

Barriers to using hardwood lumber in CLT manufacturing

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According to the CLT standard for North America, ANSI/APA PRG 320, the requirements for using lumber for CLT panels are:

- Species: any species or combination as stated in the American Standard Lumber Committee (ASLC) under PS 20.
- Specific gravity of 0.35 as published in the National Design Specification (NDS) for Wood Construction in the U.S.
- Structural grades: minimum of visual grade #2 (1200f-1.2E MSR) for the longitudinal layers and minimum of visual grade #3 for the transverse layers.
- Moisture content shall be 9-15 %.
- Net width should be 1.75 times the net thickness of the lumber for the longitudinal layers and not less than 3.5 for the transverse layers.
- Net thickness should be no less than 5/8" or more than 2".

How do these requirements relate to hardwood lumber? Let us examine each requirement in more detail.

Species: The ALSC/PS 20 standard in section 1.1.2, page 9, clearly indicates that this standard applies for softwood, hardwood, and tropical species as approved by the Board of Review. Under this document there is a partial list of the main commercial softwood species and for an extended list, ALSC/PS 20 refers the reader to the ASTM Standard D 1165-18 where there is a detailed list of US hardwood species including: Ash, Basswood, Birch, Cottonwood, Hickory, Red Oak, Yellow Poplar, and White Oak among others.

Specific gravity: All of the commercial US hardwood species in the US Forest Service Handbook meet the 0.35 and higher specific gravity criteria in the ANSI/APA PRG 320. Black Cottonwood and Basswood have the lowest specific gravity with values of 0.35 and 0.37 respectively.

Structural grades: The NDS indicates what agency oversees the structural grading rules for commercial softwood and hardwood species. For example, NELMA oversees the structural grading rules for: Aspen, Beech, Red Oak, Red Maple, and White Oak. NLSP for Yellow Poplar. The rules for structurally grading hardwood exists but there is no current market for structural hardwood. Hardwood lumber has been used traditionally for appearance applications and not for structural use.

Moisture content: Hardwood species are dried to around 8% moisture content (MC) and this should not be an issue for hardwood species to comply with the MC requirement in ANSI/APA PRG 320.

Laminations width and thickness: The majority of hardwood lumber is sawn in random widths. However; many hardwood sawmills take orders from customers that required a fixed width.

ANSI/APA PRG 320 specifies that board widths should be at least 1.75 or 3.5 times the thickness of the lamination. For example; boards should be at least 4 inches in width if thickness is 2 inches. Just as the board widths, a large volume of several hardwood lumber species are sawn in 2 inches.

By following the ANSI/APA PRG 320 standard, architects, engineers, contractors and end-customers can assure CLT panels meet safety and quality requirements for using in structural applications such as commercial and residential buildings. However; in some cases city building inspectors could approve special construction projects if test data on the new structural elements is available to assure the proposed structure complies with the specific city's regulations. For example, in 2018 the architectural firm dRMM designed and [built a yellow poplar CLT building in England](#). The required data to get the approvals was produced by a third party to satisfy the requirements of the city regulators. Similar to this project, the city of Radford, VA approved in 2018 [another yellow poplar CLT project](#) based on data generated by Virginia Tech researchers.

As described in section 7.1.2 of the ANSI/APA PRG 320 standard, custom CLT grades and layouts are permitted as long as they are approved by an authorized agency. These custom CLT panels must follow the qualifications and mechanical test requirements specified in sections 8.4 and 8.5 of the standard. What this means is that a CLT mill could produce a custom CLT grade using other combinations of lumber and layouts. [Virginia Tech has funded a new project to work with SmartLam](#) to produce a custom CLT layout using yellow poplar lumber. If the manufacturing and testing of these custom CLT panel layout passes inspection by APA, Smartlam would be certified to produced yellow poplar CLT panels that would be available for the architectural community and the construction industry in the US.

Other barriers preventing the use of hardwood lumber as raw material for CLT panels are:

- *Lumber Cost.* Manufacturing cost of hardwood lumber is usually higher than softwood lumber.
- *Lumber supply.* The production volume of hardwood lumber sawmills is very small compare to softwood lumber mills. An average hardwood lumber mill produces 20 million board feet per year (47,000 cubic meters). It will require several hardwood sawmills to supply a single CLT mill.
- *Additional testing:* mechanical properties, delamination, fire resistance, and connections are still unknown for most hardwood species.