

PROPERTIES OF STRUCTURAL PANEL PRODUCTS

by Roland Hernandez

Structural panel products are a family of wood products made by bundling veneer, strands, particles, or fibers of wood into flat sheets. The members of this family are (1) plywood, which consists of products made completely or in part from wood veneer; (2) flakeboard, made

from strands, wafers, or flakes; (3) particleboard, made from particles; and (4) fiberboard and hardboard, made from wood fibers. Plywood and flakeboard make up a large percentage of the panels used in structural applications such as roof, wall, and floor sheathing; thus, only those two types will be described here.

Plywood

Plywood is the name given to a wood panel composed of relatively thin layers or plies of veneer with the wood grain of adjacent layers at right angles. The outside plies are called faces or face and back plies, the inner plies with grain parallel to that of the face and back are called cores or centers, and the plies with grain perpendicular to that of the face and back are called crossbands. In four-ply plywood, the two center plies are glued with the grain direction parallel to each ply, making one center layer. Total panel thickness is typically not less than 1/16 in (1.6 mm) or more than 3 in (76 mm). Veneer plies may vary as to number, thickness, species, and grade. Stock plywood sheets usually measure 4 by 8 ft (1.2 by 2.4 m), with the 8-ft (2.4-m) dimension parallel to the grain of the face veneers.

The alternation of grain direction in adjacent plies provides plywood panels with dimensional stability across their width. It also results in fairly similar axial strength and stiffness properties in perpendicular directions within the panel plane. The laminated construction results in a distribution of defects and markedly reduces splitting (compared to solid wood) when the plywood is penetrated by fasteners.

Two general classes of plywood, covered by separate standards, are available; construction and industrial plywood, and hardwood and decorative plywood. Construction and industrial plywood is covered by Product Standard PS 1-95; and hardwood and decorative plywood is

covered by ANSI/HPVA HP-1-2004. Each standard recognizes different exposure durability classifications, which are primarily based on the moisture resistance of the glue used, but sometimes also address the grade of veneer used.

The exposure durability classifications for construction and industrial plywood specified in PS-1 are; exterior, exposure 1, intermediate glue (exposure 2), and interior. Exterior plywood is bonded with exterior (waterproof) glue and is composed of C-grade or better veneers throughout. Exposure 1 plywood is bonded with exterior glue, but it may include D-grade veneers. Exposure 2 plywood is made with glue of intermediate resistance to moisture. Interior-type plywood may be bonded with interior, intermediate, or exterior (waterproof) glue. D-grade veneer is allowed on inner and back plies of certain interior-type grades.

The exposure durability classifications for hardwood and decorative plywood specified in ANSI/HPVA HP-1-2004 are, in decreasing order of moisture resistance, as follows; technical (exterior), type I (exterior), type II (interior), and type III (interior). Hardwood and decorative plywood are not typically used in applications where structural performance is a prominent concern. Therefore, most of the remaining discussion of plywood performance will concern construction and industrial plywood.

A very significant portion of the market for construction and industrial plywood is in residential construction. This market reality has resulted in the development of performance standards for sheathing and single-layer subfloor or underlayment for residential construction and APA-The Engineered Wood Association (APA-EWA) Plywood panels conforming to these performance standards for sheathing are marked with grade stamps such as those shown in Fig. 6.7.3 (example grade stamps are shown for different agencies). As seen in this figure, the

