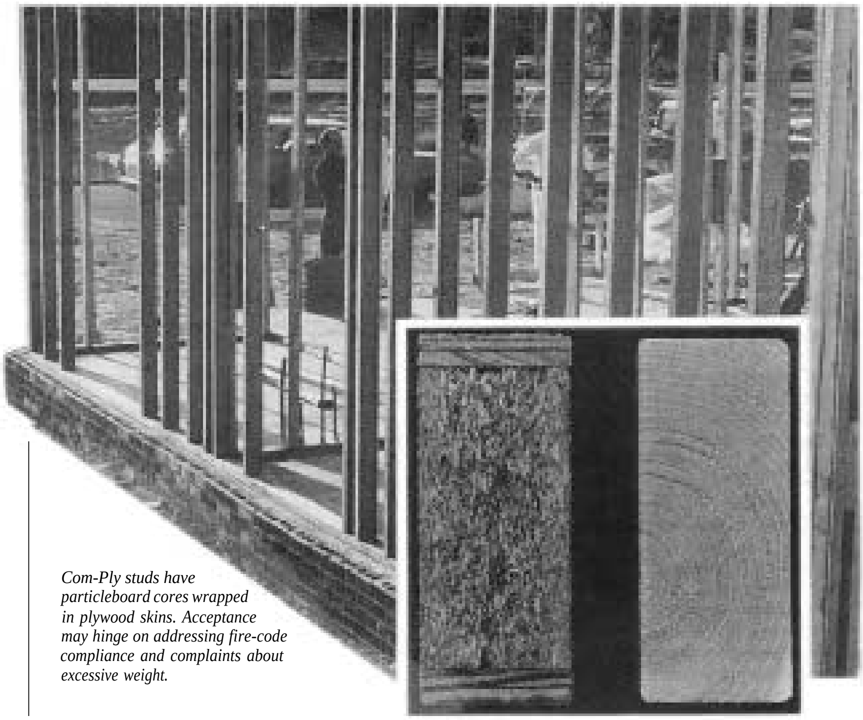
Engineered Lumber



Com-Ply studs have particleboard cores wrapped in plywood skins. Acceptance may hinge on addressing fire-code compliance and complaints about excessive weight.

by John Russo

Over the past three decades, engineered wood products have made solid, although slow, progress in construction applications.

The most common example is plywood. The use of one-inch boards for roof, floor, or wall sheathing would seem archaic today. Plywood itself is now being replaced in some cases by the relatively new particleboards.

More sophisticated wood products are being developed at a faster rate than ever before. Each is developed for individual reasons but, in general, the following factors have played a role:

1. *To improve the yield from logs.* Dimension-lumber production creates large amounts of waste (as much as 50 percent), especially from small logs. The composite and particle products use this waste.

2. *The need for specific engineered sizes, strengths, and shapes.* Dimension lumber is limited by the size, strength, and cost of available timber. Laminated and built-up products can be engineered to meet specific needs.

3. *The development of adhesion technology.* Most of the engineered products depend upon adhesion—of layers, particles, or pieces.

4. *The desire for better control of wood deformation, such as twisting and crooking.* Many of the engineered products have a better control of moisture content at the time of manufacture, and absorb less moisture during use.

5. *The need for more uniformity.* Most of the engineered products can disperse or eliminate knots, splits, and grain-slope problems that plague dimension lumber. Good quality lumber is becoming scarcer and more expensive each year.

6. *Improvements in automation.* These have made possible consistent quality and predictable strengths.

While these factors helped the development of engineered wood, others presented obstacles. Inspecting and testing authorities, which are geared toward dimension lumber, are slow to accept new products. In addition, the construction industry generally resists major shifts in basic materials—particularly in the residential and light-commercial markets.

Also, new products do not always offer clear-cut cost benefits. Many engineered wood products cost more; the benefits are in reduced labor costs or a better appearance. With such trade-offs, most markets will cautiously test the water before diving in.

This article will look at four major categories of engineered wood products:

1. Laminated layered products
2. Combination products
3. Finger-joint products
4. New developments

Laminated Layered Products

Products that use layers of veneer or dimension lumber will be considered in this category. The laminations may have alternating grain, such as traditional plywood, or parallel grains, as in Micro-Lam or glulam.

Micro-Lam

Micro-Lam® has been available since the early 1970s when it was developed by the Trus Joist Corp. It is a series of 1/10- and 1/8-inch-thick veneers laid together in a parallel grain pattern, coated with waterproof adhesives, and seal-cured by pressure and heat. The result is a dense, manufactured board up to 2 1/2 inches thick, 24 inches wide, and of continuous length—generally limited to 80 feet.

Over its 15 years of use, Micro-Lam has proved to be consistent in strength and somewhat stronger than dimension lumber. Its other major characteristics are dimensional stability, resistance to splitting, warping, and crooking, extreme lengths, and uniformity.

