MASS TIMBER DESIGN GUIDE.

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WHAT IS MASSLAM?

MASSLAM is the Australian Sustainable Hardwoods Pty Ltd (ASH) range of massive timber solutions - also sold as Glue Laminated Timber, GLT, Glulam, ATC, TCC and floor cassettes.

MASSLAM is a high strength, visually appealing, affordable, ‘ready to construct’ column, beam and flooring system for commercial and large domestic buildings.

Manufactured in Heyfield, using Australian grown, superior strength timber, the MASSLAM range of products offer significant benefits when compared with other mass timber options worldwide.

MASSLAM 45 columns at the University of Tasmania, Burnie, Australia.

SPECIFICATIONS & CHARACTERISITICS

	MASSLAM SL33	MASSLAM SL35	MASSLAM 38	MASSLAM 45
	Equivalent GL13	*Equivalent GL15*	*Equivalent GL15*	*Equivalent GL17*
Species	Plantation Oak	Australian Oak	Plantation Oak	Australian Oak
Bending Strength	F'_b = 33MPa	F'_b = 35MPa	F'_b = 38MPa	F'_b = 45MPa
Tension Strength	F'_t = 16MPa (parallel) F'_{tp} = 0.5MPa (perpendicular)	F'_t = 25MPa (parallel) F'_{tp} = 0.6MPa (perpendicular)	F'_t = 19MPa (parallel) F'_{tp} = 0.5MPa (perpendicular)	F'_t = 25MPa (parallel) F'_{tp} = 0.6MPa (perpendicular)
Shear Strength	F'_s = 4.2MPa	F'_s = 5.0MPa	F'_s = 5.0MPa	F'_s = 5.0MPa
Compression Strength	F'_c = 26MPa F'_{cp} = 10MPa (perpendicular)	F'_c = 45MPa (parallel) F'_{cp} = 10MPa (perpendicular)	F'_c = 38MPa (parallel) F'_{cp} = 10MPa (perpendicular)	F'_c = 45MPa (parallel) F'_{cp} = 10MPa (perpendicular)
Bearing Strength	F'_l = 30MPa (parallel) F'_p = 10MPa (perpendicular)	F'_l = 59MPa (parallel) F'_p = 10MPa (perpendicular)	F'_l = 45MPa (parallel) F'_p = 10MPa (perpendicular)	F'_l = 59MPa (parallel) F'_p = 10MPa (perpendicular)
Modulus of Elasticity	E = 13,300MPa $E_{0.05}$ = 9,975MPa *$E_{90,mean}$ = 890MPa	E = 15,000MPa $E_{0.05}$ = 11,250MPa *$E_{90,mean}$ = 1,000MPa	E = 14,500MPa $E_{0.05}$ = 10,875MPa *$E_{90,mean}$ = 960MPa	E = 16,700MPa $E_{0.05}$ = 12,525MPa *$E_{90,mean}$ = 1,110MPa
Modulus of Rigidity	G = 900MPa	G = 1,000MPa	G = 960MPa	G = 1,110MPa
Joint Group	JD4	JD3	JD4	JD3
Design Density	Mean = 600kg/m3 P_k = 550kg/m3	Mean = 650kg/m3 P_k = 545kg/m3	Mean = 600kg/m3 P_k = 550kg/m3	Mean = 650kg/m3 P_k = 545kg/m3
Service Class	1 & 2 only (3 if H3-treated, with limitations)	1 & 2 only (3 if H3-treated, with limitations)	1 & 2 only (3 if H3-treated, with limitations)	1 & 2 only (3 if H3-treated, with limitations)
Adhesive	Externally rated, high temperature PUR	Externally rated, high temperature PUR	Externally rated, high temperature PUR	Externally rated, high temperature PUR
Formaldehyde Emissions	None (Super E0)	None (Super E0)	None (Super E0)	None (Super E0)
Certification	PEFC/Responsible Wood	PEFC/Responsible Wood	PEFC/Responsible Wood	PEFC/Responsible Wood
Char rate	**0.68mm per min	**0.59mm per min	**0.68mm per min	**0.59mm per min
Movement in Service - Axial	0.02% per 1% change in MC	0.02% per 1% change in MC	0.02% per 1% change in MC	0.02% per 1% change in MC
Movement in Service - Radial	0.20% per 1% change in MC	0.20% per 1% change in MC	0.20% per 1% change in MC	0.20% per 1% change in MC
Movement in Service - Tangent	0.31% per 1% change in MC	0.31% per 1% change in MC	0.31% per 1% change in MC	0.31% per 1% change in MC

* Calculated according to EN384:2004
** Jensen Hughes NATA lab according to AS1530:4

SIZES

MASSLAM SL33 & MASSLAM SL35		
WIDTH (mm)		DEPTH (mm)
65		120
90		165
112		205
140		250
		290
		340
		375
		420
		450
		510
		550
		595
		635
	X	680
		720
		765
		805
		850
		890
		935
		975
		1020
		1060
		1100
		1150
		1190
		1230

Note: all depth options can be used with any width on this table.

MASSLAM SL33 & MASSLAM SL35					
120		200	270	350	420
165		270	370	470	570
205		335	460	590	710
250		410	560	710	860
290		480	660	830	1000
335		550	750	950	1150
380		620	840	1070	
420		690	940	1190	
450	X	760	1030	1250	
		830	1220		
		900	1250		
		970			
		1040			
		1110			
		1180			
		1250			

Note: all depth options can be used with any width on this table.

COATINGS & APPEARANCE

ASH operates a four-sided planer that enables members up to 1250mm x 450mm x 12,000mm to be dressed square and with an arris prior to the CNC process. Pencil round corners or square edges can be produced on request. This ensures an exceptionally accurate building product. MASSLAM is intended for use in stained or coated applications where the member is part of the aesthetics. Occasional skips in the surface are permissible and minor blemishes, checking and voids in timber shall be acceptable as standard.

MASSLAM is available and recommended to be supplied with a protective primer before leaving the processing plant. It will require sanding and polishing to achieve a furniture finish. Talk to your MASSLAM specialist about coating options.

