

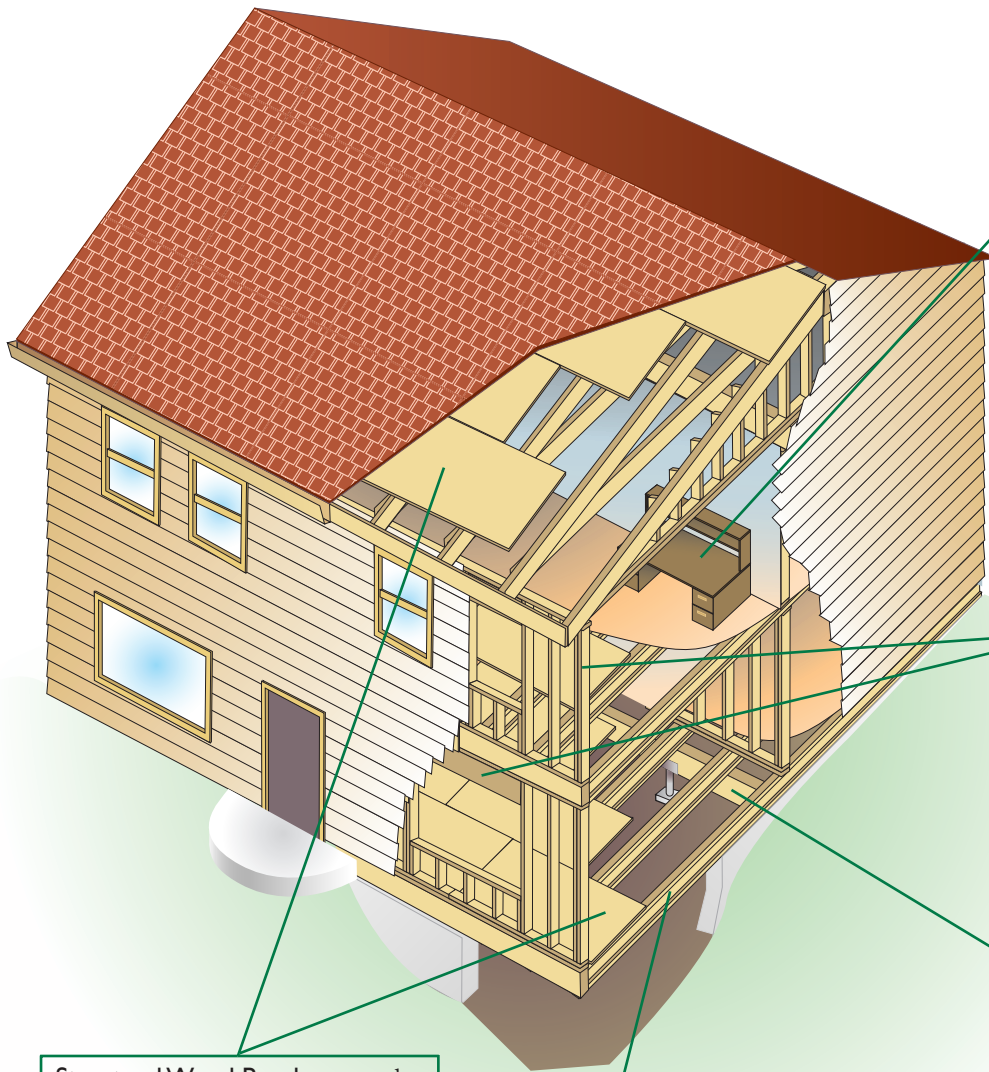
STRUCTURAL APPLICATIONS

Structural is a term used for a load-bearing member or element of a building. Structural applications for wood include roof rafters that support the weight of the roof and wall studs that support the roof and resist lateral loads caused by such things as high winds.

Structural engineered wood products are classified into four general groups: Structural Wood Panels, Glued Laminated Timber (glulam), Structural Composite Lumber, and Wood I-joists.