For light construction, Micro-Lam can be used for headers and beams, concrete forming and shoring components, ridge beams, scaffold planks, joist flanges, and office-partition framework.

Micro-Lam is used just as if it were a piece of dimension lumber. The nailability of Micro-Lam parallel to the laminations has been criticized, but substantial improvements have been made.

Glulam

Glulam (structural glue-laminated timber) products are produced primarily by the 30 or so members of the American Institute of Timber Construction. These products have been available for many years, and have been improved by better adhesives and innovative designs.

Plywood I-beams from Trus Joist use 2x wood chords and webs of vertical-grain plywood. Primary uses: floor joists and rafters.

The glulam process involves the adhesive bonding of dimension-lumber pieces up to two inches thick to form a larger structural piece with longitudinal, parallel grains. The laminations are glued edge-to-edge to form widths up to 10 1/2 inches, and end-joined to form desired lengths.

Glulam products are generally used for heavy structural jobs. They usually sit on the wide lamination faces, while Micro-Lam typically sits on the edges of the laminations. Like Micro-Lam, glulam is strong, durable, and dimensionally stable.

Glulam products are referred to as "engineered timber." Successful uses include exposed roof and floor beams, curved and shaped roof beams and arches, square, round, and tapered columns, timber decking, small bridge supports, and concrete framework.

Glulam offers better fire safety than concrete and steel. It can be engineered to meet nearly any size, shape, or span requirements, including curves and arches. Glulam presents an attractive exposed finish, and can be pressure-treated for extreme uses. It is most economical in large sizes.

The limitations of glulam products are similar to those of normal dimensional timber. Both need protection from weather before and after installation. Glulam must also be protected during loading, unloading, and placement, so that the laminations are not damaged by dropping or rough handling.

Early studies showed that Com-Ply studs could not meet fire codes unless covered with drywall.

Glulam and Micro-Lam products are available in stock or on a custom-designed basis across the country. They are accepted by major building codes.

Combination Products

Products that are built up other than in layers, or that use a combination of engineered products, will be considered here.

The three major products are trusses, I-beams/I-joists, and composite sandwiches, such as Com-Ply.

Flat Roof and Floor Trusses

Flat roof and floor trusses are derived from the steel bar-joist design, but use 2x wood or laminated-wood products for the upper and lower chords. The interior webs are generally tubular metal, flat metal, or wood connected by metal plates. These flat trusses offer wider free spans and lighter weights than dimension lumber, concrete, or steel. Their open-web design provides space for mechanical runs in floors or ceilings.

Flat trusses are generally considered medium-range, free-span products. However, heavier-duty parallel-chord and pitched-chord trusses are available; these can handle floor spans up to 70 feet, and roof spans to 120 feet. Flat trusses can be engineered with built-in cambers so that they will not deflect beyond design limits.

Most wood trusses need to be temporarily cross-braced to keep them from bowing and rolling over before sheathing is installed. Most floor trusses also require permanent bridging (continuous or spliced 2x lumber) that runs perpendicular to the bottom chords, to minimize deflection and vibration due to concentrated loads. Roof trusses generally do not need bridging unless unusual point loads are anticipated.

In light construction, flat trusses are ideal for free spans that need an open space between floors or below the roof deck. Most light-construction trusses can be handled without lifting equipment, and are readily accepted by code authorities.

I-Beams and I-Joists

These solid-web trusses are made from a 2x chord of dimension lumber or laminated lumber and a web of solid, vertical-grain plywood. The plywood is pressure-glued into grooves routed in each chord. Solid-web trusses are primarily used as floor joists.

The most interesting solid-web product is made by Trus Joist and uses Micro-Lam as the chord material. It replaces traditional 2x10 and 2x12 joists and will free-span over 40 feet with *continuous* chords the entire length. These I-joists can be top-tapered for roof drainage, and cambered to offset deflection.

Light weight and strength are the highlights of solid-web I-joists. One drawback is the need to cut holes to run piping or ductwork. While 1 1/2-inch knockout holes are provided every 12 inches, there are specific limitations that must be followed regarding the location and size of larger holes. In addition, web stiffeners must be installed in the field at all bearing points and points of concentrated loads.

Com-Ply

Com-Ply has a particleboard core covered on both sides by veneer facings. It is formed into sheets similar to plywood, or rectangular shapes that simulate 2x dimension lumber.

While composite products have been used for decades for such items as doors and desk tops, they have only recently been used in construction. The USDA Forest Service began development in the early 1970s in response to lumber and plywood shortages, and worked in cooperation with the American Plywood Association.

Com-Ply is strong enough for stud, joist, and panel (plywood) applications. It has a 50/50 to 80/20 ratio of particleboard to veneer in each piece. The biggest advantage of Com-Ply is to manufacturers. It enables them to use a larger percentage of wood from each tree (in the particleboard).

Com-Ply cuts, nails, and installs essentially like its lumber or plywood counterparts. It has the advantage of producing studs that are consistently straight, and joists of any length.

