AIRCRAFT
INSPECTION, REPAIR & ALTERATIONS
Acceptable Methods, Techniques & Practices

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CHAPTER 1. WOOD STRUCTURE

SECTION 1. MATERIALS AND PRACTICES

1-1. GENERAL. Wood aircraft construction dates back to the early days of certificated aircraft. Today only a limited number of wood aircraft structures are produced. However, many of the older airframes remain in service. With proper care, airframes from the 1930's through the 1950's have held up remarkably well considering the state of technology and long term experience available at that time. It is the responsibility of the mechanic to carefully inspect such structures for deterioration and continuing airworthiness.

1-2. WOODS.

a. Quality of Wood. All wood and plywood used in the repair of aircraft structures should be of aircraft quality (reference Army Navy Commerce Department Bulletin ANC-19, Wood Aircraft Inspection and Fabrication). Table 1-1 lists some permissible variations in characteristics and properties of aircraft wood. However, selection and approval of woodstock for aircraft structural use are specialized skills and should be done by personnel who are thoroughly familiar with inspection criteria and methods.

b. Substitution of Original Wood. The wood species used to repair a part should be the same as that of the original whenever possible; however, some permissible substitutes are given in table 1-1. Obtain approval from the airframe manufacturer or the Federal Aviation Administration (FAA) for the replacement of modified woods or other non-wood products with a substitute material.

c. Effects of Shrinkage. When the moisture content of a wooden part is lowered, the part shrinks. Since the shrinkage is not equal in all directions, the mechanic should consider the effect that the repair may have on the completed structure. The shrinkage is greatest in a tangential direction (across the fibers and parallel to the growth rings), somewhat less in a radial direction (across the fibers and perpendicular to the growth rings), and is negligible in a longitudinal direction (parallel to the fibers). Figure 1-1 illustrates the different grain directions and the effects of shrinkage on the shape of a part. These dimensional changes can have several detrimental effects upon a wood structure, such as loosening of

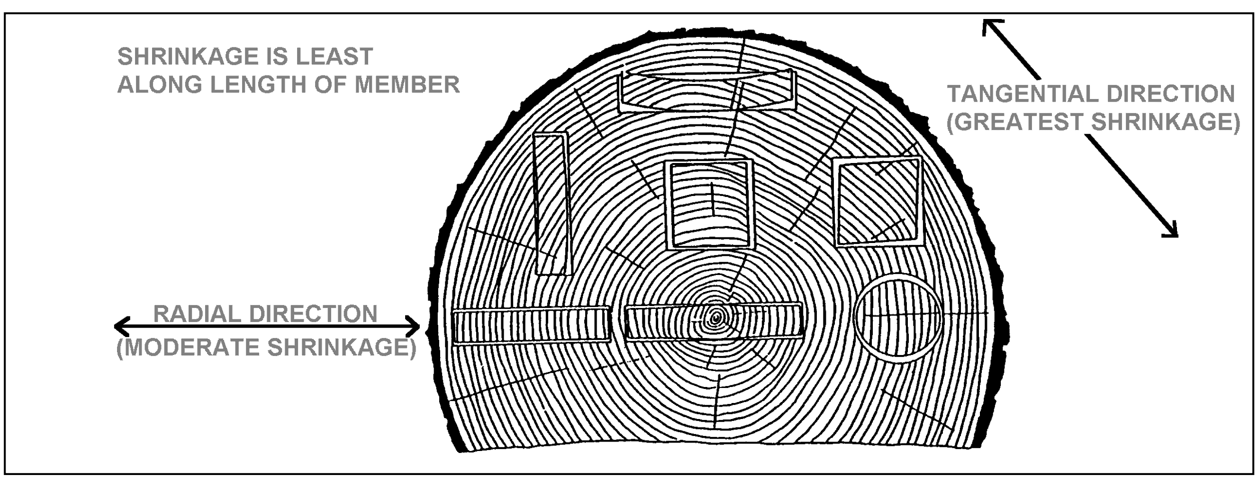

FIGURE 1-1. Relative shrinkage of wood members due to drying.