INDUSTRIAL APPLICATIONS

Many Engineered Wood Products have industrial applications—applications that are non-structural. These applications include uses in furniture, floors, roofs, heavy duty shipping containers, and concrete forms in bridge and highway construction work. These products are proven to be excellent substitutes for solid wood in many applications. The most significant non-structural engineered wood products are Particleboard and Medium Density Fiberboard (MDF).



Particleboard is used widely in the manufacture of furniture, cabinets, floor underlayment in home construction, and in many other applications.

Medium Density Fiberboard is utilized as substitute for solid wood in many interior applications. MDF allows intricate and precise machining and finishing techniques for superior products, such as stereo cabinets and relieved door fronts and moldings.

Structural Composite Lumber products are used as headers and beams, load bearing columns and studs. They are also used in hip and valley rafters, scaffold planking, and the flange - or edge material - for prefabricated wood I-joists.

Glued Laminated Lumber (Glulam) is also among the most versatile of the engineered wood products. It can be shaped into forms ranging from straight beams to complex curved members, and is used in a wide variety of residential and nonresidential building construction applications, including headers, floor girders, ridge beams and purlins, cantilever beam systems, arches, domes and exposed applications such as bridges, marinas and utility structures.

Structural Wood Panels are used for many applications; in construction primarily for siding, sheathing, flooring, and as webs for wood I-joists. Structural wood panels are also used industrially in concrete forming, pallets, crates, bins, transportation equipment, furniture, and boats.

Wood I-joists are widely used in residential and commercial construction as substitutes for 2x lumber floor supports where a high degree of structural reliability is essential.

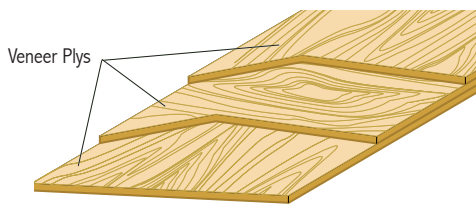
STRUCTURAL WOOD PANELS

Structural wood panels are the most widely used Engineered Wood Products, utilized for many applications; in construction for siding, sheathing, flooring, soffits, stair treads and risers, and webs for wood I-joists. Structural wood panels also have industrial uses in concrete forming, pallets, crates, bins, transportation equipment, furniture, and boats.

The year 2000 was a record for structural panel demand and production in North America. Production totaled 40.3 billion feet with projected growth to 44 billion feet by 2006. New residential construction (the largest market segment) accounted for 18.9 billion feet.

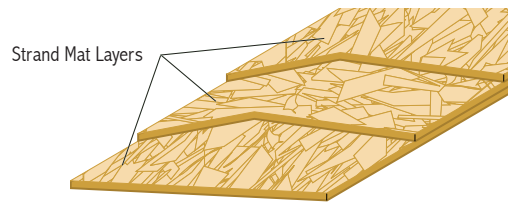
The major types of structural wood panels are plywood and oriented strand board (OSB). These products are all manufactured by laminating various wood-based materials to improve the panel's strength, stiffness, and stability. The key differences between the types is the composition of the layers.

Structural Plywood



The original structural wood panel, plywood consists of thin sheets of wood or veneers arranged in perpendicular layers. It is the cross-laminated layup of layers of veneer that gives plywood its excellent strength, stiffness and dimensional stability. Each layer may consist of a single veneer ply or two or more plies laminated with the grain running in the same direction. There are usually an odd number of layers, with the grain of the face layers typically oriented parallel to the long dimension of the panel.

Oriented Strand Board (OSB)



OSB consists of rectangular-shaped wood strands bonded with adhesives to form a mat. Like the veneer in plywood, the layers of the mat are oriented perpendicular to each other for maximum strength, stiffness and stability. OSB's layers are created during manufacture: The wood strands of three to four inches in length are oriented as they fall onto and move along a conveyor. By the time the mats are pressed into the boards, they exhibit the distinct layers. OSB evolved from waferboard in the late 1970s but differs from waferboard in that long OSB wood strands are oriented, not randomly placed.

OSB is commonly used in construction for sheathing, as the web material for wood I-joists, as the structural membranes of structural insulated panels, and in a growing number of other applications.



Plywood Close-up



OSB Close-up



Structural Panels in their construction application.

