TECHNICAL NOTE - DESIGN OF GLULAM MEMBERS

Daniel Moroder, Senior Structural Engineer
PTL | Structural Consultants

---

1 INTRODUCTION

This short technical note provides insight on the design of glulam members in accordance with the current timber design standard NZS 3603 and the upcoming NZS AS 1720.1.

When the current version of NZS 3603 was published in 1993, glulam beams were manufactured to NZS 3606. Although NZS 3606 provided strength properties for glulam members made of different sawn timber grades, these grades were made obsolete with the introduction of NZS 3603 which simply acknowledged that a structural timber member made of several glued sawn timber laminates would result in better strength properties than the individual laminates by the introduction of a lamination factor. This factor accounts for the increased strength due to the lamination effect, which quantifies the natural performance variations that characterise single members of solid sawn timber, resulting in better material characteristics due to the lower probability of a strength limiting defect.

With the publication of the glulam manufacturing standard AS/NZS 1328 part 1 and part 2 in 1998, strength properties for specific grades of glulam members were introduced. When using these values, designers no longer needed to consider the properties and number of the individual laminates, or the lamination effect. NZS 3603 and subsequent updates however never referred to these glulam grades and strength values. Unfortunately, some designers continued to apply the lamination factor to the glulam strength properties from AS/NZS 1328, leading to potentially unconservative designs.

The upcoming New Zealand Timber design standard NZS AS 1720.1 confirms that no lamination factor should be used when designing glulam members in New Zealand.

2 GLULAM DESIGN TO NZS 3603

2.1 Glulam design based on sawn timber properties

Section 8 of NZS 3603 provides guidance on the design of glulam members, with clause 8.6 referring to the design glulam members, based on the **stresses and elastic moduli of sawn timber laminates**. If the glulam member is made of vertical or horizontal laminates, the parallel lamination factor k6 can be applied to the bending, tension, compression and shear strength properties.

Section 8.7.7 further introduces a size factor k_{24}, which reduces the design capacity in bending and tension for sections with a depth of more than 300mm.

Whereas the k_6 factor increases the strength of glulam members with more horizontal laminates, the k_{24} factor reduces it, in effect almost cancelling each other out.

2.2 Glulam design based on glulam properties in AS/NZS 1328.2

In 1998, the glulam manufacturing standard AS/NZS 1328 was introduced. Part 2 provides **characteristic strength and stiffness values for different glulam grades**. Although not explicitly stated, the intent was for designers to use these values in lieu of the requirements in sections 8.6 and 8.7 of NZS 3603, which were based on sawn timber properties.

It is likely the intent was for designers to refer to the commentary clause 8.7.2 of NZS3603, which states that the k_6 factor is not to be applied to characteristic stresses of glulam members derived through testing.

The glulam grades as defined in AS/NZS 1328 are performance based, and the glulam members manufactured to that standard are assigned these characteristic stresses. These values are confirmed by qualification and routine testing.

In chapter 15, the Timber Design Guide confirms that the parallel lamination factor is not to be used when using glulam specific strength properties. It also states that the size factor k24 is not to be applied when referring to the glulam grades in AS/NZS 1328.

3 WITHDRAWAL OF AS/NZS 1328.2

As of December 2019, part 2 of AS/NZS 1328 has been withdrawn. This means that the tabulated glulam grades and respective characteristic stresses are technically no longer available or usable.

To overcome this, our Australian colleagues have introduced glulam grades and characteristic stresses into their timber design standard AS 1720.1, in Table 7.1.

New Zealand has currently not resolved this issue, and designers therefore continue to use one of the methods outlined above, that is NZS 3603 with use of the lamination factor in combination with sawn timber properties or AS/NZS 1328.2, which, although withdrawn, is considered as common practice. A solution is however in sight with the introduction of NZS AS 1720.1 as described below.

4 DESIGN TO NZS AS 1720.1

With the pending publication of the New Zealand timber design standard NZS AS 1720.1 later this year, which de facto adopts the Australian timber design standard AS 1720.1, the use of sawn timber properties and the parallel lamination factor in NZS 3603 will no longer be part of the Verification Method. Appendix ZZ of NZS AS 1720.1 introduces a table specifying glulam grades and characteristic stresses to be used for the design of glulam members manufactured to AS/NZS 1328.1 in New Zealand.

Although the new standard does not refer to a size factor, the tension strength of glulam members needs to be reduced by a factor $(150/d)^{0.167}$ for members with a width or depth d larger than 150mm. This factor is not to be applied to any other strength property.
This reduction is based on tension test data and brittle facture mechanics, which suggest that there is a greater statistical probability of finding a defect in a critical location in a larger timber member. This defect can be a knot, a gum vein, a shake or slope of grain, the presence of which could lead to a brittle tension failure (refer to SA HB 108 and NZ Wood Design Guide, Section 1.2).

4.1Glulam grades to NZS AS 1720.1 and AS 1720.1

It is interesting to note that the strength properties for some glulam grades in AS 1720.1 and appendix ZZ of NZS AS 1720 differ slightly, although they are both based on the same manufacturing standard AS/NZS 1328.1. Until this discrepancy is overcome through testing and/or an updated glulam manufacturing standard, designers are encouraged to confirm characteristic properties with their glulam manufacturer.

5 CONCLUSION AND SUMMARY

Based on the current NZS 3603, glulam member design can be based on sawn timber characteristic properties and the use of the parallel lamination factor k6 and the size factor k24. Alternatively, glulam members can be designed based on the glulam grades and characteristic properties in AS/NZS 1328.2, without the use of the k_6 and k_{24} factors (although this standard is currently withdrawn).

Once the new NZS AS 1720.1 is published and cited in the NZ Building Code, glulam members will be designed based on the glulam grades and characteristic properties as published in that standard. Only the tension strength needs to be reduced with a size factor for sections with a dimension larger than 150 mm.

A new glulam manufacturing standard and a comprehensive testing programme are needed to provide better guidance on the strength properties of glulam members, ideally valid for glulam members produced in both New Zealand and Australia.

6 REFERENCES AND FURTHER READING

AS 1720.1. Timber Structures. Part 1: Design methods. Standards Australia, 2010

AS/NZS 1328.1. Glued Laminated Structural Standard. Part 1: Performance requirements and minimum production requirements. Standards New Zealand, 1998.

AS/NZS 1328.2. Glued Laminated Structural Standard. Part 2: Guidelines for AS/NZS 1328: Part 1 for the selection, production and installation of glued laminated structural timber. Standards New Zealand, 1998.

NZ Wood Design Guide. Trees, Timber, Species and Properties. WPMA, 2020.

NZS 3603. Timber Structures Standard. Standards New Zealand, 1993.
NZS 3606 Specification for the Manufacture of Glue Laminated Timber. Standards New Zealand, 1987.

NZS AS 1720.1 Timber Structures. Part 1: Design Methods. Standards New Zealand. In publication, refer to DZ NZS AS 1720.1 Public consultation draft, November 2018.

SA HB 108. Timber Design Handbook. Standards Australia, 2013.

Timber Design Guide. 3rd Edition. A. H. Buchanan, New Zealand Timber Industry Federation, 2007.

NEW ZEALAND
TIMBER DESIGN SOCIETY