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Technical Topics

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Allowable Depth-to-Width Ratios for Glulam Beams

The *National Design Specification for Wood Construction* (NDS), published by the American Wood Council (AWC), has, since the 1944 edition, provided prescriptive lateral-bracing recommendations for wood bending members having varying depth-to-width (d/b) ratios. Current guidelines for the lower and upper limits of bracing requirements are shown below, with bracing requirements for intermediate d/b ratios falling somewhere between these.

- $d/b \leq 2$ no lateral bracing required
- $6 < d/b \leq 7$ lateral restraint required at the ends to prevent torsion and lateral displacement: both edges must be laterally restrained over their full lengths

While intended for sawn-lumber members, these guidelines are often interpreted as being applicable to other rectangular-shaped engineered wood products such as structural glued laminated timber (glulam). In addition, since no mention is made of d/b ratios greater than 7, it is often assumed that the maximum d/b ratio for a wood bending member is 7 when, in fact, a wood bending member having any d/b ratio can be designed using the beam-stability calculations provided in the NDS.

Experimentally verified equations for calculating critical lateral-buckling load capacities in rectangular-shaped wood beams have been available since 1931. Research conducted at the University of British Columbia in the 1960s and reported in the papers *Lateral Stability of Glued Laminated Beams* by Hooley and Madsen and *Lateral Buckling of Simply Supported Glued Laminated Beams* by Hooley and Duval, led to the adoption of provisions for determining the adequacy of lateral support for glulam bending members in the 1968 edition of the NDS. One of their test beams was a glulam with a cross section of 3-1/4 x 66-5/8 inches (d/b ratio = 20.5). While this represented an extreme example of a high d/b ratio, no lateral buckling was observed at failure when the compression edge was fully restrained laterally.

One of the advantages of glulam is that it can be manufactured in virtually any size or shape and one of the most efficient configurations is a narrow, deep bending member. Since the early 1980s, one of the most popular forms of glulam has been resawn beams used as purlins in panelized roof construction. These members are typically 2-1/2 inches wide with depths up to 28-1/2 inches or a d/b ratio of 11.4. An emerging technology uses high-strength fiber-reinforced plastic (FRP) or high grades of laminated veneer lumber (LVL) to reinforce the tension zone of glulam beams, resulting in d/b ratios of 10 or greater.

When the narrow, deep, resawn glulam purlins were introduced, structural engineers expressed concern about the inherent lateral stability of the purlins. To address these concerns, the glulam industry sponsored a series of full-scale bending tests on narrow, deep glulam purlins at Oregon State University in 1989. This involved testing a series of glulam beams having a span of 40 feet with d/b ratios of 9 and 11.4, which were representative of the resawn purlins being used in the field. These tests were conducted with varying degrees of lateral bracing of the top or compression edge of the beams. This bracing ranged from a fully braced compression edge to unbraced lengths of 15 feet.

As anticipated, the purlins with minimal lateral bracing did undergo varying degrees of lateral buckling, typically buckling in an "S"-shaped curve between points of lateral support. The failure load in all cases, however, exceeded the values calculated with the NDS design methodology.

In conclusion, if a glulam beam has the compression edge fully braced as would occur by the normal attachment of sheathing or decking with mechanical fasteners, there is no need to limit the d/b ratio to 7 or less. If the compression edge is not braced, the member shall be checked in accordance with the lateral stability provisions of the NDS, but this procedure does not require any specific limit on the beam d/b ratio. **As a practical limitation, it is recommended that an upper-limit d/b ratio of 12 be applied for glulam beams regardless of the bracing used.**

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