Photo provided by: APA-The Engineered Wood Association

STRUCTURAL COMPOSITE LUMBER

Structural composite lumber is an engineered wood product manufactured to substitute for sawn lumber. SCL is created by layering dried wood veneers or strands with waterproof adhesive into blocks of material known as billets. The orientation of each layer runs in the same direction, rather than cross-laminated as in structural wood panels. These billets are then sawn to consistent sizes resulting in parallel-laminated lumber which out-performs conventional lumber when either face- or edge-loaded and is a solid, highly predictable and uniform product that is virtually free from warping and splitting.

One important benefit of SCL is that the veneering and gluing process enables large timbers, which previously required large trees, to be made from relatively small trees of many species, thereby providing for efficient utilization of wood fiber resources.

LVL production totaled 48.8 million cubic feet in 2000 with continued growth projected to almost 70 million cubic feet by 2006. About 50% of total LVL volume is utilized to make I-joist flanges while the rest is used in beam and header applications as well as other miscellaneous uses.

This group of engineered wood products includes; laminated veneer lumber (LVL), parallel strand lumber (PSL), and oriented strand lumber (OSL). Like structural panels, each product type differs from the others in the composition of its layers.

Laminated Veneer Lumber (LVL)

LVL is produced by bonding thin wood veneers together in a large billet so that the grain of all veneers is parallel to the long direction. The LVL billet is then sawn to desired dimensions depending on the construction application. LVL is the most widely used of the structural composite lumber products, particularly in header and beam applications. Besides its uses as headers and beams, LVL is also used in hip and valley rafters, scaffold planking, and the flange—or edge material—for prefabricated wood I-joists.

The strength of LVL is very predictable. LVL is stronger in bending strength than lumber of equivalent size by a factor of two or more.



Laminated Veneer Lumber (LVL) Close-up

Parallel Strand Lumber (PSL)

PSL consists of long veneer strands laid in parallel formation and bonded together with an adhesive to form the finished structural section. Like LVL and glulams, this product is used for beam and header applications where high bending strength is needed. PSL is also frequently used as load bearing columns.



Parallel Strand Lumber (PSL) Close-up

Oriented Strand Lumber (OSL)

Similar to PSL, oriented strand lumber is made from flaked wood strands that have a high length-to-thickness ratio (they are much longer than they are thick). Combined with an adhesive, the strands are oriented and formed into a large mat or billet and pressed. OSL is used in a variety of applications from studs to millwork components.



Laminated Veneer Lumber (LVL) being used with I-joists.

Photos Courtesy of Trus-Joist

GLUED LAMINATED LUMBER (GLULAM)

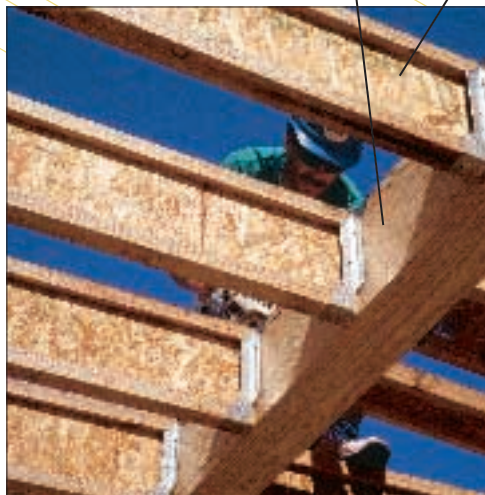
Glulam is among the most versatile of the engineered wood products. It can be shaped into forms ranging from straight beams to complex curved members, and is used in a wide variety of residential and nonresidential building construction applications, including headers, floor girders, ridge beams and purlins, cantilever beam systems, arches, domes and exposed applications such as bridges, marinas and utility structures. Some of the largest wood structures in the world have been framed using glulam components.

Glulam is an engineered stress-rated product created by bonding together individual layers of lumber having a thickness of two inches (50 MM.) or less. Individual pieces of lumber in these layers are finger-jointed together to create long lengths referred to as laminations. These laminations are then bonded together along their lengths to create the finished product. Large, wooden beams can be made from the lumber that is produced from smaller trees.