CHARACTERISTIC	MASSLAM SL33	MASSLAM SL35	MASSLAM 38	MASSLAM 45
Machine finish	≡ 60 grit	≡ 60 grit	≡ 60 grit	≡ 60 grit
Grain structure of feedstock	Quarter sawn for stability	Quarter sawn for stability	Back sawn	Quarter sawn for stability
Gum Vein – Tight	No limit	No limit	No limit	No limit
Gum Vein – Loose	No limit	No limit	No limit	No limit
Gum Pockets	No greater than 7mm wide and 4mm deep	No greater than 7mm wide and 4mm deep	No greater than 7mm wide and 4mm deep	No greater than 7mm wide and 4mm deep
Sound Knots/Burls	No limit	No limit	No limit	No limit
Loose Knots	Nil	Nil	Filled	Nil
Pinhole	No limit	No limit	No limit	No limit
Hobnail	No limit	No limit	No limit	No limit
Black Speck	No limit	No limit	No limit	No limit
Rot/Decay	Nil	Nil	Nil	Nil
Heartwood	Nil	Nil	Nil	Nil
Checking	No limit	No limit	No limit	No limit
Laminate size	Varied	Varied	Varied	Varied

Note: Appearance qualities relate to visual surface only. Surfaces marked ‘non-visual’ in shop drawings shall accept non-visual grade which allows any visual characteristic.

ACCEPTABLE TOLERANCES

	MASSLAM
Width	± 2mm
Depth	± 2mm
Squareness	± 2mm per 300mm depth
Length ≤ 6m	± 2mm
Length ≥ 6m	± 0.05%
Spring/Straightness ≤ 6m	± 6mm
Spring/Straightness ≥ 6m	± 0.1%
Machining (holes, millings, slots, etc) location relative to member	± 3mm in both plan axis
Machining (holes, millings, slots, etc) location relative to other local machining	± 2mm in both plan axis
Machining of holes – diameter	± 1mm
Machining of holes – wandering to mid-width/depth of member	± 1.0% of width/depth
Machining of millings and slots – size (width and depth)	+ 2mm - 1mm
Machining of millings and slots – size (length)	± 2mm

	CUSTOM FABRICATED BRACKETRY
Thickness of plates	± 0.5mm
Width (individual plates)	± 2mm
Squareness (individual plates)	± 1%
Length ≤ 500mm	± 2mm
Length ≥ 500mm	± 4mm
Straightness	± 2mm
Machining (holes, millings, slots, etc) location relative to member	± 1mm in both plan axis
Machining (holes, millings, slots, etc) location relative to other local machining	± 1mm in both plan axis
Machining of holes – diameter	+ 0.5mm - 0.2mm
Machining of millings/cuts – size (width, depth, length)	+ 0.5mm
Weld sizes	+ 2mm
Assembly of parts – location relative to other parts	± 1mm in both plan axis
Assembly of parts – angle relative to other parts ≤ 500mm long	± 1 degree in all three primary planes
Assembly of parts – angle relative to other parts ≥ 500mm long	± 0.5 degree in all three primary planes

DESIGN

Span Capacity

MASSLAM is produced in lengths up to 12m in the factory. Long span roofs are achievable with MASSLAM by using mechanical splices to join several 12m lengths together.

Vibration

The human body is very sensitive to low frequency vibration within a building. Due to the lightweight nature of timber, careful consideration is required during design and construction. However, with the help of an accredited engineer and in combination with other materials, this issue is easily resolved. High density timbers used in MASSLAM can offer an acoustic advantage compared to low density timber species.

Deflection and Creep

When designing a timber beam, deflection is the governing factor in most cases. This is especially true in a Mid-Rise building where high standards need to be met or long spans between columns are required. MASSLAM offers the perfect solution considering the unique stiffness.

Creep is mostly caused through a long-term and constant application of load. This complex phenomenon is influenced by the moisture content, ambient condition, size and load history. As part of the serviceability deflection calculations, the load factor for creep deformation (j_2 =2) has been included into the equation to consider the effect of creeping.

Connections

The range of connectors available is wide and varied. Hardwood glulam presents the opportunity to utilise bearing connections which simplify connections from a time, cost, tolerance, and installation perspective. The designer has an opportunity to be creative in their connection design. Possibilities include bearing connections, concealed connectors, dovetail timber joints, mortice and tenon joints, bolts, plugged screws, and more. The MASSLAM Design Team is available to provide early design and DfMA assistance from concept through the detailed documentation.

Fire Resistance

When timber burns, a char layer will develop around the exposed surface. Unlike steel, timber will maintain strength directly proportionate to the uncharred timber below for a determined amount of time due to the charring that insulates and protects the inner fibres. The charring rate, which determines the speed that timber burns, is lower in hardwoods compared to common softwood species. The charring rate for MASSLAM has been verified by NATA-accredited third-party testing facilities.

DURABILITY, WEATHER EXPOSURE AND SUITABILITY

Service Class 1

Characterised by moisture content in the material corresponding to a temperature of 20 ºC and relative humidity of the surrounding air only exceeding 65% for a few weeks per year – i.e. Indoor, controlled environment.

Service Class 2

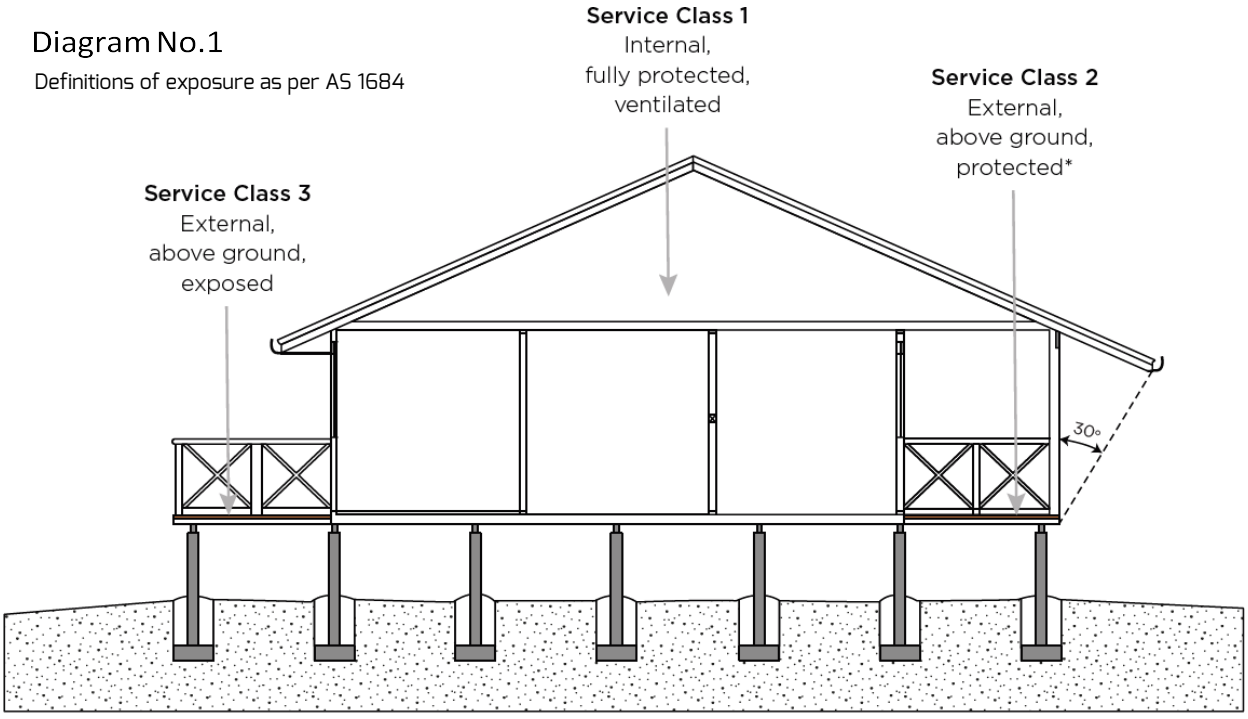
Characterised by moisture content in the material corresponding to a temperature of 20 ºC and relative humidity of the surrounding air only exceeding 85% for a weeks peryear – i.e. protected from weather but exposed to environment.

