

Fingerjoined Lumber

Introduction

Finger-joined lumber is becoming a very popular and desirable product in the construction industry's repertoire of engineered wood products. Its popularity can be attributed several factors:

- Straightness
- dimensional stability
- interchangeability with non-finger-joined lumber
- efficiency in wood fiber use



Along with this growth comes the need to educate architects, designers, engineers, building inspection officials, and end users about the advantages and acceptability of this product.

What is Finger-joined Lumber?

Finger-joined products are manufactured by taking shorter pieces of quality kiln-dried lumber, machining a "finger" profile in each end of the short-length pieces, adding an appropriate structural adhesive, and squeezing the pieces together to make a longer piece of lumber. Although fingerjoining is used in several wood product manufacturing processes including the horizontal joints for glulam manufacture, the term fingerjoined lumber applies to dimension lumber.



The two major advantages of this product are its straightness and dimensional stability. The straightness factor is the result of stable short length pieces of lumber being combined in the manufacturing process. With fingerjoining, the length of a piece of lumber is not limited by tree size. In fact, the process may result in the production of joists and rafters in lengths of 12m (40') or more. Another advantage is the greater value derived from the forest resource since the short-length pieces can be cut out of lower grade lumber.

The fingerjoining process allows the removal of strength reducing defects to produce a product with higher engineering properties. The strength of the joints is controlled by stipulating the quality of wood which must be present in the area of the joint.

The structural properties are confirmed through a comprehensive quality assurance program with independent third party verification. Daily structural tests are certified to verify that the product meets the requirements as set out by the North American lumber grading system. Each piece must be comprised of species from the same species group, and strict tolerances are established for the machining of the fingers; the quality, the mixing, and the curing of the adhesive. Depending on the type of fingerjoined lumber being manufactured, edge and flat bending tests and tension tests are performed on each piece to ensure the joint can meet the design value for the lumber.

There are two categories of finger-joined lumber depending on the intended end use. The first category, sometimes referred to as a structural fingerjoint, uses a phenol-resorcinol

formaldehyde adhesive, such as used in panel products, or in glued-laminated timber. This allows the product to be used in either vertical or horizontal load applications. The second category, VERTICAL STUD USE ONLY, typically uses a polyvinyl acetate adhesive and, as indicated by its name, is for vertical use only [i.e. studs]. Both products may be used interchangeably with solid sawn lumber in terms of strength and end use. A description of both products is provided in Table 1 below.

Table 1. Recognizing and understanding finger-jointed lumber		
	VERTICAL STUD USE ONLY	Structural Fingerjoint
Grade Stamp Designation (Examples)	<div style="display: flex; align-items: center;"> <div style="background-color: #d9ead3; padding: 2px; font-weight: bold; writing-mode: vertical-rl; transform: rotate(180deg); margin-right: 5px;">Both must appear</div> <div style="border: 1px solid black; padding: 5px; text-align: center;"> SPS 3 CERT FGR JNT or CERT GLUED JNTS <hr/><hr/> VERTICAL STUD USE ONLY </div> </div>	SPS1 CERT FGR JNT or CERT EXT JNTS ¹
Grade Stamp Facsimile		
Product Standards	SPS 3 and C/QC 101.97	SPS 1 and C/QC 101.97
Comparison to Non-Finger-jointed Lumber	Intended for use as wall studs, limited to normal short term bending and tension loads	Fully interchangeable with lumber of the same grade and species
Permissible Uses	Load bearing studs ² , non-load bearing studs, locations where any bending or tension stresses are of short duration (e.g., wind or earthquakes), interior use ⁴ only	Load bearing studs, Non-load bearing studs, Headers, lintels, built-up beams, Floor and roof joists, etc., Interior or exterior use
Adhesives	Typically polyvinyl acetate and white-colored, but can be any glue which meets the applicable standards	Phenol-resorcinol or equivalent performance that meets or exceeds ASTM D2559 or CSA O112.7, dark-colored
Grades Allowed ³	Stud , Construction, Standard, recently added: No.1, No.2, No.3	Select Structural (SS), No.1, No.2
Dimensions ³ and Lengths	2x2", 2x3" , 2x4" , 2x6" 8' to 12'	2x2", 2x3" , 2x4" , 2x6" , 2x8" , 2x10" , 2x12" 8' to 40'
<p>¹ This designation can also be used under Vertical Stud Use Only finger-jointed lumber, but is not common.</p> <p>² Except in the case where longer term bending or tension loads are applied, such as with soil loads acting on a permanent wood foundation.</p> <p>³ Highlighted items are those most commonly produced.</p> <p>⁴ Interior use means inside the building envelope which includes studs in the exterior walls of a building.</p>		