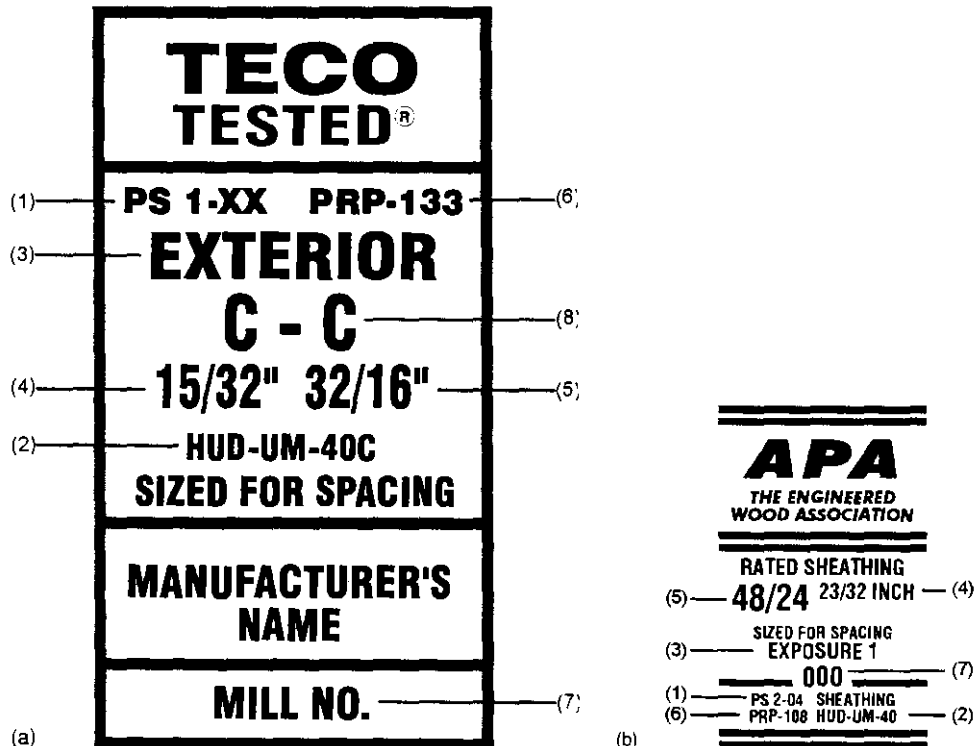


Fig. 6.7.3 Typical grade marks for (a) sheathing-grade plywood conforming to Product Standard PS 1-95 and (b) sheathing-grade structural-use panel conforming to Product Standard PS 2-95. 1, conformance to indicated product standard; 2, recognition as a quality assurance agency; 3, exposure durability classification; 4, thickness; 5, span rating; 6, conformance to performance-rated product; 7, manufacturer's name or mill number; 8, grade of face and core veneers.

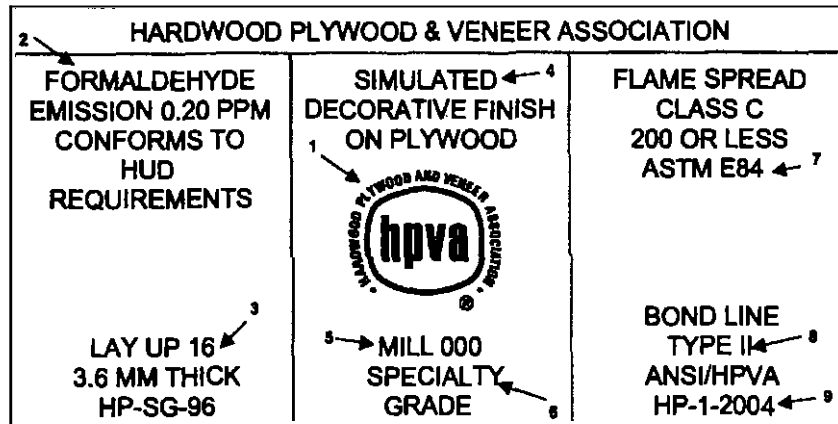


Fig. 6.7.4 Grade stamp for hardwood plywood conforming to ANSI/HPVA HP-1-2004, 1, trademark of Hardwood Plywood and Veneer Association; 2, formaldehyde emission characteristics; 3, structural description; 4, face species or finish type; 5, HPVA mill number; 6, veneer grade of face; 7, flame spread classification; 8, bondline type; 9, standard that governs manufacture.

grade stamp must show (1) conformance to the plywood product standards; (2) recognition as a quality assurance agency by the National Evaluation Services (NES), which is affiliated with the Council of American Building Officials, (3) exposure durability classification; (4) thickness of panel; (5) span rating, 32/16, which refers to the maximum allowable roof support spacing of 32 in (813 mm) and maximum floor joist spacing of 16 in (406 mm); (6) conformance to the performance-rated standard of the agency; (7) manufacturer's name or mill number, and (8) grades of face and core veneers.