Service Class 3

Characterised by climatic conditions leading to higher moisture contents than Service Class 2, or where timber is directly exposed to sun and/or rain– i.e. fully exposed.

Diagram No.1

Definitions of exposure as per AS 1684



* Exernal timbers are regarded as protected in AS 1684 if they are covered by a roof projection (or similar) at 30° to the vertical and they are well detailed and maintained (coated and kept well ventilated).

MASSLAM is manufactured from kiln dried timber with a target moisture content of 10% and therefore requires protection from moisture that can occur from:

- Exposure to direct sun and rain (including during construction)
- Contact or close exposure with moisture laden, porous material (e.g. Concrete blocks)
- Exposure to extreme environments such as dry heating systems (e.g. slow combustion wood heaters), air conditioning, large north or west facing windows or moisture laden environments such as pool enclosures

Indoor Pool Environments

MASSLAM can be used in indoor pool environments for both structural members and architectural finishes with approval from the MASSLAM Design Team. The natural durability of the hardwood species used by ASH means that these glulam members are suitable for the high-chlorine environment.

Humidity regulation is very important for internal spaces where mass timber will be used, so increased attention and awareness of the mechanical specification/design is required. Due to the expected humidity in such environments (particularly if reality differs from the mechanical specification/design), ASH can provide H3 treatment on MASSLAM to provide durability against fungal attach. H3 treatment can only be undertaken in Australia.

Please send the specified indoor operating conditions (target humidity, temperature, acceptable fluctuations, etc.) through to the MASSLAM Design Team for review.
Final coating of timber for an indoor pool environment will require specific consideration to the operating parameters/specification. Contact the MASSLAM Design Team for guidance and recommendations of coatings suppliers.

COMPLIANCE

MASSLAM is manufactured in accordance with AS 1328 – ‘Glued-laminated structural timber’.

MASSLAM’s char rate, fire performance under load and glue lamination formula is third party tested atWarrington Fire (Australia) in accordance with AS 1530.4.

H1, H2, H3 and IRON ASH® treatments are treated to the requirements of AS1604.1:2012 and is tested for penetration and retention by NATA accredited laboratory, AgriSolutions, to comply with AS/NZS 1605.3:2006 Section 15 – ‘Determination of Tebuconazole and Propiconazole in Preservative-Treated Timber' and AS/NZS 1605.3:2006 – Section 16 ‘Determination of Permethrin in Timber Extracts’.

MASSLAM PROTECTION METHODS & MOISTURE MANAGEMENT

Design for Service Class 2 Applications

Detailing tips for Service Class 2 applications:

- Use building overhangs and other structures, which protect the members from excessive moisture and sun exposure
- Directly shield the members from moisture or direct sun. The use of metal, fibro or plastic shields on the exposed faces or ends of beams is required to help maintain the member in an unstressed dry condition.
- All members should be provided with adequate ventilation so that moisture content within timber will not exceed 15% and moisture gradients across the member will not occur.
- Use arrised or pencil round corners on members to reduce the likelihood of coating failures on sharp edges.
- Use drip edges or other devices which provide a path for free moisture to flow away from the timber beam. Refer to the 'capping details' or ‘end protection’ diagram below.
- Columns should be elevated greater than or equal to >300mm above ground level and with adequate drainage. Refer to the 'base details' diagram below.
- Joint detailing should, wherever possible, comply with the following:
    - Consider movement in service of members and attach connectors in a way that prevents splitting of wood fibre caused by rigid mechanical fixings.
    - Keep horizontal contact areas to a minimum, in favour of self-draining vertical surfaces.
    - Ventilate joint surfaces by using spacers, wherever possible.
    - Always use compatible fasteners which have adequate corrosion protection and do not cause splitting during installation e.g. galvanised coatings or stainless steel.
    - Ensure any moisture entering a joint is not trapped and can adequately drain away from the joint.
    - Preference concealed bolted connections over plugged dowels to accommodate movement in service

Design for Exterior Applications

MASSLAM is not to be used for in-ground applications.

MASSLAM is not to be used in fully weather exposed, exterior applications (Service Class 3).

MASSLAM is only recommended to be used in external, above-ground, protected applications (Service Class 2) when special consideration is given to level of weatherand UV exposure; coating, maintenance of coating and joint detailing is adequate; durable species is selected.

MASSLAM members used in Service Class 2 applications must be correctly detailed and protected by fully protecting the member with a physical barrier and capping (see diagram 2).

This may be achieved by correctly coating the timber with a premium quality protective finish (e.g. light-coloured pigmented external paint system or penetrating oil) to prevent moisture infiltration. It is important that an inspection and maintenance program based on exposure level and the paint manufacturer's recommendations be prepared, implemented, and maintained accordingly (refer to the MASSLAM Coatings guide for advice).

Delivery and Protection

ASH can deliver members to site wrapped in plastic or by other arrangement. Members will require a forklift, crane or hand unload on site. It is essential that members be protected from weathering, which can occur quickly. Carefully store members once delivered to prevent damage or surface marks. Minor damage or marking cannot always be prevented during delivery and assembly. Planing, sanding or re-working any marks should be taken into consideration for construction allowances.