Product Acceptance

In the United States, the monitoring of the inspection, grading and marking systems for softwood lumber, including finger-jointed lumber, is under the jurisdiction of the American Lumber Standards [ALS] Committee and Board of Review. The organization and functions of the ALS are outlined in the American Softwood Lumber Standard, Voluntary Product Standard DOC PS 20-99.

The PS 20-99 standard establishes lumber sizes, grades, species, assignment of design values, and the preparation of grading rules. The standard is prepared in accordance with U.S. Department of Commerce procedures and is implemented through an industry wide accreditation and certification program.



The ALS Board of Review evaluates and certifies the conformity of any grading rules published by lumber rules-writing agencies, such as the National Lumber Grades Authority [NLGA] in Canada, the Southern Pine Inspection Bureau [SPIB], Western Wood Products Association [WWPA], West Coast Lumber Inspection Bureau [WCLIB] and the Redwood Inspection Service [RIS]. The building codes only recognize lumber that has been graded, inspected and marked in accordance with a certified grading rule developed by an accredited rules-writing agency.

Finger-jointed lumber must meet the identical requirements found in the grading rules for regular sawn lumber. Grading rules do not consider the presence of finger joints to reduce strength properties. Finger-jointed lumber must also meet special product standards on quality control requirements for strength and durability of the joints. NLGA's *Special Product Standards SPS 1 and SPS 3* in Canada or WWPA's *Glued Products Procedures & Quality Control, C/QC 101.97* are examples of these product standards.

Finger-jointed lumber meeting these standards is considered equivalent to solid sawn lumber of the same dimensions, grades and species and is recognized by the three major model-building codes and the new International Building Code for such applications. An excerpt, from the 1997 Uniform Building Code (UBC), section 2304.2, attests to the product's acceptance:

"Approved end-jointed lumber may be used interchangeably with solid-sawn members of the same species and grade. Such use shall include, but not be limited to, light-framing joists, planks and decking."

Stud Uses

The most common use of finger-jointed lumber is in exterior shearwalls and load bearing walls as studs. The most important factor for studs is straightness. Finger-jointed studs will stay straighter than solid sawn studs when subjected to heat or humidity. This feature results in significant benefits to the builder and homeowner including a superior building, the elimination of nail pops in drywall and other related wall problems. This also makes finger-jointed lumber with a "Stud" grademark an ideal candidate for interior non-load bearing partitions.



Finger-jointed lumber for VERTICAL STUD USE ONLY can be manufactured from any commercial species or species group specified by a certified grading agency. The most commonly used species group from which finger-jointed lumber is produced is Spruce-Pine-Fir [S-P-F].

NLGA in Canada was one of the first certified rules-writing agencies to develop finger-jointed lumber standards, SPS 1 and SPS 3, and hence has one of the most recognizable grade markings that includes the product standard designation on it. In December 1999 the SPS 3 standard was revised by NLGA to allow additional grades to be produced under the standard and to include a new grademark designation, "VERTICAL STUD USE ONLY". Lumber with this grademark is typically Stud grade, which is separately marked on the grade stamp. VERTICAL STUD USE ONLY describes how it is most commonly used, however it is not limited to this use. See Table 1 for other permissible uses.

