining Technology Research Centre, Oxford Brookes University, UK**

### **SUMMARY**

In order to contribute to the ongoing discussion on the reliability of epoxy (EP) and polyurethane (PUR) adhesives for load bearing structures, a study was conducted at LNEC where several structural adhesives were subjected to several temperature regimes and subsequently assessed, namely to compare their glass transition temperature ( $T_g$ ) with tensile strength and stiffness decrease with increasing service temperature. Bonded joints including three different wood species and four selected adhesives were also tested in shear at a range of service temperatures in order to assess to what extent the thermal sensitivity of adhesives reflects in the behaviour of bonded joints.

The results showed that the PUR and EP adhesives display significantly different viscoelastic responses over the temperature ranges attained normally in service during summer (20 to 60°C). The study of the specific components and formulations of the various adhesives studied, showed a clear relationship with their strength and temperature stability. Temperature-induced creep is a risk factor that needs to be considered cautiously when approving novel adhesive types for structural applications. Because of that, careful adhesive selection, considering its glass transition temperature, thermal performance and possibly a post-cure procedure, should be made.

Early assessment of bonded joints suggest that temperature may have a complex interaction with the materials and interfaces involved in the joint, where adhesive strength and stiffness play a role. Nevertheless, with the results obtained, when comparing DMA to Tensile Tests, the former seems to be a more expedite and revealing technique to help predicting the adhesives thermal behaviour when in a bonded joint.

**Keywords:** Epoxy, polyurethane, thermal stability, bonded timber joints.

### **INTRODUCTION**

Novel formaldehyde-free adhesive systems, such as EP and PUR adhesives are gaining popularity in special applications like on-site repair or strengthening of timber structures, where the adhesives have to fulfil special requirements, such as, cure at room temperature without significant pressures applied, bond-line thickness variations tolerance, good gap-filling properties, and strong adhesion to several materials.

In applications requiring thick bond-lines, both PUR and EP adhesives exhibit excellent joint strength when tested in standard climate conditions. However, their use is often still restrained by

---

<sup>1</sup> Laboratório Nacional de Engenharia Civil (LNEC), Departamento de Materiais, Núcleo de Betões, Av. Brasil 101, 1700-066 Lisboa, Portugal, Tel. +351 218443964, Fax +351 218443023, [jcustodio@lneec.pt](mailto:jcustodio@lneec.pt)