Handling

MASSLAM should be lifted and secured by strategically placed lifting points; or with fabric or plastic slings and edge protectors to avoid slipping and marking of members. To guarantee the members are not overstressed, spreader bars should be used on members longer than 5.4m. Do not drop or drag MASSLAM as this will damage the surface and possibly affect the structural integrity of the product.

Storage on Site

MASSLAM members need to be stored in a dry area, protected from all direct weather. If members are not used immediately, dunnage should be used to support them. Dunnage needs to be evenly spaced to supply adequate support and airflow. If a dry place is not available, dunnage should allow for drainage.
If MASSLAM is delivered with a temporary wrapping, members should be placed with the material 'edge face' down (refer diagram 4). At all times the members need good air circulation whilst protected from moisture. This may require making changes to the original plastic wrapping provided. Protect MASSLAM from dirt, abrasions, footprints or damage to corners. See diagrams 3 & 4 for detail.

During Construction

In line with all other advice within this Design Guide and other MASSLAM guides, protection measures employed during construction should aim to limit members from variation of temperature, humidity, and/or UV exposure as much as possible until the timber elements are protected in their permanent and intended application. This will help limit impacts and associated reworks resulting from UV degradation, expansion, contraction and/or water damage.

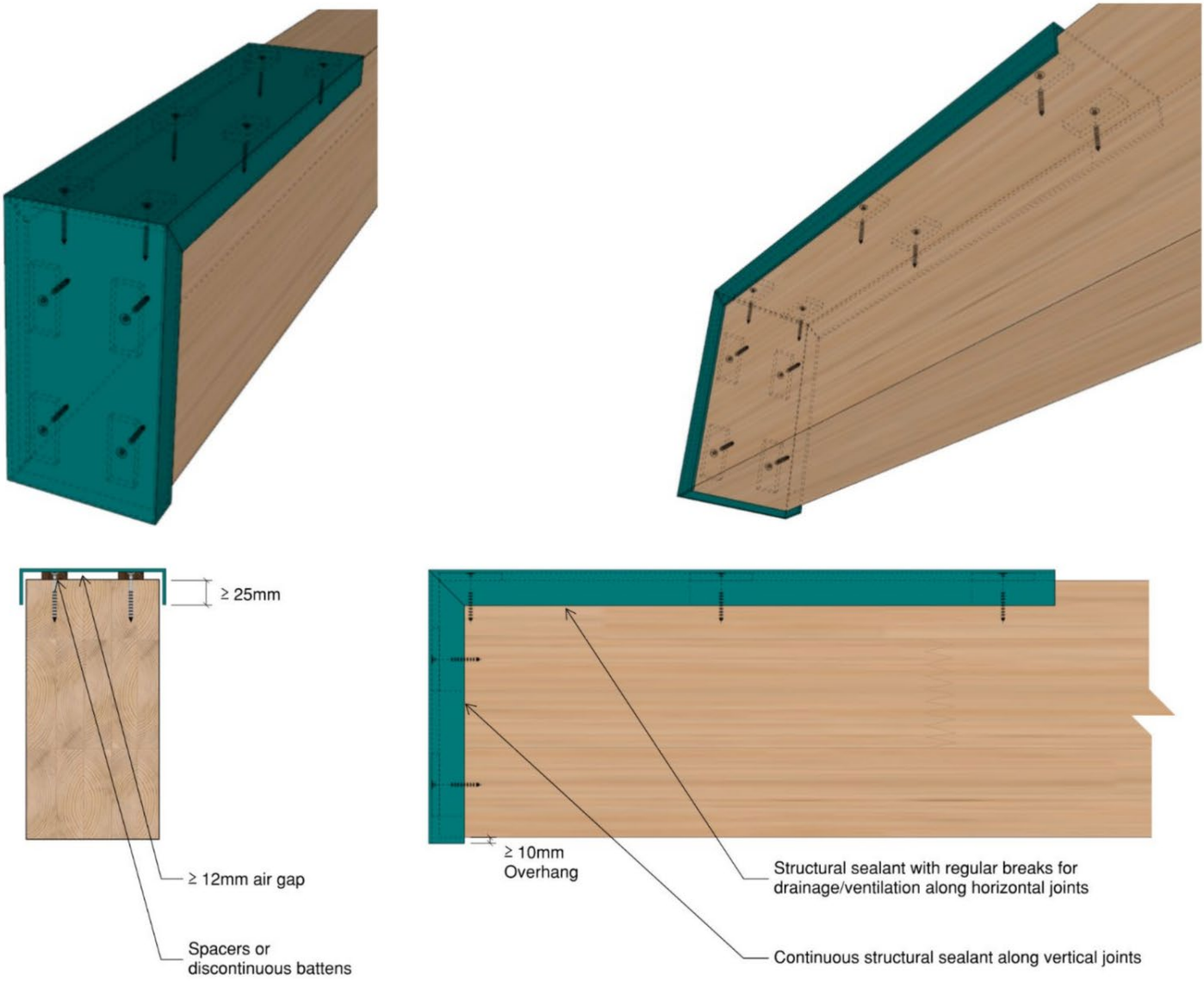
All MASSLAM is 'end sealed' prior to leaving the Processing Plant. It is mandatory that all end grain be sealed permanently. ASH recommends MASSLAM products be sealed on all surfaces to protect them from the environment during construction prior to leaving the ASH Processing Plant. If MASSLAM is not supplied coated and is

expected to be exposed for a period or become wet, it is a requirement that the member be sealed with a construction sealer or moisture permeable wrap that is compatible with the final paint or varnish finish, or wrapped in plastic to provide protection (note: plastic is a temporary protection measure only and must allow for drainage and for the timber to breathe). Speak to your MASSLAM specialist about breathable membranes.