Finger-jointed lumber can be used in wall construction taking into account the same design factors as would be considered with solid sawn lumber.

Example 1

For example, one could substitute S-P-F finger-jointed lumber with a "Stud" grademark for regular studs marked "Standard" grade, because the Standard design values are lower. It could also substitute for No.3 grade, because the No.3 regular grade values are the same as for Stud. One could not normally substitute finger-jointed lumber marked "Stud" grade for "No.2" grade because No.2 grade design values are higher than for Stud; however, if the application only requires Stud grade lumber, the finger-jointed product is fine.

Example 2

Regarding species groups, substitution also depends on the application. In high-wind or seismic areas, walls may be required to resist horizontal loads as well as vertical loads. Shearwalls are the primary structural elements that provide resistance to applied horizontal loads. In earthquake zones such as California, designs have traditionally been based on Douglas fir, however, other species may also be used.

Let's look at an example where finger-jointed S-P-F lumber is considered as an alternative for Douglas fir studs. If the exterior wall acts as a shearwall, then the reduced base shear capacity of the lower density S-P-F needs to be considered. One possible solution is to decrease the edge nail spacing to meet or exceed the required base design shear as shown in Table 2.

Another factor to consider in a shearwall is the capacity of the hold-down to transfer tension forces. Direct substitution of a lower density material will result in a lower connection capacity, which may require a redesign of the connection.

However, California structural consulting engineer Norman Sheel describes another alternative for direct field substitution of Douglas fir solid lumber with S-P-F finger-jointed lumber in a

shearwall application without requiring redesign. He notes that, " If the members where the edge nailing is applied are left as Douglas fir, and the top and sill plates are left as Douglas fir, I feel that the Douglas fir [base shear] design values are valid." This suggests that, because of stress distribution, intermediate framing that does not occur at panel edges can be directly substituted without reducing the shearwalls base shear capacity to resist wind and earthquake loads. With this in mind, over 95% of the wall framing in a typical California single-family residence could be built using S-P-F finger-joined lumber. Only the 4x4 posts at the end of shearwalls and 2x3 members adjoining the panel edges in shearwalls would be required to remain as Douglas fir to preserve shearwall resistance.

Table 2. Comparison of structural properties of S-P-F finger-joined VERTICAL STUD USE ONLY lumber

	F_b	E	Base Shear Capacity*
D.Fir-L Solid Sawn	1050 psi	1.4 x 10 ⁶ psi	392 plf - 6" edge nail spacing
S-P-F Finger-joined	1015 psi	1.2 x 10 ⁶ psi	457 plf - 4" edge nail spacing

*Based on 2x4", Stud grade, 16"o/c, 3/8" Type I structural sheathing, SBCCI wind, 8d nails, 12" field nail spacing

I-Joist Uses

Finger-joined lumber is also commonly used for flange material in wood I-joists. This application of the product requires the wood fibers and the glued joint to resist long-term tension loads when in use. For this reason, finger-joined lumber used for manufacture of I-Joists must comply with the requirements of a standard such as SPS 1. Wood I-joist manufacturers undertake additional quality assessment procedures during production.

Service Conditions

Finger-joined lumber is typically produced from lumber that has no more than 19% moisture content [S-Dry] for ease of manufacturing the joint to meet the strict quality control standards. For this reason, finger-joined lumber is almost always sold as S-Dry.

Adhesives used in the manufacture of VERTICAL STUD USE ONLY finger-joined lumber are not suitable for joining wet lumber and therefore only S-Dry lumber is processed in order to ensure a quality joint. It is also important to avoid exposing the end product, VERTICAL STUD USE ONLY finger-joined lumber, to excessive moisture while in storage or during construction. Although VERTICAL STUD USE ONLY finger-joined lumber will resist short term exposure to moisture generally expected during construction, like any wood product intended for dry use, it should be allowed to dry after wetting before or during installation.

Information in this section comes from Wood Design & Building #12 by Michel Boudreau P. Eng