Glulam production in North America in 2000 was 377 million board feet. (356 million board feet U.S., 21 million board feet Canada) Over half (52%) of U.S. glulam goes to new residential and remodeling uses.



Close up of a glulam beam (Note the layers of laminated lumber.)



Glulam Beam and I-joists being utilized in a header beam/joist application

WOOD I-JOISTS

Wood I-joists are structural, load-carrying engineered wood products designed for long span applications. The I-shape takes advantage of the fact that most of a beam's stress is along the top and bottom edges. Since much material towards the center of the beam is unnecessary, it can be removed, saving weight and resources without sacrificing strength. I-joists require 50 percent less wood to make than a solid wood beam of the same strength. I-joists are most commonly utilized in floor and roof applications.

I-joists concentrate strong fiber where the stress is maximum in the top and bottom flanges and replace the middle section with a strong, thin web. The flange material for I-joists is typically dimension lumber or LVL while the web material is OSB or plywood. I-joists are typically available in long lengths up to 60 feet meaning they can span distances that sawn lumber cannot, and, because they are very light, they can be easily handled at the job site without the need for costly handling equipment. Their I configuration provides high bending strength and stiffness characteristics.

I-joist use has seen significant growth in all markets during the past decade as design professionals and builders became more familiar with the product's inherent advantages. They are used primarily as floor joists. In 2000, 866 million linear feet of I-joists were produced in North America (693 million linear feet in the U.S. and 173 million linear feet in Canada). Forecasts estimate market share gains of about 5 to 10 % per year for the next several years.



Various I-joists

Photos Courtesy of APA—The Engineered Wood Association

Industrial Products

Many engineered wood products like plywood and OSB have industrial applications—applications that are not structurally load-bearing. Along with these, there are several engineered wood products produced specifically for industrial applications. While these products make use of wood products and adhesives like the structural products, they are not subject to load bearing demands. Instead they are typically used in interior applications as substitutes for solid wood. The most significant non-structural engineered wood products are Particleboard and Medium Density Fiberboard (MDF).

Particleboard

Particleboard is a wood panel product consisting of wood particles of various sizes that are bonded together with a synthetic resin or binder under heat and pressure.

Wood chips, edging, and planer shavings are all utilized. The wood particleboard industry grew out of a need to dispose of large quantities of sawdust, planer shavings, and to a lesser extent, the use of mill residues and other relatively homogeneous waste materials produced by other wood industries.

Particleboard is used widely in the manufacture of furniture, cabinets, floor underlayment in home construction, and in many other applications.

Particleboard was developed in the United States and Europe during the 1930s. The parallel development of urea-formaldehyde and phenol-formaldehyde resins for the bonding agents was an important advancement.



Particleboard Close-up

Photos Courtesy of Willamette Industries Inc.

Medium Density Fiberboard (MDF)

Medium Density Fiberboard is made by rubbing apart fiber bundles instead of mechanically breaking them apart, as in the preparation for particleboard. MDF is made in much the same way as particleboard, however the surface is flatter, smoother, more uniform, and generally more dense. MDF is an excellent substitute for solid wood in many interior applications except where the higher stiffness of solid wood is required. MDF allows intricate and precise machining and finishing techniques for superior products, such as stereo cabinets, relieved door fronts and moldings, and table and furniture tops having profiled edges.

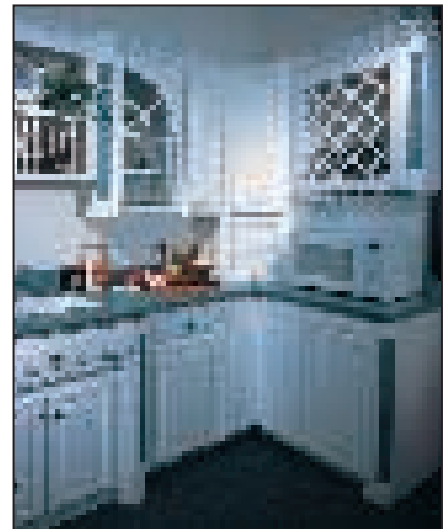
MDF has grown in favor to become a premier substrate for wood veneer, vinyl films, low and intermediate basis weight papers, resin-saturated papers and heat transfer foils. This is due primarily to its smooth surface and edge finishing qualities. MDF is uniform throughout. (A substrate is a material that provides the surface on which an adhesive or coating is spread). MDF has been one of the most rapidly growing composite board products to enter the world market in recent years.