Temporary protection measures recommended will vary with each project and connection detail, however must include the following:

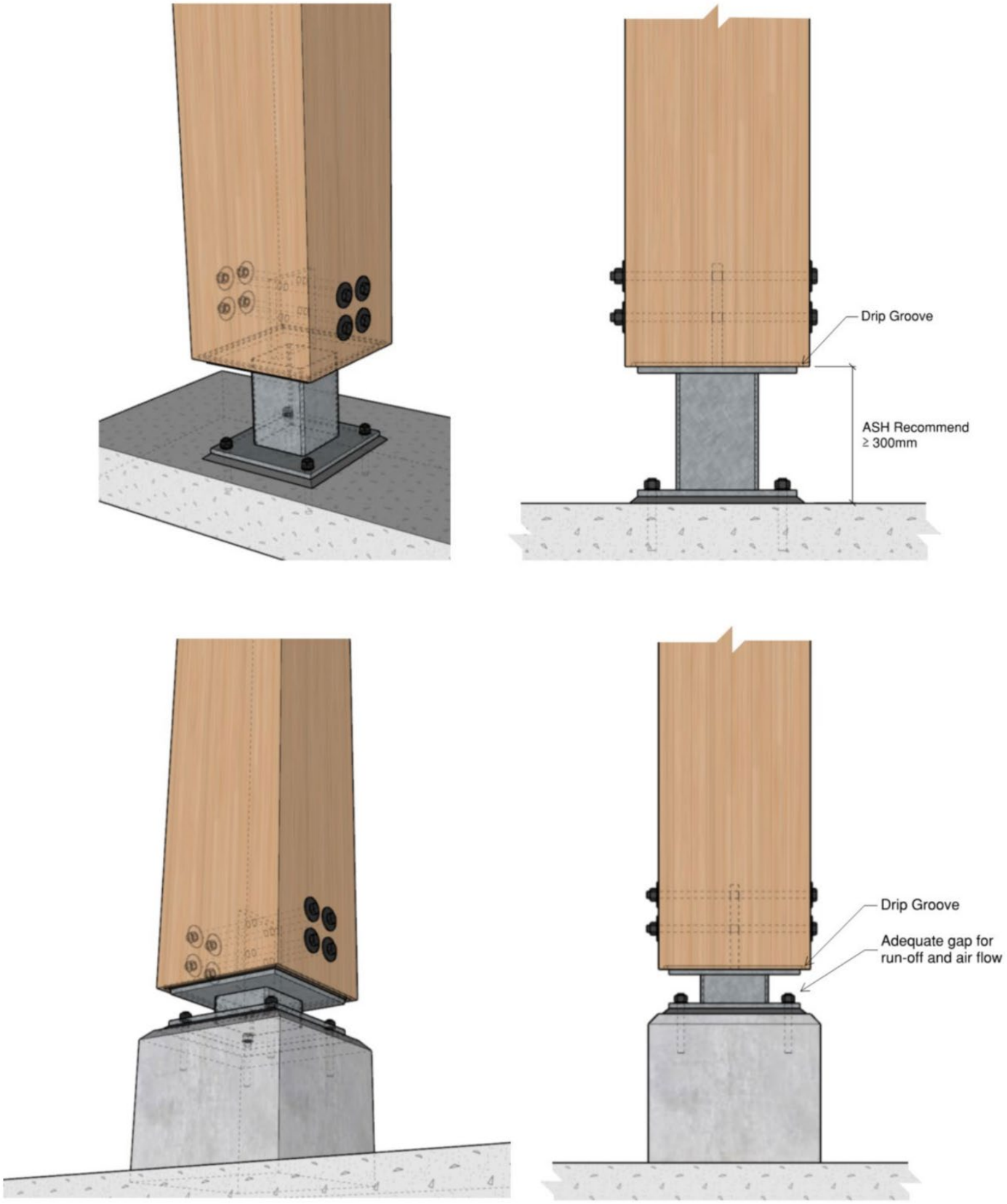
- Protecting horizontal elements, floor joints, and/or gaps from weather with self-adhesive, vapour permeable wrap (e.g., Wraptite SA) or use of construction tents.
- Protecting exposed elements with an adequate volume of coating design for the exposure time or use of temporary high performing vapour permeable & UV limiting wraps (e.g., Traspir 110).
- Shielding connections, millings, and other pockets that can house/trap rainwater with temporary shields.
- Encapsulation of timber as soon as feasible through installation of facades and levels/rood above.
- Avoiding installation of cover plates, plugs, capping, or other preventors of moisture run-off until building envelop is installed and members are at the permanent equilibrium moisture content.
- A time and cost allowance for finishing sanding and coat(s) once building is enclosed.

Diagram No. 2



Note: This capping detail is **NOT** a method of protection to allow members to be deemed Service Class 2 elements, but rather recommended practice for members that already comply with Service Class 2 requirements.

Diagram No. 3



Note: 75mm clearance is acceptable between podium and base of column.

