A FEW CLARIFICATIONS ARE IN ORDER!

GLUING TROPICAL TIMBER

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PREAMBLE

In the timber industry, the gluing sector, especially the gluing of tropical timber, is probably the one that has developed the most since the 1980s. The introduction of new and more efficient adhesives enable the gluing of all types of timber, regardless of their characteristics, with increased requirements in terms of water resistance and mechanical resistance.

These technological advances make it possible to optimise the use of tropical timber by gluing a portion of the forest resource and cuts that are difficult to use in their current state: secondary timber varieties, poorly shaped or small-diameter logs, timber with major defects, downgraded timber, sawmill waste.

Reconstituted solid timber provides a stable and homogeneous material. The combination via gluing of timber varieties featuring highly different appearances offers new possibilities in terms of the further integration of timber into upscale projects (figure 1).

Figure 1: Tropical multi-species laminated panel (photo J. Gérard)

Gluing timber to other materials is now possible (figure 2)

Figure 2. Bubinga Ravier® crystal door (solid timber and acrylic glass combination), Amstelveen (Netherlands). Manufactured by Ravier SARL, Domblans (France). © Ravier SARL

The gluing of tropical timber appears to be limited by constraints linked to the specific characteristics of certain timber varieties and the need to comply with the rules of the trade. However, studies conducted by the CIRAD, in particular, have shown that the gluing of timber with defects or extreme characteristics produces satisfactory results if the recommended implementation conditions are used.

The choice of adhesive will depend on the final use of the bonded product, the production system, the required assembly time and the desired pressing time.

THE MAIN TYPES OF GLUE

Aminoplast adhesives

These single or two-component, thermosetting adhesives provide irreversible bonding that is obtained or accelerated by heat. These adhesives are not thermoplastic. There are 4 main categories:

- **Phenolic adhesives** (phenol-formaldehyde, = PF) are single-component and without hardener
- **Resorcinol adhesives** (resorcinol-phenol-formaldehyde, = RPF), which were the first industrial adhesives used for carpentry
- **Urea formaldehyde adhesives** (UF) which are two-component adhesives (resin + hardener) that are used either cold or hot
- **Melamine-urea-formaldehyde** (MUF) adhesives which are two-component adhesives (resin + hardener) that are used cold or hot

In 2015, new generations of formalin-free resins emerged, albeit in combination with urea formaldehyde and melamine urea formaldehyde technologies.

Thermoplastic adhesives

These adhesives are heat reversible; they fall into **four main categories.**

- **Vinyl adhesives** (vinyl acetate), or polyvinyl acetate, = PVAc) which are single or two-component (two-component with hardener with hardener for a D4 classification, see the following section).
- **Ethyl vinyl acetate** (EVA) adhesives which are single-component
- **Hot-melt adhesives**, based on EVA (ethyl-vinyl-acetate) which are thermo-fusible
- Solvent-based **neoprene adhesives** with an acetone base, which are tending to disappear in favour of aqua-spray neoprene adhesives (neoprene glue in aqueous phase)

Other adhesives

- **EPI adhesives** (Emulsion Polymer Isocyanates) which are a good compromise between vinyl and polyurethane adhesives.
- **Polyurethane adhesives** (PUR) which are single-component (react to humidity) or two-component (= PURbi, chemical reaction with hardener) thermosetting adhesives.
- **Polyurethane hot melt adhesives**, which are thermo-fusible and reactivatable while demonstrating the same qualities as polyurethanes.
- **Epoxy adhesives**, which are always two-component.

Adhesives from green chemistry

New adhesives based on green chemistry and manufactured using plants such as corn, potatoes, soybeans, etc., have been developed. However, the development of these adhesives remains limited by problems related to the regular supply and security of raw materials, as well as by the variability of their characteristics.

CLASSIFICATION OF BONDS

A classification of glues has been established according to their resistance against humidity and their stress tolerance. It is governed by the NF EN 204 standard (April 2002) *Classification of thermoplastic adhesives for non-structural timber* (= "D" classification) and the NF EN 12765 standard (April 2002) *Classification of thermosetting resin adhesives for non-structural timber* (="C" classification) which define 4 classes:

D1 and C1: indoor applications where the temperature will occasionally exceed 50°C for short periods of time; the humidity of the timber will not exceed 15%.

D2 and C2: indoor applications with occasional short periods of exposure to water or humid atmospheres; the timber's humidity content must not exceed 18%.

D3 and C3: indoor applications with frequent short-term exposure to dripping water, condensation, damp atmospheres, and/or with exposure to high humidity; outdoor applications, in sheltered areas not exposed to bad weather.

D4 and C4: indoor applications with long and frequent exposure to dripping water, condensation; outdoor applications with exposure to bad weather but with an adapted surface protection (varnish or paints).

MECHANISMS DETERMINING THE GLUING OF TIMBER

Current gluing technology enables us to avoid conventional mechanical assemblies, which are both expensive and time-consuming to implement. Glues ensure that adhesion and cohesion between two timber substrates are superior to those achieved using solid timber.

Proper gluing must take into account the intrinsic characteristics of the timber that is used: humidity content, density and wettability. Shaping and manufacturing conditions depend on the nature of the products and the adhesives that are chosen. The main parameters and mechanisms governing the gluing of timber are as follows:

- *Wettability*, glue weight and assembly time
- Glue penetration
- Gluing pressure
- Polymerisation of adhesives
- Stabilisation

OVERVIEW OF GLUING TECHNOLOGIES

The table below provides an overview of the main gluing technologies listed according to primary areas of application, defining for each the adhesives to be used and the type of gluing machines and presses to be used.

Application	Adhesive	Gluing machine	Press
Particleboard, OSB and fibreboard (MDF and high density)	UF, MUF, PUR	Spray gluing	Continuous strip press
Plywood panels	UF, MUF, PF	Roller gluing machine	Multi & single level board press
Calendering of decorative papers for standard furnishings	UF, PVAc	Roller gluing machine	Roll press
Doors (cellular, solid, insulating, fireproof, intrusion-proof, etc.)	UF, MUF, (PVAc, PUR)	Roller gluing machine	Multi & single level board press
Flooring	UF, MUF, PUR (PVAc)	Roller gluing machine	Single level board press
Seat shells, bed slats, skateboards, curved fittings	UF, MUF, (PVAc)	Roller gluing machine	Multi & single level presses with moulds
Construction: beams, frames	MUF, PRF, PUR	Curtain gluing machine	Lateral press with screws or cylinders
Solid casing or structural panels	UF, MUF, EPI, PUR	Roller gluing machine	Multi & single level board press
Solid panels for furniture, coffins, fittings, etc.	UF, MUF, PVAc, EPI	Cord gluing machine	Panelling machine for solid timber
Joinery, battens, square cuts, verandas	UF, MUF, PVAc, EPI, PUR	Roller gluing machine	Cylinder framing machine
Joinery assemblies (mortise and tenon, dowels, etc.)	UF, MUF, PVAc, EPI, epoxy	Cord gluing	Cylinder framing machine
Edgebanding and coatings for furniture, fittings, etc.	Hot-melt, PVAc, neoprene	Spray gluing	Multi-roller press for edge-banding and coating
Replating on shaped panels for kitchen doors and joinery	UF, PVAc	Roller gluing machine	Membrane press
Laminated kitchen door	Reactivatable PUR	Spray gluing	Vacuum press