

INFORMATION SHEET

STRUCTURAL MATERIALS



GLUE-LAMINATED TIMBER MANUFACTURE

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

SPECIES

In New Zealand, radiata pine and Douglas fir are the most commonly used species for the manufacture of glulam. Because of its plentiful supply as a renewable resource, and its suitability for kiln drying and machining, radiata pine represents approximately 75% of laminating stock. Other species can be used but these may require special care and are often more expensive.

KILN DRYING

Good kiln drying is basic to successful laminating. Prior to gluing, the moisture content of the laminating stock must not be greater than 18% nor should it be less than 12%. In addition the range of moisture content for laminations in any one member must not exceed 5%. These provisions will ensure an optimum bond for the adhesive and limit dimensional changes in the timber. Differential shrinkage of laminations within a member can induce stresses that lead to surface checking, particularly at the gluelines.

GRADING

Grades for the design and manufacture of Glulam beams are set out in AS/NZS 1328.2:1998 Table 1.2. The most common grade produced by NZ manufacturers is GL8. Higher grades of GL10 and to a lesser extent GL12 are available at a premium and require the manufacturer to verify the properties by physical testing. In addition to meeting the strength requirements, appearance requirements will often require that large knots and other defects be removed.

Guidance for manufacturing the most common grades are:

GL8 grade

The GL8 grade of glulam is made using VSG8 or MSG8 grade timber. Stiffer, denser pieces will be those furthest from the pith of each log, and can be identified by looking at the growth rings at the end of each board. These pieces should be placed outermost in the finished member. Inner laminations, in the middle half of the member depth, can be of lower grade.

GL10 grade

For the outer laminations the timber must be VSG10 or MSG10 grade. To improve strength, docking may be done in the outer laminations, but will need to be replaced with finger joints of strength appropriate to the grade. Appearance requirements will often demand that most knots are docked out. Inner laminations, in the middle half of the member depth, can be of lower grade.

GL12 grade

Outer laminations must be selected only from machine graded MSG12 grade timber. Often this will be available in small sizes only, so edge-laminating will be necessary for wide glulam members. If strength is critical in a GL12 member, then proof testing of the outermost tension laminations by the glulam manufacturer is recommended, the tests carried out in either bending or tension. Alternatively, laminated veneer lumber (LVL) can be used for the outer laminations. The use of a high stiffness species, such as some hardwoods, for the outer laminations is an option, although the poor gluing characteristics of harder timbers can be a problem. Inner laminations, in the middle half of the member depth, can be of lower grades.

END JOINTING OF LAMINATIONS

Since the length of glulam members normally exceeds the length of available timber, random length pieces are usually *finger-jointed* and glued together to make continuous laminations. Finger joints vary in size according to the manufacturer. All laminated timber manufacturers using finger joints are licensed under AS 5068 to manufacture structural finger joints. *Scarf jointing* of laminations is still done by some manufacturers, which is the gluing of carefully prepared bevel cuts on the ends of adjacent laminations. Care is needed in the gluing and alignment of scarf joints especially where scarfs are not pre-set but are laid up as part of the beam. End joints should be scattered at random throughout the member if possible. End joints should not be located in the very highly stressed outer laminations near moment-resisting portal frame connections. Butt joints should not be considered as a method of achieving structural end jointing.

SURFACING OF LAMINATIONS

Individual full length laminations are planed to exact dimensions before gluing to ensure tight glue lines and accurate finished beam sections. Laminations should not be sanded before gluing. At the time of gluing the timber surfaces are required to be free of dust or exuded treatment salts. The standard finished thickness of laminations for straight members is normally 45 mm although some manufacturers prefer to produce laminations 40 mm or 42 mm thick. Thinner material is used for bending laminations for curved members.

ADHESIVES

Selection of the most appropriate glue is governed by the final exposure of the glulam beam. For interior use where the moisture content is below 18% (most houses, offices and other indoor uses) a selection can be made between urea, polyurethane, isocyanate (API, EPI), or melamine/urea (MUF). MUF is the most widely used adhesive for internal uses. It is moisture resistant, but not long term weatherproof, hence its use is restricted to indoor structures. Unfortified Urea has limitations in high temperatures.

For areas that experience wide variations of temperature and humidity such as laundries, and in situations exposed to exterior atmosphere but sheltered from direct rain and sun (e.g. porches and soffits) the choice is between melamine fortified urea with at least 40% melamine content, polyurethane, isocyanate (API, EPI), and resorcinol glues. In situations directly exposed to the elements or in extreme climatic conditions, and for use with CCA treated material, only resorcinol adhesives should be used. While the resorcinol glues are the most durable, the cost is several times that of the other glues which can add an overall additional price of between 7-10% on the finished beam. The other glues mentioned have proven reliable performance within the limitations mentioned. Resorcinol glues are a reddish brown colour, whereas most of the other glues are clear. Epoxies have not yet proved effective or cost efficient for laminating purposes, but they are extensively used for repairs or in the fixing of metalwork dowels and plates into beams for jointing purposes.