TABLE 1-1. Selection and Properties of Aircraft Wood. (See notes following table.)

Species of Wood	Strength properties as compared to spruce	Maximum permissible grain deviation (slope of grain)	Remarks
1.	2.	3.	4.
Spruce(Picea) Sitka (P. Sitchensis) Red (P. Rubra) White (P. Glauca).	100%	1:15	Excellent for all uses. Considered as standard for this table.
Douglas Fir (Pseudotsuga Taxifolia).	Exceeds spruce.	1:15	May be used as substitute for spruce in same sizes or in slightly reduced sizes providing reductions are substantiated. Difficult to work with handtools. Some tendency to split and splinter during fabrication and considerable more care in manufacture is necessary. Large solid pieces should be avoided due to inspection difficulties. Gluing satisfactory.
Noble Fir (Abies Nobiles).	Slightly exceeds spruce except 8% deficient in shear.	1:15	Satisfactory characteristics with respect to workability, warping, and splitting. May be used as direct substitute for spruce in same sizes providing shear does not become critical. Hardness somewhat less than spruce. Gluing satisfactory.
Western Hemlock (Tsuga Heterpphylla).	Slightly exceeds spruce.	1:15	Less uniform in texture than spruce. May be used as direct substitute for spruce. Upland growth superior to lowland growth. Gluing satisfactory.
Pine, Northern White (Pinus Strobus).	Properties between 85 % and 96 % those of spruce.	1:15	Excellent working qualities and uniform in properties, but somewhat low in hardness and shock-resisting capacity. Cannot be used as substitute for spruce without increase in sizes to compensate for lesser strength. Gluing satisfactory.
White Cedar, Port Orford (Charaecyparis Lawsoniana).	Exceeds spruce.	1:15	May be used as substitute for spruce in same sizes or in slightly reduced sizes providing reductions are substantiated. Easy to work with handtools. Gluing difficult, but satisfactory joints can be obtained if suitable precautions are taken.
Poplar, Yellow (Liriodendrow Tulipifera).	Slightly less than spruce except in compression (crushing) and shear.	1:15	Excellent working qualities. Should not be used as a direct substitute for spruce without carefully accounting for slightly reduced strength properties. Somewhat low in shock-resisting capacity. Gluing satisfactory.

Notes for Table 1-1

1. Defects Permitted.

a. Cross grain. Spiral grain, diagonal grain, or a combination of the two is acceptable providing the grain does not diverge from the longitudinal axis of the material more than specified in column 3. A check of all four faces of the board is necessary to determine the amount of divergence. The direction of free-flowing ink will frequently assist in determining grain direction.

b. Wavy, curly, and interlocked grain. Acceptable, if local irregularities do not exceed limitations specified for spiral and diagonal grain.

c. Hard knots. Sound, hard knots up to 3/8 inch in maximum diameter are acceptable providing: (1) they are not projecting portions of I-beams, along the edges of rectangular or beveled unrouted beams, or along the edges of flanges of box beams (except in lowly stressed portions); (2) they do not cause grain divergence **at the edges of** the board or in the flanges of a beam more than specified in column 3; and (3) they are in the center third of the beam and are not closer than 20 inches to another knot or other defect (pertains to 3/8 inch knots—smaller knots may be proportionately closer). Knots greater than 1/4 inch must be used with caution.

d. Pin knot clusters. Small clusters are acceptable providing they produce only a small effect on grain direction.

e. Pitch pockets. Acceptable in center portion of a beam providing they are at least 14 inches apart when they lie in the same growth ring and do not exceed 1-1/2 inches length by 1/8 inch width by 1/8 inch depth, and providing they are not along the projecting portions of I-beams, along the edges of rectangular or beveled unrouted beams, or along the edges of the flanges of box beams.

f. Mineral streaks. Acceptable, providing careful inspection fails to reveal any decay.