All hardwood plywood represented as conforming to American National Standard ANSI/HPVA-HP-1-2004 is identified by one of two methods: either marking each panel with the HPVA plywood grade stamp Fig. 6.7.4) or including a written statement with this information with the order or shipment. The HPVA grade stamp shows (1) HPVA trademark; (2) formaldehyde emission characteristics; (3) structural description; (4) face species or finish type; (5) HPVA mill number; (6) veneer grade of face; (7) flame spread classification; (8) bondline type; and (9) standard that governs manufacture.

The span-rating system for plywood was established to simplify specification of plywood without resorting to specific structural engineering design. This system indicates performance without the need to refer to species group or panel thickness. It gives the allowable span when the face grain is placed across supports.

If design calculations are desired, a design guide is provided by APA-EWA in "Plywood Design Specifications" (PDS, 2004). The design guide contains tables of grade stamp references, section properties, and allowable stresses for plywood used in construction of buildings and similar related structures. For the design and fabrication of curved panels, plywood-lumber beams, plywood stress-skin panels, plywood sandwich panels, and all-plywood beams, information is available in supplements to the PDS standard from APA-EWA.

If calculations for the actual physical and mechanical properties of plywood are desired, formulas relating the properties of the particular wood species in the component plies to the laminated panel are provided in "Wood Handbook." These formulas could be applied to plywood of any species, provided the basic mechanical properties of the species are known. Note, however, that the formulas yield predicted actual properties (not design values) of plywood made of defect-free veneers.

Structural Flakeboards

Structural flakeboards are wood panels made from specially produced flakes—typically from relatively low-density species, such as aspen or pine—and bonded with an exterior-type water-resistant adhesive. Two major types of flakeboards are recognized, **oriented strandboard** (OSB) and **waferboard**. OSB is a flakeboard product made from wood

strands (long and narrow flakes) that are formed into a mat of three to five layers. The outer layers are aligned in the long panel direction, while the inner layers may be aligned at right angles to the outer layers or may be randomly aligned. In waferboard, a product made almost exclusively from aspen wafers (wide flakes), the flakes are not usually oriented in any direction, and they are bonded with an exterior-type resin. Because flakes are aligned in OSB, the bending properties (in the aligned direction) of this type of flakeboard are generally superior to those of waferboard. For this reason, OSB is the predominant form of structural flakeboard. Panels commonly range from 0.25 to 0.75 in (6 to 19 mm) thick and are 4 by 8 ft (1 by 2 m) in surface dimension. However, thicknesses up to 1.125 in (28.58 mm) and surface dimensions up to 8 by 24 ft (2 by 7 m) are available by special order.

A substantial portion of the market for structural flakeboard is in residential construction. For this reason, structural flakeboards are usually marketed as conforming to a product standard for sheathing or single-layer subfloor or underlayment and are graded as a performance-rated product (PRP-108) similar to that for construction plywood. The Voluntary Product Standard PS 2-95 is the performance standard for wood-based structural-use panels, which includes such products as plywood, composites, OSB, and waferboard. The PS 2-95 is not a replacement for PS 1-95, which contains necessary veneer grade and glue bond requirements as well as prescriptive layup provisions and includes many plywood grades not covered under PS 2-95.

Design capacities of the APA-EWA performance-rated products, which include OSB and waferboard, can be determined by using procedures outlined in the APA-EWA Technical Note N375A. In this reference, allowable design strength and stiffness properties, as well as nominal thicknesses and section properties, are specified based on the span rating of the panel. Additional adjustment factors based on panel grade and construction are provided.

Because of the complex nature of structural flakeboards, formulas for determining actual strength and stiffness properties, as a function of the component material, are not available.

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