Strict procedures are followed covering the mixing, application and spreading of glues. After application of a controlled quantity of adhesive by glue spreader, the laminations are assembled in a clamping jig and pressures of between 400 kPa and 700 kPa are applied. The jigs are set out to the required camber or shape of the member. Careful checking of pressures by torque wrench or load cell is carried out. Once members are secured in the press jigs, temperatures are maintained during the curing process. Depending on the type of adhesive it may be necessary to provide heating to the pressing area to keep temperatures above the minimum curing temperatures specified by the glue manufacturer.

CURVED MEMBERS

The flexibility of glulam allows it to be formed into almost any shape. However the higher cost of tighter curves reflects the increased expenses involved. As a general rule the radius of curvature should be as large as possible, see Table 1.

Table 1: Minimum radius of curvature (from NZS 3603:1993)

Net thickness of laminations	Member with constant curvature	Member with tangent ends (usual case)
Thickness (mm)	Radius (mm)	Radius (mm)
10	1400	1200
13	2200	1800
16	3000	2300
19	3500	2800
32	8500	6700
45	12000	9700

Each reduction in radius and subsequent lamination thickness brings the extra cost of more machining and a greater quantity of glue. However in considering comparative structural options and materials it needs to be remembered that the finished curved beam or portal is a completed structural and architectural component needing no further expense after installation. The standard options of timber thickness for curved members are:

- 45 mm laminations (ex 50 mm stock).
- 32 mm laminations (ex 40 mm stock).
- 19 mm laminations (ex 25 mm stock).
- 16 mm laminations (ex 25 mm stock).

Various forms of curved members are available for both beams and portals. For curved portal frames, the use of an “open knee” can bring savings upwards of 10% compared to a “solid knee”. No steam bending of laminations is permitted. Because timber is a “living” material with variable stresses some slight variability in final shape may occur due to spring-back.

CAMBER

Straight beams that will be simply supported in the finished job should be cambered to allow for deflection due to permanent load. The usual camber is span/400 at mid-span unless otherwise specified.

FINISHES

This is an area often grossly over-specified. The natural appearance of some timber blemishes is often more aesthetically acceptable than the best artificial repair. The final position from which many members will be seen tends to minimise the visual effects of many blemishes. AS/NZS 1328 specifies three qualities of surface finish; Appearance Grades A, B, & C, as shown in Table 2. There are several options within each quality, so the desired finish should be specified carefully.

For members which will not be visible in the finished job, even the glue need not be removed from the sides, giving a very rough appearance. In most cases however the members are just planed, leaving a number of surface blemishes, allowing safer handling, and producing a more attractive surface.

Table 2: Definition of appearance grades.

Appearance grade	Description
A	This grade is intended for use in applications where appearance of the member is important and clear or painted finishes are used. All surface voids are filled or repaired. Unless it is specified otherwise, the surfaces shall be sanded to a minimum of 60-grit finish.
B	The grade is intended for use in painted applications where appearance is important but a planed finish is acceptable. The machining shall conform to No. 2 dressed surfaces grade as defined in AS 2796. Occasional skips in the surface are permissible and minor blemishes, voids and machining want shall be acceptable. The outer-most laminations shall be free of loose knots and voids.
C	This grade is intended for the use in applications where appearance is not important. All blemishes and voids are acceptable.

Note: The Appearance Grades most commonly produced in New Zealand are Grades **A** and **B**.

QUALITY CONTROL

Bureau Veritas in conjunction with the NZ Timber Certification Board issues licences to glulam manufacturers to make glulam in accordance with AS/NZS 1328 and AS/NZS 1491 (finger jointing). The licensee is required to carry out a regular quality control program, and is inspected twice each year by both Bureau Veritas and the New Zealand Timber Certification Board to ensure that all manufacturing processes and materials as well as quality control records comply with relevant codes. When making GL8, GL10 or GL12 beams the manufacturer must carry out testing to demonstrate that the required strength and stiffness properties have been achieved. The quality control programme consists of daily random tests on finger-joints and gluelines between laminations, as well as controls on plant, facilities and procedures. The licence permits the manufacturer to display the “S” mark on the finished product. It is recommended that only licensed manufacturers be engaged to make structural glue laminated timber.