Medium Density Fiberboard (MDF) Close-up

Other Composites

When wood is combined with other materials such as gypsum, cement, or plastic, a variety of interesting new products can be made. Many of them have characteristics that fill a unique niche in the building products industry.



MDF is used for detailed finish applications like cabinets.



Particleboard is used in computer desks and other furniture.

SUMMARY

Wood is a renewable resource, but we have to manage it sustainably. More wood is being put off-limits to harvesting, especially larger, older, and higher quality trees, which limits the availability of large-size, high-quality lumber. This is where engineered wood products come in. We can employ technology to utilize traditionally less desirable species, smaller trees, and lower quality trees to engineer excellent wood products. Additionally, engineered wood products are helping to convince architects, specifiers, and builders that wood should be the first option considered. Engineered wood products, in addition to solid wood, treated wood, and paper products are helping create a wood culture.

Living sustainably means meeting our material needs by choosing renewable resources whenever possible. Wood is the most environmentally sound building material when compared to plastic, metal, and cement. Converting non-renewable raw materials into useful products takes more energy, while creating more waste and pollution. Like solid wood, Engineered Wood Products compare very favorably with non-wood substitutes based on such criteria as embodied energy and emissions of carbon dioxide and other pollutants during manufacture. Most important, they're also made from our only truly renewable building material.

ADHESIVES

Adhesives play a key role in the manufacture of all engineered wood products. Craftsmen have utilized glue to bond wood for centuries and plywood and glulam have been used in North America since the late nineteenth century. It wasn't until the development of phenolic resins in the mid-twentieth century that engineered wood could be used in exterior applications thus opening the market for the products we see today. The process of producing engineered wood products involves binding the wood materials (veneer, strands, boards) with a resin under heat and pressure to form the aforementioned products.

The most commonly used resin-binder systems include; phenol-formaldehyde, urea-formaldehyde, melamine-formaldehyde, and isocyanate. These adhesives were utilized according to their suitability in binding their respective products taking into consideration; materials to be bonded, mechanical properties, durability and cost.

Exterior applications require engineered wood products utilizing full waterproof glue strength. **Phenol-formaldehyde (PF)** resins are the most commonly used exterior adhesive, utilized in the manufacturing of OSB, LVL, softwood, plywoods and siding.

The more economical **Urea-formaldehyde (UF)** resins are used in engineered wood products such as particleboard and MDF which are used for internal, non-structural applications. It is a light-colored resin and is generally the least expensive.

Melamine-Formaldehyde resins have excellent durability though they tend to be expensive.

Isocyanate (diphenylmethane di-isocyanate MDI) is used commonly in the manufacture of OSB.

Research is demonstrating that soybean-based adhesive and extender products can deliver a number of compelling benefits, including lower cost, faster curing time, improved stability, reduction of formaldehyde emissions, and suitability for use with wet, dry, or green wood. (Engineered Wood Journal, Fall 1998)

Performance Advantages of Wood Products

Wood is a more energy efficient building product with an R-rating 413 times greater than steel and 8 times greater than concrete.

Wood products make up approximately 47 percent of all industrial raw materials manufactured in the U.S., yet only consume 4 percent of the energy needed to manufacture all industrial raw materials, according to a 1987 study.

Wood frame construction meets code requirement for fire safety.

Homeowners in high-risk coastal areas found that by using high-strength engineered wood framing material, able to withstand higher wind speed, their insurance costs were lower.

Analysis of earthquake damage in California and Japan revealed that panel sheathed wood frame structures fared better than did masonry and concrete building.

When time constraints arose, the 1996 Olympics' Centennial Olympic Park pavilion was built with engineered lumber.

Pound for pound, wood is stronger than steel because it has a more favorable strength to weight ratio.

