STRUCTURAL
TIMBER
EXPERTS
SINCE 1992

Checking & Delamination in Laminated Timber.

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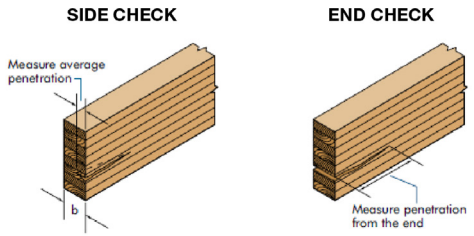
1 Checking and delamination in laminated timber

Timber is a natural material, so its natural properties must be taken into account when designing and constructing timber buildings. Some surface checking may occur due to changes in moisture content. Surface checks are sometimes called “seasoning checks” Checks are typically defined as cracks which are smaller than 15% of the beam or column width.

Timber naturally swells and shrinks when its moisture content increases or decreases. The moisture content is affected by moisture levels in the surrounding atmosphere. The optimum form of moisture management is to manufacture all glulam beams from laminations which have a moisture content close to the equilibrium moisture content expected in the final building, and to avoid excessive changes in moisture content (%MC) during construction. The usual interior %MC settles around 11 +/- 2% and can drop to even less in buildings with active ventilation system and significant direct sun exposure when left visually exposed. In exterior applications the %MC is highly dependent on the level of exposure to the environment and ability to dry off when getting exposed to direct moisture .

2 Surface checking in glulam beams

Surface checking can occur in any timber member due to differences in moisture content between the core and the surface. This is a particular problem in large glulam beams manufactured from wood with a high moisture content, because surface drying will cause local shrinkage, leading to perpendicular-to-grain tensile stresses which can result in checking (splitting along the line of the grain). The larger the glulam member, the greater the potential problem, because of potential for larger differences in moisture content between the core and the surface.



Checking can occur along the side a glulam beam, or at the ends, as shown below. The ends are more vulnerable for checking because of more rapid drying through the end grain than the side grain.

3 Influence of checks

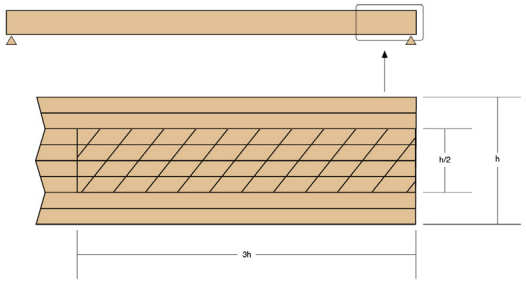
The influence of checks on the structural performance of glued laminated timber members is generally minor. The concern about surface checks is often only cosmetic. Where the checks affect the

appearance of glulam members, they can be hidden by filling the checks and re-finishing the surface.

The structural influence of checks rarely affects the bending strength because the checks are parallel to the grain. The biggest structural concern of checking is a possible reduction in shear strength. Shear strength will be reduced when the checks occur as large side cracks or large end cracks near the ends of glulam beams. Checks in a glulam beam are typically not considered to be a structural problem, unless they are more than 15% of the beam width, regardless of location.

The shear-critical zones are typically at each end of a simply supported glulam beam, in a length of 3 times the beam depth, and within the middle half of the beam depth, as shown below. Any checks in this region should be carefully assessed, and they can be repaired if necessary.

