

# INFORMATION SHEET

# STRUCTURAL CONNECTIONS



## ADHESIVES

### PERFORMANCE/DESIGN DATA

The information provided below has been taken from the New Zealand Timber Design Guide 2007, published by the Timber Industry Federation and edited by Professor A H Buchanan. To purchase a copy of the Timber Design Guide, visit [www.nztif.co.nz](http://www.nztif.co.nz)

#### ELASTOMERIC ADHESIVE DESIGN

Elastomeric adhesives should not be used as a structural joint for connections under long-term or live loads, they should only be used to contribute to the strength and stiffness of a joint under wind, earthquake or other transitory load.

Mechanical fixings (nails or screws) should be used to maintain contact between the adhered surfaces.

Under short-term loads, the mechanical fastener should be assumed to make no contribution to the strength or stiffness of the joint.

Elastomeric adhesives exhibit high creep under sustained loads so the maximum long-term load should be that of the fastener.

The strength of a jointed interface should satisfy:

$$V_p^* \leq \phi Q_{nsi}$$

where:

$V_p^*$  = design shear force

$\phi$  = strength reduction factor = 0.7 for glued joints

$Q_{nsi}$  = nominal design strength of the joint, given by the lesser of:

$$Q_{nsi} = k_1 k_{14} k_{15} k_{17} f_{sh} w I / Q$$

or

$$Q_{nsi} = k_1 k_{14} f_s w I / Q$$

where:  $k_1, k_{14}, k_{15}, k_{17}$  = modification factors

$f_{sh}$  = characteristic rolling shear stress  $f_{sr}$  or panel shear stress  $f_{ps}$  for plywood (from plywood design section)

$f_s$  = characteristic shear stress for timber

$w$  = width of bead of glue

$I/Q$  = effective shear area =  $2/3bd$  for a rectangular section of uniform modulus of elasticity glued at the neutral axis (see plywood design section).

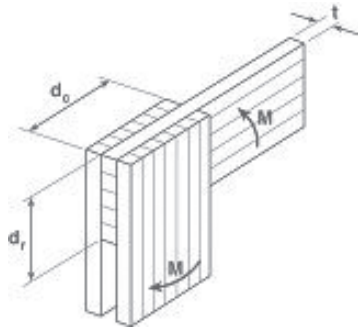
#### Epoxy adhesive design

See Epoxied steel rods for details on design and use.

**CROSS-LAPPED GLUED JOINT DESIGN**

Cross-lapped glued joints are used to fix multiple laminates together. Glu laminated timber is factory glued to produce a visually attractive joint.

**Diagram 1: Glued cross-lapped joint**



**Illustration: Courtesy Timber Design Guide, 2007**

Diagram 1 shows a typical cross-lapped glued joint. Bending stress in the members rather than the fracture strength of the joint will govern if the width-to-thickness ratio of the individual members that interleave in this type of joint is five or greater.

To provide sufficient bending strength, dimensions must be chosen that satisfy the design equation:

$$M^* \leq \phi M_n$$

where:

$M^*$  = the design level of bending moment, resulting from the factored applied loads

$\phi$  = strength reduction factor from section 2.5 of the New Zealand Timber Structures Standard NZS 3603

$M_n$  = nominal bending moment, based on fracture mechanics theory, given by:

$$M_n = k_1 \sqrt{\frac{3nEH I_r I_c (d_r + d_c)}{I_r + I_c}}$$

where:

$k_1$  = duration of load factor

$n$  = number of glue lines (two shown)

$E$  = modulus of elasticity

$I_r, I_c$  = moment of inertia of rafter and column members respectively (ignoring the packing members)

$d_r, d_c$  = depth of rafter and column members respectively

$b_r, b_c$  = breadth of rafter and column members respectively

$H$  = characteristic fracture toughness

$$= 240 (1 + \sin 2\theta) \text{ Nm/m}^2$$

$\theta$  = slope of rafter.

When  $d_r = d_c = d$  and  $b_r = b_c = b$ , the equation for nominal bending strength simplifies to:

$$M_n = k_1 \frac{d^2}{2} \sqrt{nEHb}$$

Stresses due to shear and axial forces on the joint are included in the derivation of this equation and do not need to be considered further.

An alternative expression for nominal moment, based on the 'rivet group' analogy (suitable for crane corbels or other joints with significant shear forces), is:

$$M_n = k_1 \frac{n\tau d_c d_r (d_c^2 + d_r^2)}{6 \cos^2 \theta \sqrt{d_c^2 + d_r^2 + 2d_c d_r \sin \theta}}$$

where:  $\tau$  = characteristic rolling shear stress on the glue line (2.2 MPa for radiata pine in dry condition – see table 6.1 of NZS 3603).

For  $d_c = d_r = d$  this simplifies to:

$$M_n = k_1 \frac{n\tau d^3}{3\sqrt{2} \cos^2 \theta \sqrt{1 + \sin \theta}}$$

The rolling shear stress and the fracture toughness value for these two formulae were determined from tests on joints with depths ranging from 200 to 400 mm. For joints larger than 500 mm wide, the fracture mechanics theory is the more conservative and is therefore recommended.