Diagram No. 4

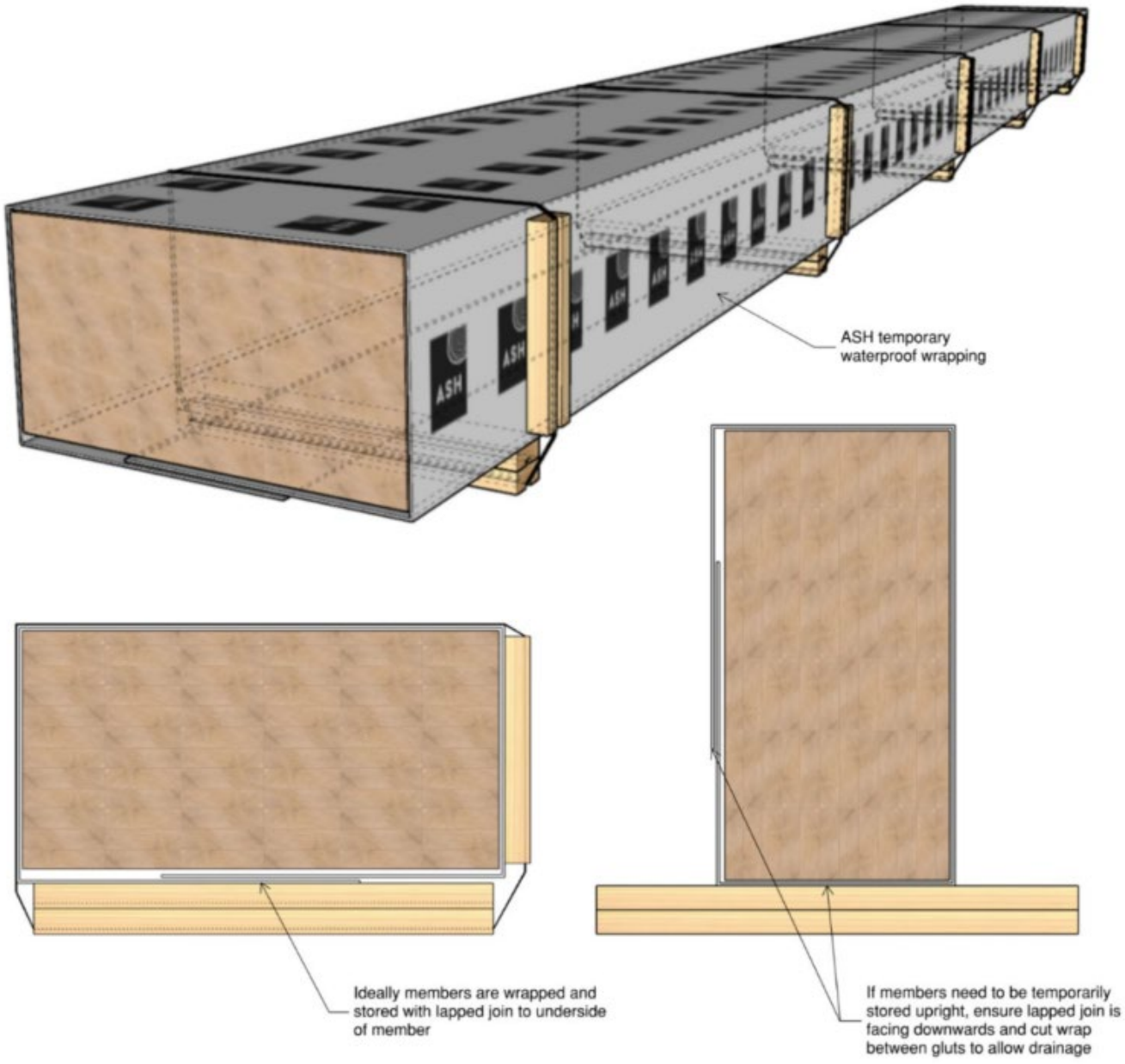

ASH temporary
waterproof wrapping
Ideally members are wrapped and
stored with lapped join to underside
of member
If members need to be temporarily
stored upright, ensure lapped join is
facing downwards and cut wrap
between gluts to allow drainage

Diagram No. 5

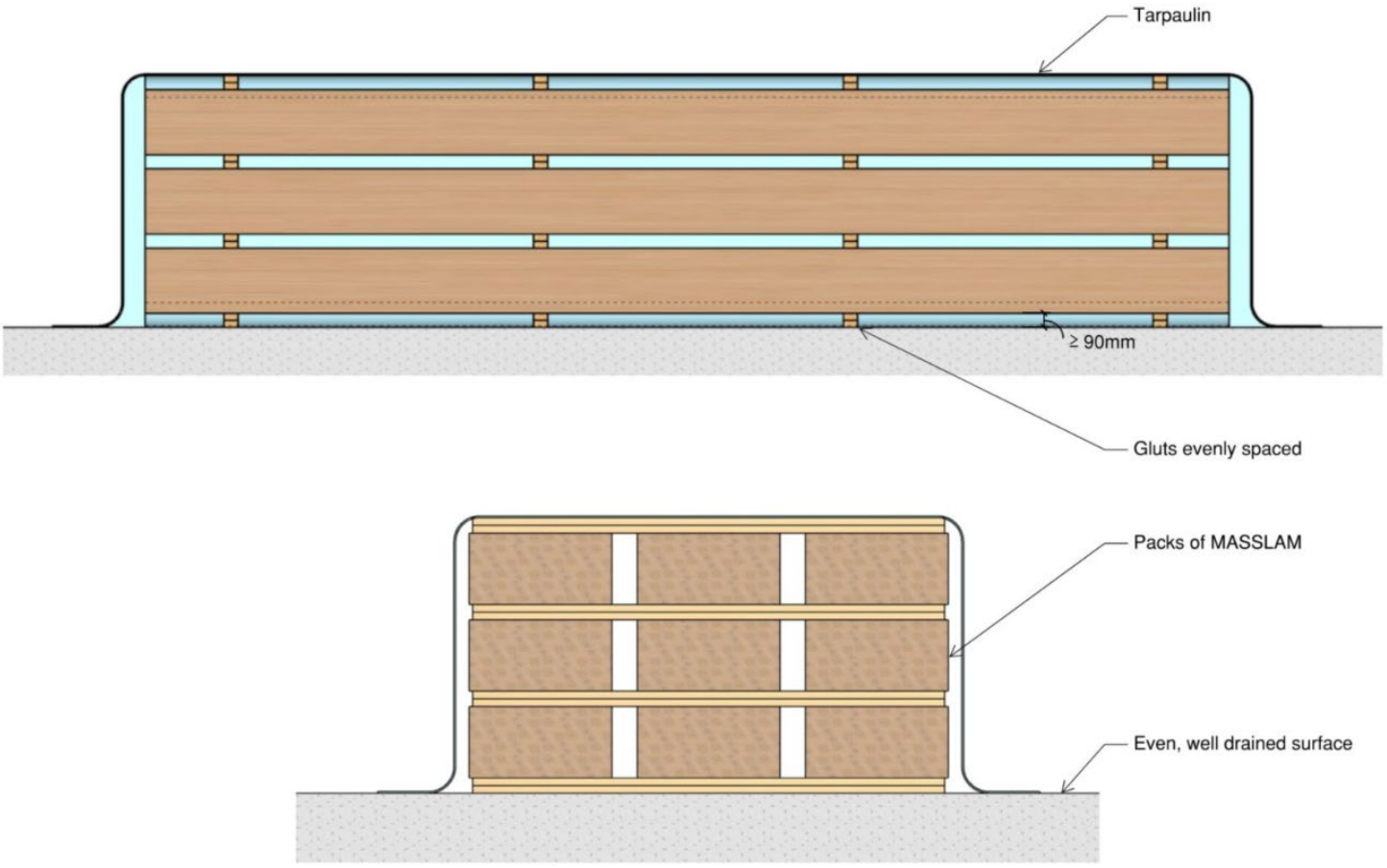
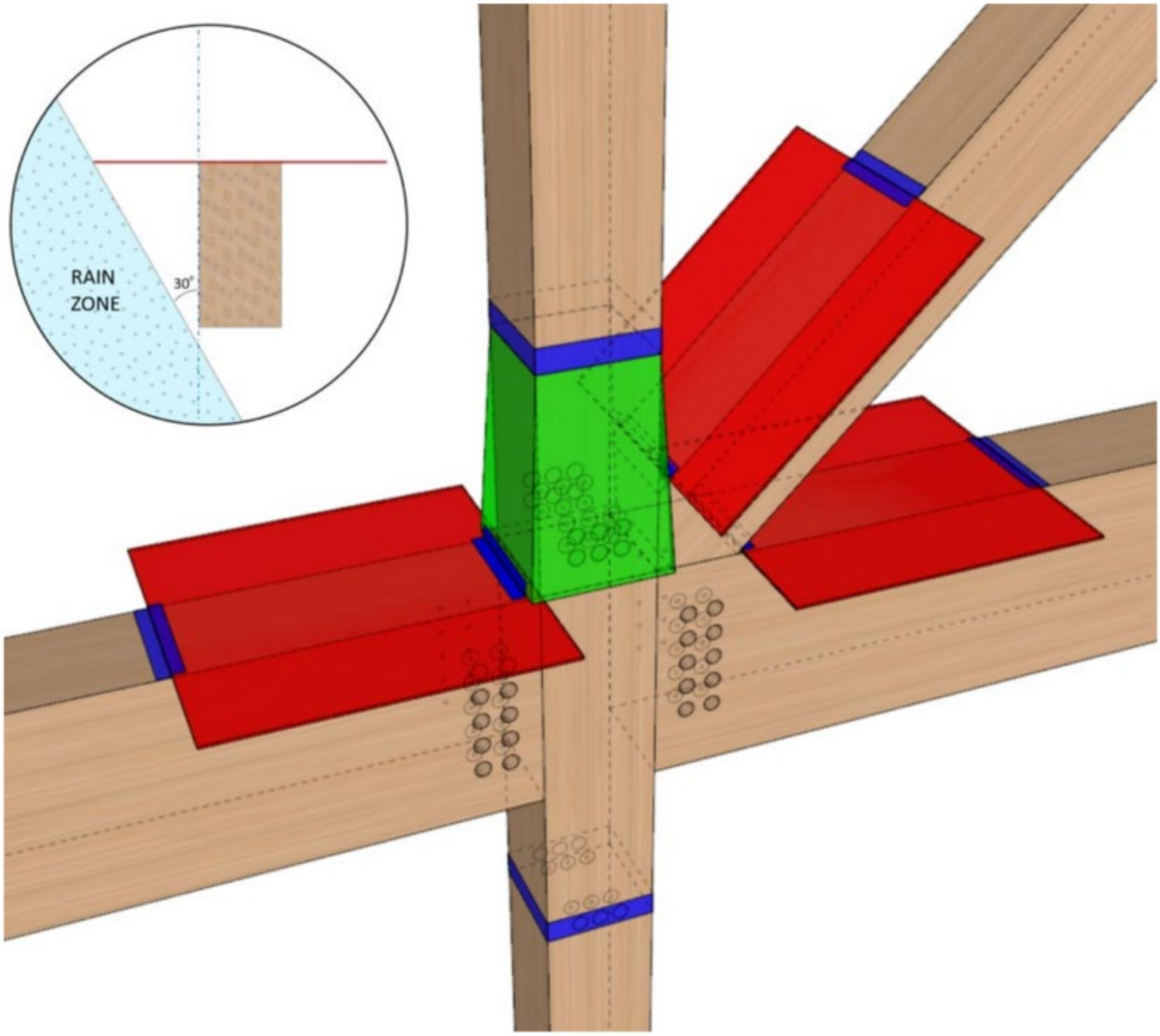
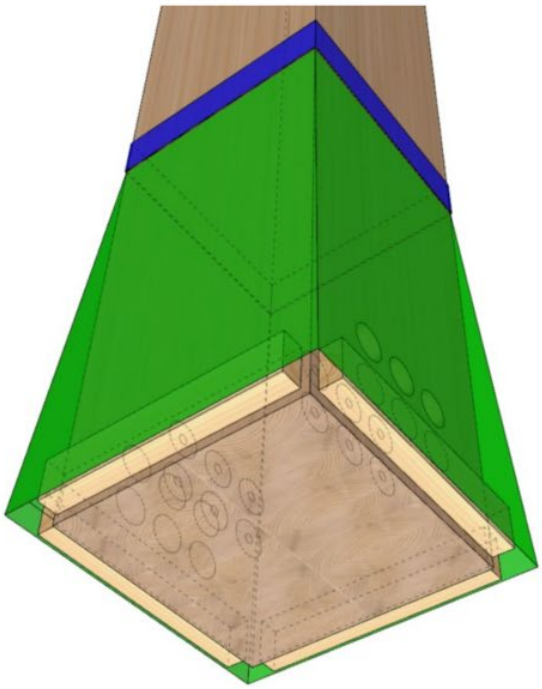