TABLE 1-1. Selection and Properties of Aircraft Wood. (See notes following table.) (continued)

2. Defects Not Permitted.

a. Cross grain. Not acceptable, unless within limitations noted in 1a.

b. Wavy, curly, and interlocked grain. Not acceptable, unless within limitations noted in 1b.

c. Hard knots. Not acceptable, unless within limitations noted in 1c.

d. Pin knot clusters. Not acceptable, if they produce large effect on grain direction.

e. Spike knots. These are knots running completely through the depth of a beam perpendicular to the annual rings and appear most frequently in quarter-sawed lumber. Reject wood containing this defect.

f. Pitch pockets. Not acceptable, unless within limitations noted in 1e.

g. Mineral streaks. Not acceptable, if accompanied by decay (see 1f).

h. Checks, shakes, and splits. Checks are longitudinal cracks extending, in general, across the annual rings. Shakes are longitudinal cracks usually between two annual rings. Splits are longitudinal cracks induced by artificially induced stress. Reject wood containing these defects.

i. Compression wood. This defect is very detrimental to strength and is difficult to recognize readily. It is characterized by high specific gravity, has the appearance of an excessive growth of summer wood, and in most species shows little contrast in color between spring wood and summer wood. In doubtful cases reject the material, or subject samples to toughness machine test to establish the quality of the wood. Reject all material containing compression wood.

j. Compression failures. This defect is caused from the wood being overstressed in compression due to natural forces during the growth of the tree, felling trees on rough or irregular ground, or rough handling of logs or lumber. Compression failures are characterized by a buckling of the fibers that appear as streaks on the surface of the piece substantially at right angles to the grain, and vary from pronounced failures to very fine hairlines that require close inspection to detect. Reject wood containing obvious failures. In doubtful cases reject the wood, or make a further inspection in the form of microscopic examination or toughness test, the latter means being the more reliable.

k. Decay. Examine all stains and discoloration carefully to determine whether or not they are harmless, or in a stage of preliminary or advanced decay. All pieces must be free from rot, dote, red heart, purple heart, and all other forms of decay.

fittings and wire bracing and checking or splitting of wood members. A few suggestions for minimizing these shrinkage effects are:

(1) Use bushings that are slightly short so that when the wood member shrinks the bushings do not protrude and the fittings may be tightened firmly against the member.

(2) Gradually drop off plywood faceplates by feathering as shown in figure 1-2.

(3) Thoroughly seal all wood surfaces, particularly end grain and bolt holes, with varnish, epoxy, or other acceptable sealer to slow or prevent moisture changes in the member. (See Section 5. Finishing Wood Structures.)

1-3. MODIFIED WOOD PRODUCTS. The most common forms of modified woods found in aircraft construction are plywood. Although not a wood product, Phenolic parts are sometimes incorporated into structures. These products are used whenever the manufacturer requires specialized strength or durability characteristics.

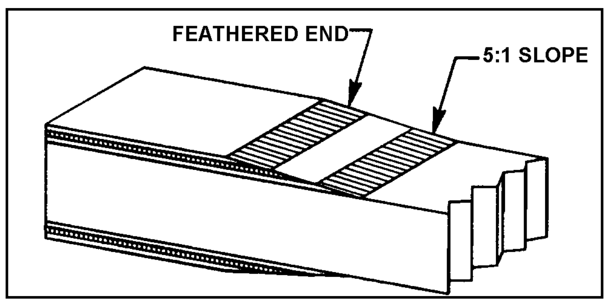

FIGURE 1-2. Tapering of faceplate.

1-4. ADHESIVES. Because of the critical role played by adhesives in aircraft structure, the mechanic must employ only those types of adhesives that meet all of the performance requirements necessary for use in certificated civil aircraft. Use each product strictly in accordance with the aircraft and adhesive manufacturer's instructions.

a. Adhesives acceptable to the FAA can be identified in the following ways:

(1) Refer to the aircraft maintenance or repair manual for specific instructions on acceptable adhesive selection for use on that type aircraft.

(2) Adhesives meeting the requirements of a Military Specification (Mil Spec), Aerospace Material Specification (AMS), or Technical Standard Order (TSO) for wooden aircraft structures are satisfactory providing they are found to be compatible with existing structural materials in the aircraft and the fabrication methods to be used in the repair.

b. Common types of adhesives that are or have been used in aircraft structure fall into two general groups: casein and synthetic-resins. Adhesive technology continues to evolve, and new types (meeting the requirements of paragraph 1-4a) may become available in the future.

