



EVALUATION OF TEMPERATURE EFFECTS - LNEC
Proposal for discussion at the meeting in Bordeaux
(prepared in 2003-04-08)

⇒ **FRP materials or cured adhesives**

a) TMA (Termomechanical analysis)

Assesses the mechanical behaviour as a function of temperature in three-point bending; the applied load is a percentage of bending strength; mid-span deformation and time to failure are measured. Uses very small test specimens.

b) Tension test under high temperature or after temperature cycles

Instron machine: 10 kN
measures MOE and MOR in tension
ISO 527-2: Plastics. Determination of tensile properties. Part 2: Test conditions for moulding and extrusion plastics
+ in-built temperature chamber (T up to 200°C)

specimen size: 160mm long (110mm between grips) and thickness up to 12mm

cured adhesive (or FRP moulded on site from GF+adhesive) test specimens obtained by pouring liquid adhesive into shallow box, machining material after curing to specified dimensions;

Test b1)

test materials in tension under a range of temperatures (20°C, 60°C?, 80°C?, 100°C?)

Test b2)

test materials in tension at 20°C, after exposure to different ageing cycles

Note: **b1)** temperatures and **b2)** ageing cycles (Temperature, humidity, both (+U.V.) to be defined according to information from literature, polymer type and results of **a)**

c) Bending at 20°C after temperature/ ageing cycles

Instron machines (several possibilities)
specimen size: to be defined
measures MOE and MOR in bending

cured adhesive (or FRP moulded on site from GF+adhesive) test specimens obtained by pouring liquid adhesive into shallow box, (after curing) machining material to specified dimensions.

ageing cycles (Temperature, humidity, both, (+U.V.) to be defined after results of a)

FRPs or cured adhesives - Other (standard) tests :

- ❑ density
- ❑ water absorption
- ❑ hardness
- ❑ impact strength (Charpy)
- ❑ characterisation of composition by IR analysis
- ❑ fibres content (for FRPs only)

- ❑ DSC (Differential Scanning Calorimetry).
Determines heat absorption / emission by the material when subjected to raising temperature; gives information on some of the characteristics of the polymer, like vitreous transition point, melting point, etc. (Intended mainly for thermoplastics).

- ❑ TG (Termogravimetry)
Determines mass variations as a function of temperature; gives information on the ability of the material to withstand high temperature.

⇒ Interfaces (wood/adhesive or FRP/adhesive)

d) compressive shear test under high temperature

specimens configuration as proposed in Lavici et al (a shear test for structural adhesives used in the consolidation of old timber)

Test d1)

specimens tested under a range of temperatures (20°C, 60°C?, 80°C?, 100°C?)

Test d2)

specimens tested at 20°C, after exposure to different ageing cycles

e) Tension shear test under high temperature

Instron machine 10 kN
Fitted-in temperature chamber (T up to 200°C)

Adapt specimens configuration proposed in Lavichi et al (a shear test for structural adhesives used in the consolidation of old timber)

Test e1)

specimens tested under a range of temperatures (20°C, 40°C?, 60°C?, 80°C?, 100°C?)

Test e2)

specimens tested at 20°C, after exposure to different ageing cycles

Note 1: problems may occur if high temperature (and specially ageing cycles) distort the specimens...

Note 2: displacement measured only from loading head movement

⇒ (slice of) **Strengthened beam**

f) Thermal conductivity

(Specimen dimensions and test set-up based on EN 12667)

A slice of the strengthened beam (300mm x300mm wide, 100mm thick) is fitted between two metal plates (300mmx300mm) which have different temperatures in the range –18°C, 200°C. Heat flow between the metal plates is measured.

Since in standard tests metal plates are at 1°C and 19°C, respectively, different temperatures may be used for comparative assessment only, for instance: the effect of metal bars or GFRP bars inserted in a timber beam in its global thermal conductivity (or indirectly: the effect of these bars in temperature transmission inside the timber).

g) Reaction to fire

A slice of material 300mm x 400mm wide, <50mm thick is exposed to the flame.
Measures: time to ignition, flame height and heat development.

Purpose: comparison between solid timber and timber with surface GFRP strengthening; or comparison between solid timber cross section with a cross section of a beam with inserted bars.