A board foot, or 12 x 12 x 1 inches, is the basic unit of measurement for lumber. Panels, on the other hand, are measured in more familiar square feet.

The average size home these days is 2,085 square feet. A home that size uses about 13,125 board feet of lumber.

Approximately one-third of all new single family homes are manufactured homes.

Although we've been harvesting wood in the forests of America for four centuries, growth now exceeds harvest by 35%!

Timeline

Late 19th Century First significant use of glulam in construction of an auditorium in Basel, Switzerland.

1913 British Columbia's first plywood plant went into production at Fraser Mills (Coquitlam), just eight years after the first West Coast softwood plywood plant went into production at Portland, Oregon.

1930s Particleboard developed.

1933 American Plywood Association (APA) established

1934 First Glulam structure erected in US—Research laboratory for USDA Forest Products laboratory, Madison, Wisconsin

1942 Introduction of fully water resistant phenol-resorcinol adhesives allows glulam to be used in exposed exterior environments.

1959 Canadian Wood Council (CWC) established

1960s Laminated veneer lumber (LVL) was first developed and produced commercially.

1960s Use of phenolic resins for plywood use made outdoor use possible.

1969 Trus Joist Corporation (TJ) invented the wood I-joint industry. Wood I-joists are currently produced by over a dozen companies in North America.

1970 Laminated veneer lumber (LVL) becomes the first engineered lumber successfully mass-produced by any company in the world.

Late 1970s OSB evolved from waferboard.

1978 OSB received national attention when the American Plywood Association, now APA - The Engineered Wood Association, incorporated the newly developed OSB panel into its Performance Rated Panel Standard PRP 108.

1984 Parallel strand lumber (PSL) was developed

Early 1990s Laminated strand lumber (LSL) was developed.

Terms

Beam

Normally a horizontal or sloping member that is designed to carry vertical loads.

Flange

Top and bottom longitudinal members of a beam or I-joist.

Header

For panels, a cross member placed between studs or joists to support loads over openings for stairways, chimneys, doors, etc. For glulam beams, a beam which is used to support walls and/or floor and roof joists that run perpendicular to it.

Joist

Horizontal framing member of a floor, ceiling or flat roof.

Old Growth

Mature trees of a specified age or size that generally provides longer, stronger lumber than younger *second growth trees*.

Paneling

Wood panels joined in a continuous surface, especially decorative panels for interior wall finish.

Second/Third Growth

Young, small-diameter trees.

Sheathing

The structural covering, usually of wood panels or boards, on the outside surfaces of framing. It provides support for construction, snow and wind loads and backing for attaching exterior facing materials such as wall siding, roof shingles or underlayment in double-layer floors.

Soffit

The underside of the roof overhang. Structural wood panels are often used as finishing materials for soffits.

Structural

For wood products, a term denoting load-bearing members or elements of a building.

Truss

A combination of members usually arranged in triangular units to form a rigid framework for supporting loads over a span.

Veneer

A thin sheet of wood laminated with others under heat and pressure to form plywood, or used for faces of composite panels. Also called *ply*.

Web

The structural wood panel component of an I-joist, the web is the vertical section located between the two flanges.

Links & Resources

APA - The Engineered Wood Association

Phone: (253) 565-6600
Web: <http://www.apawood.org>
E-mail: help@apawood.org

American Wood Council

Phone: 1-800-AWC-AFPA (1-800-292-2372)
Web: <http://www.awc.org>
AWCINFO@afandpa.org

American Forest and Paper Association

Web: <http://www.afandpa.org>

Boise Cascade

Engineered Wood Products Division

Web: <http://www.bcawp.com>

Canadian Wood Council

Phone: (613) 747-5544
Web: <http://www.cwc.ca>

Structural Board Association

Web: <http://www.osbguide.com>

Louisiana Pacific Corporation

Web: <http://www.lpcorp.com>

Trus-Joist, A Weyerhaeuser Business

Web: <http://www.trusjoist.com>

Willamette Industries

Web: <http://www.wii.com>

Wood University.org

A service of APA - The Engineered Wood Association

Web: <http://www.wooduniversity.org>



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