Tarpaulin
≥ 90mm
Gluts evenly spaced
Packs of MASSLAM
Even, well drained surface

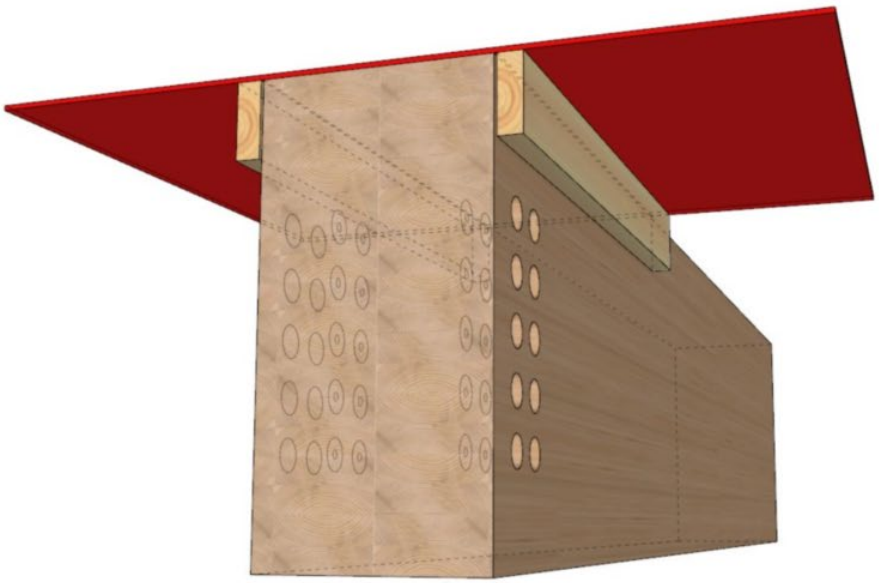
Diagram No. 6



Note: ASH recommend that temporary breathable membranes be stapled to structural flooring or fixed to timber blocks with joint tape used to effectively seal the membrane to the intersecting board, floor, or member.