Shear Critical Zone in a Glulam Beam

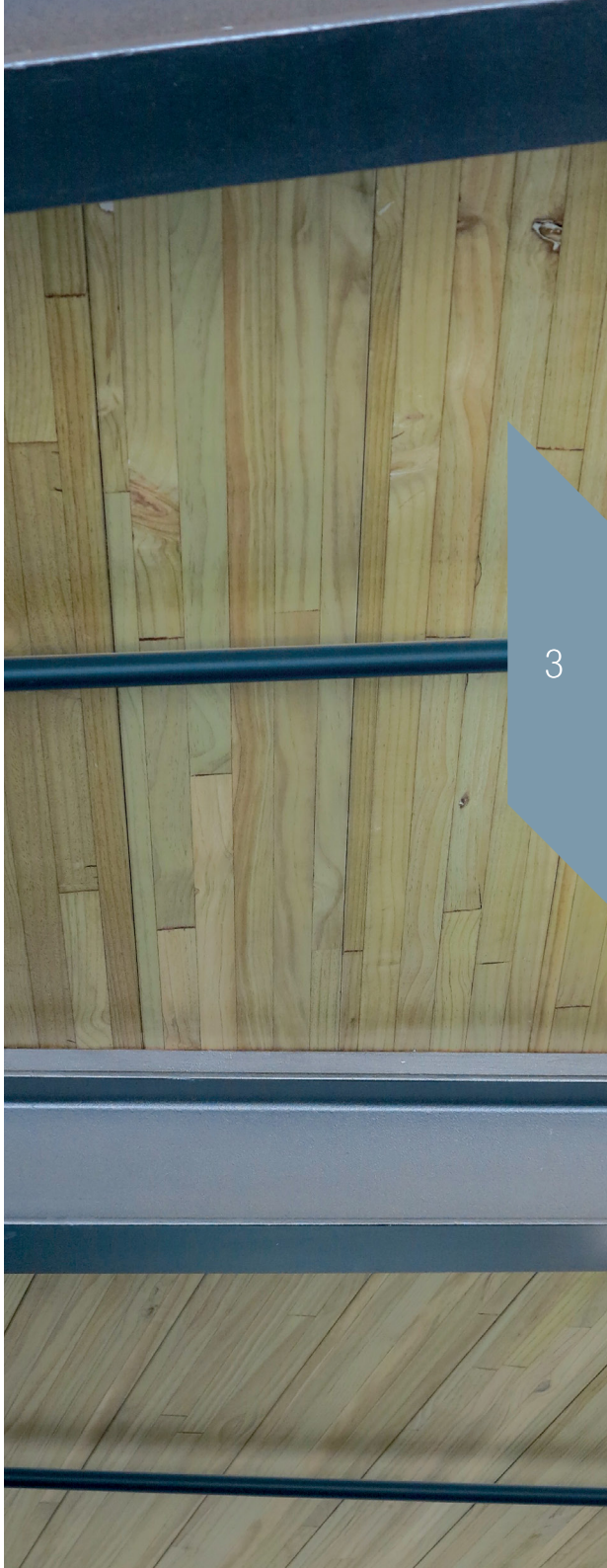


4 Checks in Techlam glulam timber

Significant surface checks are not common in Techlam glue-laminated timber. The individual laminations are carefully dried, and are generally 45mm or less, which means they have uniform moisture content. The maximum moisture content of these laminations is 14% at the time of gluing. As a result, checks occur less frequently than in large solid timber, logs, or round timber. Checking can be further minimized by careful installation practices that avoid prolonged exposure of the members to wet weather during construction.

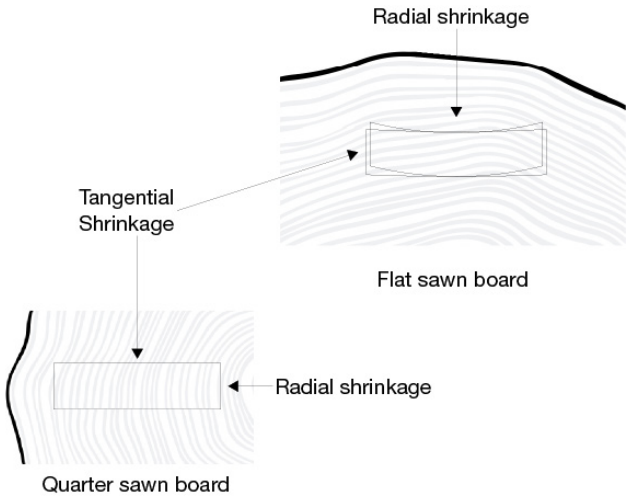
5 Identification of checking

Checks occur as transverse separations or openings that are nearly parallel to the grain direction and generally follow the grain direction around knots and along sloping grain. Differences in the shrinkage rate of individual laminations in glue-laminated timber tends to concentrate shrinkage stresses at or near glue lines, resulting in checks. Checks are often confused with delamination that occurs when the glue bond is not adequate. The presence of wood fibre separation in these openings is the key distinguishing characteristic of seasoning checks. Openings due to inadequate adhesive bonding may appear as smooth wood surface separations, possibly darkened by the adhesive film, or as glossy surface areas of adhesive with an absence of torn wood fibres.

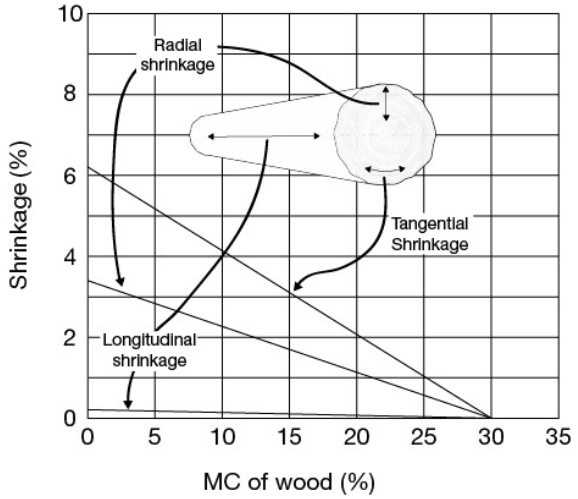


6 Timber characteristics and checking direction

The below images show the different directions a lamination can shrink or swell depending on the grain direction. There is almost no shrinkage or swelling along the length of a board. Swelling is larger in the tangential direction than the radial direction which causes distortion of flat-sawn boards. This can also cause large longitudinal checks in poles and round timber.



Distortion of boards caused by different shrinkage in different directions.
(NZ Timber Design Guide)



Shrinkage at various directions to the grain.
(NZ Timber Design Guide)

7 Exposed Glulam Delamination

Extract from: NZ Timber Design Journal, Issue 2 Volume 8

Should Exposed Glulam be Sealed?