(1) Casein adhesive performance is generally considered inferior to other products available today, modern adhesives should be considered first.

CAUTION: Casein adhesive deteriorates over the years after exposure to moisture in the air and temperature variations. Some modern adhesives are incompatible with casein adhesive. If a joint that has previously been bonded with casein is to be rebonded with another type adhesive, all traces of the casein must be scraped off before the new adhesive is applied. If any casein adhesive is left, residual alkalinity may cause the new adhesive to fail to cure properly.

(2) Synthetic-resin adhesives comprise a broad family which includes plastic resin glue, resorcinol, hot-pressed Phenol, and epoxy.

(3) Plastic resin glue (urea-formaldehyde resin glue) has been used in wood aircraft for many years. Caution should be used due to possible rapid deterioration (more rapidly than wood) of plastic resin glue in hot, moist environments and under cyclic swell-shrink stress. For these reasons, urea-formaldehyde should be considered obsolete for all repairs. Any proposed use of this type adhesive should be discussed with the appropriate FAA office prior to using on certificated aircraft.

(4) Federal Specification MMM-A-181D and Military Specification MIL-A-22397 both describe a required series of tests that verify the chemical and mechanical properties of resorcinol. Resorcinol is the only known adhesive recommended and approved for use in wooden aircraft structure and fully meets necessary strength and durability requirements. Resorcinol adhesive (resorcinol-formaldehyde resin) is a two-part synthetic resin adhesive consisting of resin and a hardener. The appropriate amount of hardener (per manufacturer's instruction) is added to the resin, and it is stirred until it is uniformly mixed; the adhesive is now ready for immediate use. Quality of fit and proper clamping pressure are both critical to the achievement of full joint strength. The adhesive bond lines must be very thin and uniform in order to achieve full joint strength.

CAUTION: Read and observe material safety data. Be sure to follow the manufacturer's instructions regarding mixing, open assembly and close assembly times, and usable temperature ranges.

(5) Phenol-formaldehyde adhesive is commonly used in the manufacturing of aircraft grade plywood. This product is cured at elevated temperature and pressure; therefore, it is not practical for use in structural repair.

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AC 43.13-1B and AC 43.13-2B

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FEDERAL AVIATION ADMINISTRATION

This handbook for Aviation Maintenance Technicians (AMTs), repair stations, aircraft owners and homebuilders details the standards for acceptable methods, techniques, and practices for the inspection, repair, and alteration of aircraft. It is a compilation of the two most important Advisory Circulars (ACs) written by the Federal Aviation Administration (FAA) on this topic—namely, *Acceptable Methods, Techniques, and Practices—Aircraft Inspection and Repair* (AC 43.13-1B) and *Acceptable Methods, Techniques, and Practices—Aircraft Alterations* (AC 43.13-2B).

AC 43.13-1B provides details on the materials and practices, health and safety, inspection, repair, and finishes for wood structures, fabric covering, fiberglass and plastics, and metal structures, welding and brazing. It includes chapters dedicated to nondestructive inspection (NDI), corrosion, inspection and protection, aircraft hardware, control cables and turnbuckles, engines, fuel, exhaust, propellers, aircraft systems and components, weight and balance, electrical systems, avionics, and human factors.

AC 43.13-2B is a manual filled with details and instructions for the installation of aircraft components and systems, such as communications, navigation, and emergency systems, anticollision and supplementary lights, skis, oxygen systems in nonpressurized aircraft, rotorcraft external-load devices, cargo slings and external racks, glider and banner tow-hitches, aircraft batteries and more, including guidance on adding or relocating instruments.

These combined manuals provide this pertinent information where no manufacturer repair or maintenance instructions exist. The details and standards for methods and practices covered are applicable to nonpressurized civil aircraft with a gross weight of 12,500 pounds or less. Illustrated throughout; includes a glossary, and a list of useful acronyms and abbreviations.

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