The primary problems reported concern weight and fire resistance. Initial complaints that Com-Ply studs were heavier than normal studs seem to have been resolved by switching to different composite wood materials. They are still slightly heavier than regular, dimensional white-fir and spruce studs, however.

Early studies also showed that Com-Ply studs and joists could not meet fire codes unless covered with a layer of gypsum drywall. Care must be taken, therefore, when Com-Ply studs or joists are covered with wood paneling or other finishes that don't offer enough fire protection. Thicker veneers on the Com-Ply are being considered to improve its fire resistance.

Another drawback of this and other particle products is the increased wear on saw blades. A high glue content dulls saw blades quickly and requires the use of more expensive hardened blades. Particleboard also tends to be harder to nail.

While Com-Ply products are not available throughout the entire U.S., they have generally been competitively priced where they are produced.

Finger-Joint Products

Finger-joint products, primarily railings, moldings, and studs, are considered "engineered" because they are not made of one continuous piece of wood. They depend upon glue technology to join separate, small pieces of wood end-to-end. Both the shape of the end joint and the glue are critical.

Finger-joint railings and moldings have been used for years. Finger-joint studs are relatively new, and not yet in widespread use. Early indications are that they perform as well as dimensional studs, at least in vertical applications.

New Developnents

It is impossible to review all of the engineered wood products that are in the development or early-use stages. Two products of particular interest, though, are Parallam and prestressed wood beams.

Parallam

Parallam™ is manufactured by laminating long (approximately 1/2 inch by 3/16 inch) Douglas fir strands with exterior adhesives. The strands are adhesive-coated and parallel-oriented, and heat-pressed into shapes similar to those of dimension lumber. This product, developed by MacMillan Bloedel of Canada, was a "product of the future" at Vancouver's Expo '86.

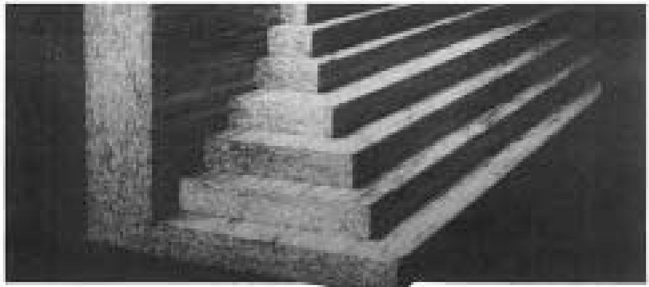
The American Plywood Association has provided testing and quality-control inspections. In addition, the product has been accepted for structural use by all major building codes.

Parallam's major characteristics include more strength and stiffness than dimension lumber, uniformity, straightness, and greater sizes and lengths. It has a unique appearance that takes on fashioning, stains, and varnishes for an exceptional finished look. Fire resistance is equivalent to that of equal-sized dimension lumber. It is said to handle like dimension lumber, and be of comparable weight.

Its limitations, outlined in reports by the Council of American Building Officials and the International Conference of Building Officials, include the requirements to space nails closer when nailing parallel to the wide face, and not to use it where the moisture content might exceed 19 percent.

Parallam is manufactured in standard framing sizes, and can be made up to 60 feet long and, in cross sections, up to 7x14 inches for heavy-timber uses. Suggested uses include scaffold planking, long truss chords, and I-beams and box beams.

Although it is currently available only in western North America, plans are for its manufacture and distribution to spread eastward in 1987.



Parallam—soon to be introduced—is made from long, skinny strands of wood glued together. The lumber is strong and stiff, and has a distinctive grain pattern.

Prestressed Wood Beams

Stressed-camber beams, developed by Trus Joist, are Micro-Lam beams that have been prestressed during manufacture. This produces a beam that is very strong in tension. As with prestressed concrete, applied loads must first overcome the prestress tension before the normal carrying capacity of the member is brought into play.

Stressed-camber beams allow smaller beam sizes to carry greater loads. This is the only advantage of the product, but it can be of major importance if space or weight considerations are critical in a design.

The beam cannot be tapered or its cross section reduced *in any way* in the center 20 feet of its span.

There is one product limitation, not normally found in other beam applications: the beam cannot be tapered or its cross section reduced *in any way* in the center 20 feet of its span.

Stressed-camber beams are available only in the western U.S., but availability will spread throughout the country in 1987.

This is the only major prestressed wood product I am aware of. It may represent the early stage of a significant development in engineered wood.

Final Thoughts

Engineered wood will play an increasingly important role in construction in the coming decades. While there are many products on the market now, they represent only the tip of the iceberg. Lumber shortages, and the economic need to get the greatest use from each log will motivate manufacturers to continually improve wood and adhesive technologies. ■

John Russo is president of CCI, Ltd., a Minneapolis-based construction consulting firm. Dr. Russo is former head of the construction engineering program at Iowa State University.