It can be assumed that stresses will develop along glue-lines in exposed glulam, simply because the grain orientation, ring orientation, wood density, response to moisture etc. thus will differ between adjacent laminations. European specifications for exposed glulam state that the growth rings in the laminations must all be oriented the same way, and they show a diagram of flat-sawn laminations all with the pith-side downwards. This is hardly practical in New Zealand with Radiata as the ring

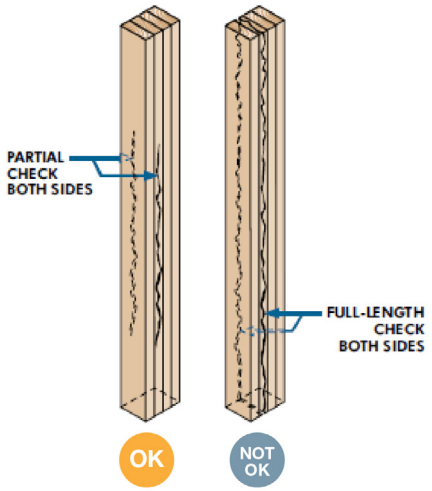
orientation is likely to change across a finger joint, and many laminations will be quarter-sawn, flat sawn and everything in between. Therefore, delamination is to be expected but generally should not penetrate more than 20 mm in properly cured glulam, made with resorcinol adhesive. Exposed treated solid timber is likely to develop similar checking. The reason for this is that the moisture fluctuations that give rise to the stresses do not penetrate far, i.e., they are damped out by the resistance of the wood to diffusion of moisture.

Forest Research

Forest Research has tested glulam from a cool store that showed obvious delamination. There appeared to be little effect on strength unless the delamination goes right through. There have been experiments to determine how much delamination can be tolerated before an effect on shear is noticed. Where the glue-line was artificially narrowed by placing adhesive tape along the laminations prior to gluing, there was no effect down to 25% of the width remaining. When the glued area was reduced by placing adhesive strips across the wood at intervals, an immediate effect was noticed. It all has to do with the stress-raisers generated by the delamination. Some type of sealing is certainly helpful, and painting is excellent, but it must be maintained. An oil-based preservative such as creosote is effective because the oiliness acts as a water repellent. I have seen a thick tacky substance applied to glulam bridge stringers, same as can be applied to steel as a rust preventative. The bridge in question is at the entrance to the Whakarewarewa village in Rotorua and is still giving good service after 40 years.
There are several proprietary formulations of water repellent sealants on the market, and some manufacturers apply ‘Enseal’ as a matter of course.

- Written by Bryan Walford, Forest Research Institute, Rotorua

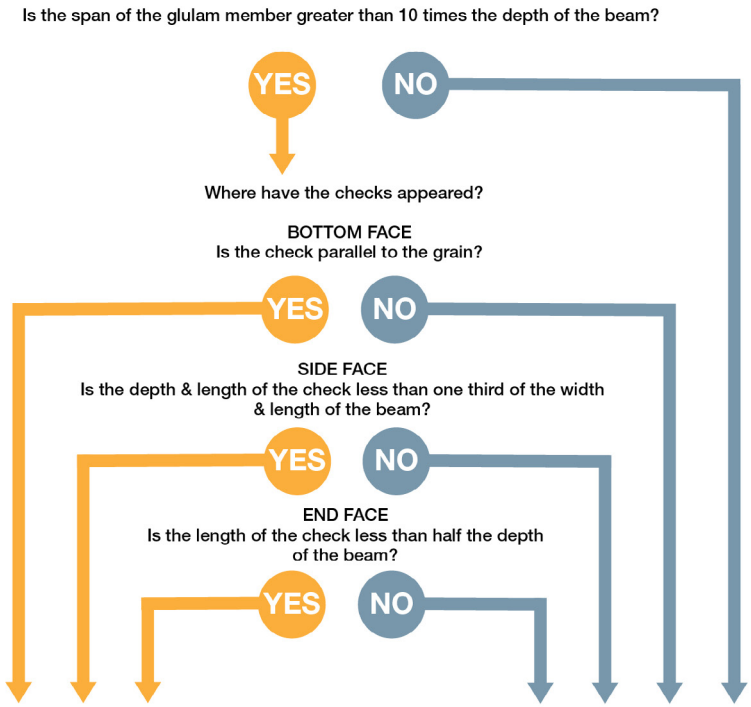
The drawing to the right shows the structural effect of checking on a glulam column, showing that partial-length checks are not considered to be serious structural problems:



8 Summary of structural effects

The following flow chart clarifies the structural effect of checking on a glulam beam.

Is my Glulam Structurally Sound?



NO STRUCTURAL CONCERN

If the checks on your building's glulam pose no structural problems, engineering analysis is not required. These recommendations apply to both simple span beams and multiple span beams under uniform loads.

CONSULT DESIGN PROFESSIONAL

If the checks in a glulam beam exceed these sizes and situations, a qualified design professional should evaluate the effect of the checks.

Sources:

APA Wood Technical Notes:

Timber Design Guide. New Zealand Timber Industry Federation, 2007.

NZ Wood Design Guide - TREES, TIMBER, SPECIES & PROPERTIES. Chapter 1.2 | February 2020

Andy Buchanan - PTL Structural Consultants

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