Diagram No. 7



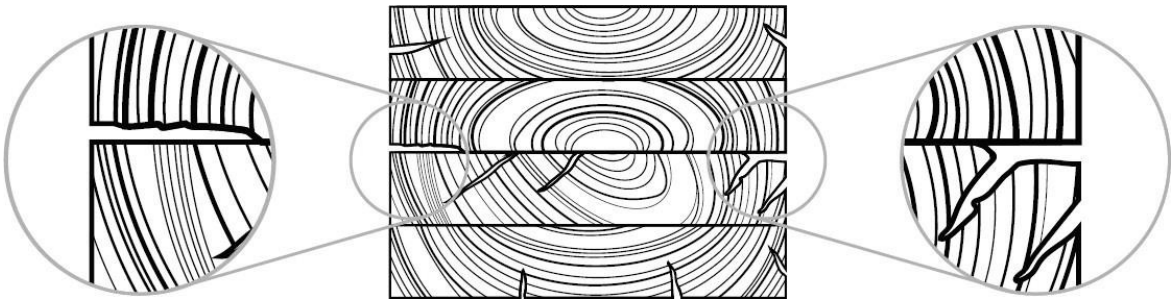


CHECKING IN MASSLAM

MASSLAM is dried to a target of 10% Moisture Content (MC) as the Equilibrium Moisture Content (EMC) of an indoor environment is typically 10-12% MC. When a MC within timber matches the EMC of an environment, timber is in its most stable form.

In drier conditions, timber loses moisture to the surrounding atmosphere and the outer fibres of the member shrink at a more rapid rate than do the inner fibres. As outer fibres contract, they are restrained by the inner portion of the member that has a higher moisture content. The more rapid the rate of drying, the greater differential in shrinkage between the outer and inner fibres - resulting in fibre stress. These resultant stresses to the grain can cause characteristic wood seasoning ‘checks’. The influence of checks on the structural performance of glued laminated timber members is generally minor. See Diagram 8 below. Checking can be minimised by adding a protective coating and with careful installation practices that avoid prolonged exposure of the members during construction.

Diagram No. 8



Checking often occurs along the first glue line adjacent to the outer lamination that may dry more rapidly because a larger surface area of that lamination is exposed to the elements. In general, checks have little to no effect on the strength of glued laminated members. Seasoning checks in bending members affect only the horizontal shear capacity. In establishing allowable horizontal shear values, normal checking due to seasoning has been considered.

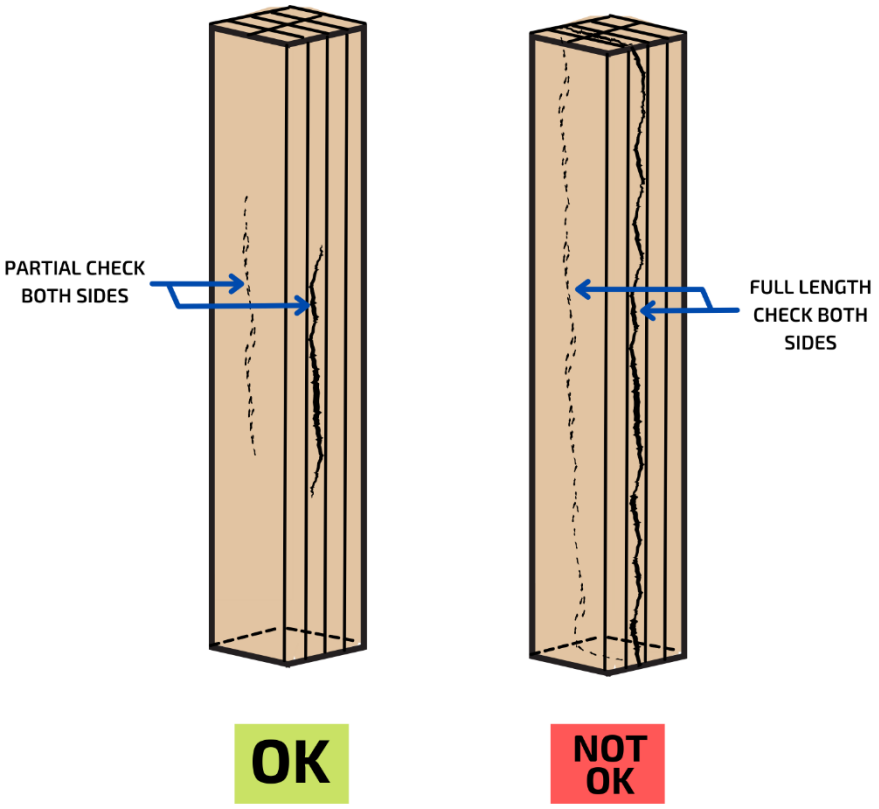
Checks are usually not of structural importance unless:

- The design of the member is governed by shear, and
- checks are significant in depth, and
- they occur in the mid-height of the member near the supports.

If these conditions exist, the reduction in shear strength is directly proportional to the ratio of the depth of checks to the width of the bending member. Checks in columns are not of structural importance unless the check develops into a split, thereby increasing the slenderness (L/d) ratio of the column.

While checking is not considered to be of structural significance, the reason for the checking and the means by which further checking may be minimized should be determined. If there is concern regarding structural adequacy, advice can be obtained from a structural engineer experienced and qualified in glued laminated timber. They should evaluate the significance of the checking.

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



IS MY CHECKING OK?

Is the span of the glulam beam greater than 10 times the depth?

Example: Depth is 300mm, span is greater than 3m

YES NO

Where do the checks appear?

BOTTOM FACE

Is the check parallel with the grain of wood?

YES NO

SIDE FACE

Is the depth of the check less than one-third the width of the beam, and is the length less than one-third the length of the beam?

YES NO

END FACE

Is the length of the check or split less than one-half the depth of the member?

YES NO

NO STRUCTURAL CONCERN

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

CONSULT DESIGN PROFESSIONAL

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

Diagram derived from the 'Evaluation of Check Size' document. Number EWS R475E by The Engineered Wood Association, USA

I,_____of_____
understand and accept the advice given in this MASSLAM Design Guide from Australian Sustainable Hardwoods and understand the level of manufacturing, coating technology, design advice, storage and handling options that ASH have made available to me. Failing to adhere to these recommendations may result in reduced performance of members.

Dated_____

DISCLAIMER

The MASSLAM Design Guide provides general advice based on current information and industry practices. ASH acknowledges that these recommendations will not suit every possible project. If in doubt, ASH recommends that independent expert advice is obtained. ASH accepts no responsibility for the performance of members in every possible application in accordance with these recommendations or otherwise. If you have any questions about these guidelines, contact a MASSLAM specialist on 03 5139 7001.