

INFORMATION SHEET

STRUCTURAL CONNECTIONS

SCREWS

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

EFFECT OF SPECIES

The New Zealand Timber Structures Standard NZS 3603 gives fastener strengths for five classes of wood quality, specified as joint groups J1 to J5. Some species or materials may be classified in different joint groups for different modes of loading.

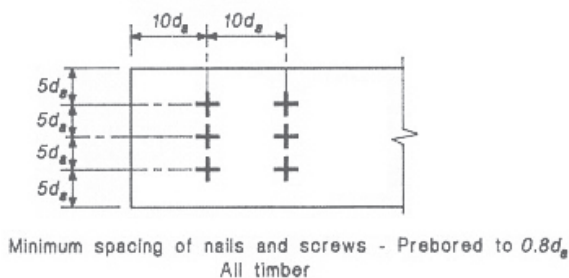
The manufacturers of engineered wood products (such as **laminated veneer lumber (LVL)**) publish the appropriate joint group for their products after experimental testing.

Fastener strengths given here are only for radiata pine and Douglas fir. See NZS 3603 for other materials or species.

SCREW SPACING

The diagram below shows the minimum screw spacing given in NZS 3603 for radiata pine.

Minimum screw spacing from NZS 3603



Reproduced from NZS 3603 with the permission of Standards New Zealand under Licence 000702 – to purchase NZS 3603 go to www.standards.co.nz

CHARACTERISTIC FASTENER STRENGTH

NZS 3603 specifies the characteristic strengths for screws as a function of fastener diameter, see table 1 for radiata pine and Douglas fir.

The characteristic strengths have been derived by applying a soft conversion multiplier of 2.95 to the basic working strengths used in the previous version of NZS 3603.

The original basic working loads were determined from tests of solid timber joints incorporating various fastener diameters, using the lesser of:

- the lower 5 percentile ultimate strength, divided by a load duration and safety factor of 4.15, and
- the lower 5 percentile strength at 0.4 mm slip divided by a safety factor of 1.25.

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For screws, the characteristic strength Q_k (N) for a shank diameter d (mm) is:

$$Q_k = 81d^{1.9}$$

To determine the design strength, these characteristics are modified to take account of such factors as timber moisture content, timber thickness, fastener length, end grain, double shear, multiple fastener joints and duration of load.

Table 1: Characteristic strengths for one screw in single shear in side grain in dry timber

Screw diameter (mm)	2.74	3.1	3.45	3.81	4.17	4.52	4.88	5.59	6.3
Gauge	4	5	6	7	8	9	10	12	14
Strength (N)	554	700	854	1025	1229	1429	1652	2140	2663

DESIGN STRENGTH

The design strengths for laterally loaded fasteners should be determined by multiplying the appropriate characteristic strengths (table 1) by one or more of the following factors to take account of the actual service condition of the joint.

LOAD DURATION

The modification factor k_1 from NZS 3603 should be applied to the characteristic strengths to take account of load duration.

MOISTURE CONDITION

A reduction factor of 0.8 should be applied to the characteristic strengths [of screws when the joints are:

1. fabricated dry but become wet in service, or
2. fabricated green and remain green in service, or
3. fabricated green and allowed to dry in service.

The reduction factors for conditions 1 and 2 above can be explained by noting that the crushing resistance of the timber under the fastener shank reduces with increasing moisture content.

The reduction for condition 3 is due to the timber shrinking with drying, resulting in a gap of as much as 1.0 mm at the interface of the two timber members. This gap causes a reduction in the initial stiffness of the joint and design strength.

PLYWOOD SHEATHING FASTENED TO TIMBER

For plywood sheathing fastened to solid timber, the fastener strengths are higher than those in timber to timber joints by a factor of 1.4.

Fastening of wood based products, such as particleboard, fibreboard and hardboard to timber can be designed using the same strengths as plywood, but they may not provide the same level of ductility.

MULTIPLE SHEAR FACES

For a joint with several shear faces the design strength is directly proportional to the number of shear faces. Note that very long screws would be necessary for a screwed joint to be designed with multiple shear faces.

Three member joint loaded in shear

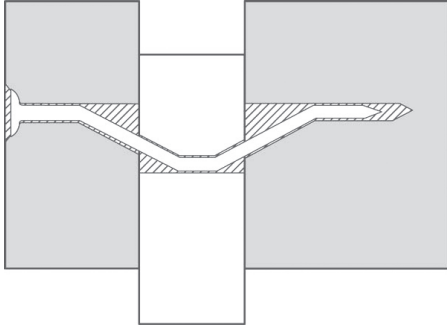


Illustration: Courtesy Timber Design Guide, 2007

FASTENER LENGTH

Screw penetration of the point of the fastener into the timber should be at least 7 screw diameters.

Fastener penetration and timber thickness affect the way the fastener bends in the timber and this, in turn, influences the design strength.

Joint strength is greatest when the fastener is long enough to develop two plastic hinges and lowest when the fastener does not bend at all.

NZS 3603 gives reduced strengths when the recommended penetration requirements are not met.

Table 2: Maximum fastener diameters for fixing sheathing to timber in shearwalls and diaphragms

	Sheathing thickness (mm)				
	4.5*	7.5*	9	12.5	15+
Plywood	2.8*	2.8*	3.3	3.3	4.0
MDF or particleboard	Not suitable			3.3	4.0

* Not suitable for fully ductile design.

LARGE NUMBER OF FASTENERS

When the number of fasteners in a connection exceeds 50, the design strength on each can be increased by a factor of 1.30.

For fewer screws, the factor is obtained by linear interpolation to a value of 1.0 for four fasteners. This accounts for variability in strengths by moving from the 5th percentile value for one fastener towards a mean value for multiple fasteners. This factor should be used for large gusset connections or plywood shearwalls.

STEEL SIDE PLATE

Where fasteners are driven through tight fitting thick steel plate, the plate effectively clamps the screw shank forcing the plastic hinge to form at the interface of the two joint members. This significantly increases the joint stiffness and design strength.

A significant although smaller increase in stiffness also occurs when screws are driven through loose fitting or thin steel plate.

To achieve this benefit for screws, care must be taken to ensure a tight fit on the screw shank, which may not be possible if the thread diameter is bigger than the unthreaded shank diameter.

Manufacturers of metal connection products publish their own characteristic screw strengths, based on independent test results (see Metal plate fixings).

JOINTS LOADED IN WITHDRAWAL

NZS 3603 specifies the characteristic withdrawal strengths in terms of the screw diameter and its penetration into the timber as given in table 3.

Note that there is an upper limit on the withdrawal load per screw due to the maximum tensile strength of the screw.

Designers should also consider failure of the joint through the screw head pulling through the top layer, particularly if the screw thread terminates before the head.

Table 3: Characteristic withdrawal strength per millimetre of fastener penetration (N/mm)

Screw diameter (mm)	2.8	3.5	4.1	4.7	5.4	6.1
Screw gauge number	4	6	8	10	12	14
Radiata pine and Douglas fir	34.7	43.5	52.6	61.7	70.8	79.5
Maximum per screw (N)	1,030	1,630	2,380	3,270	4,280	5,440