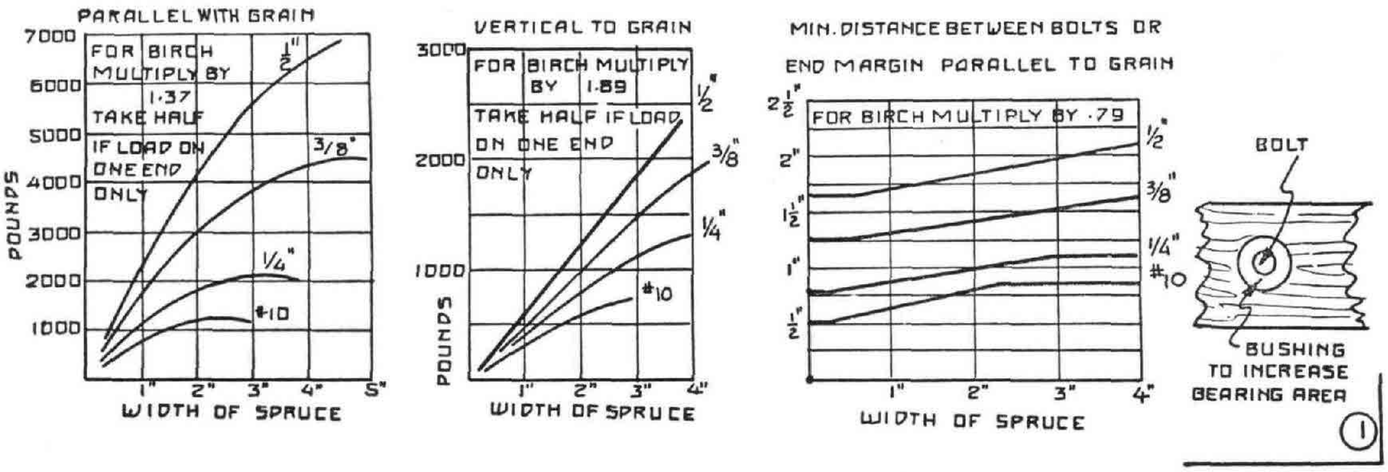

The Importance Of Fittings

By Raoul J. Hoffman

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In a previous issue we brought you the strength values of various materials used in aircraft design and the estimation of simple stresses, stresses that are equally distributed over the cross - sectional area. These stresses are pure tension, compression (bearing) or shear, and are equal to the load divided by the area of the section.

Allowable loads that create stresses not easily evaluated are usually taken from tests conducted at various laboratories such as the U. S. Dept. of Agr., the Bureau of Standards and others.

Charts showing the safe loads of heat-treated nickel-steel bolts in spruce beams parallel or vertical to the grain accompany this article. These charts are correct, within certain limits, when bushings are added to increase the bearing area without increasing the size of the bolt, and when the shear strength of the bolt is not below the bearing load indicated on the charts (Sec. 1).

Having obtained from the stress analysis all loads acting at a joint the designer should be able to produce safe and simple fittings with the aid of the charts.

Although a diversified knowledge be at command at the initial layout, a few fundamental principles will be of additional help.

It is desired that all main stresses be tension (or plain compression) equally distributed, and that all materials of connection (rivets, bolts, dowels) and all materials of adhesion (welding, brazing, soldering and glueing) to be in shear. No eccentricity should appear when loads are applied and that no stresses should be added when assembling.

Bolts that attach fittings to wood beams should be spaced to take their apportioned loads; this can be accomplished if other tests are not available by locating them conforming with the outline sketch in Sec. 2. The proximity of the bolts, as in Sec. 2, shows the principle of conservation of energy, that is, that the work done is causing a deformation of material will always be the minimum.

In order to prevent eccentricity the proper location of the bolts relative to the load line must be found by the methods of moments as illustrated by an example in Sec. 3. Draw a base line and lines through the center of bolts parallel to the line of the main load; then the sum of all moments (load times distance) divided by the sum of all loads gives the distance where the main load should pass.

An example of eccentric loading is the special shank designed to take two control cables. This fitting will break, for both cables cannot be made to have the same tension. A variation shown in the lower sketch of Sec. 4 or the use of two turnbuckles will eliminate eccentricity.

To obtain concentricity we join all loads and all neutral axes (gravity lines of members) at a common point (Sec. 5).

But not all centric forces result in a well designed fitting especially if they create bending stresses (see Sec. 6); then a reduction of the distance to the fastening will improve the design if the bending radius is at least equal to the thickness of the material.

Welding plays a big part in production of fittings, for complicated fittings can be made at low cost.

The cross-sectional area for estimating the strength of the weld should be taken at the throat of the weld and not at its contact with the material. To reduce residual stresses we weld from the outside towards the center; and if possible, we do not use circumferential welds.

We find, in Sec. 7 a few examples of welded lugs, in Sec. 8 various tube connections with their approximate efficiencies and at the lower part a tube connection with rosette weld and rivet weld. Rosette weld, which is welding of drilled holes, should not be employed; rivet weld, which is inserting rivets into drilled holes and welding their ends, is of poor appearance but it is easily disassembled by filing off the welded part of the rivet.

In Sec. 9 we find tube and fittings with lugs or bearings, their selection depending on the load to be transmitted. In order to have the unit aligned the tubing used for the bearing is trimmed after welding. Universals shown in Sec. 10 are used for two-way motions; a heat-treated tubing, a few thousandths longer than the oscillating part is bolted securely.

Designs of hinges for control surfaces are shown in Sec. 11 and Sec. 11A; in case clamping pressure is too high for the spruce beam a three-ply wood piece or a sheet steel base may be used.

A multitude of fittings could be designed for fuselage joints; some are shown in Secs. 13, 14, 15, and 16. Simple control levers are illustrated in Sec. 11A and Sec. 15.

Wing fittings usually give the engineer ample opportunity to show his talent of simplifying the design and his ability to conceal it within the wing itself. Wing fittings from the old pusher type to the latest all-metal biplanes are shown in Secs. 17, 18, 19 and 20.

Special problems confront the builder of landing gear fittings, especially if the landing gear is to be retracted. One question of importance is whether the axle is to be heat-treated or not, and if it is to be heat-treated before or after the welding. In case the axle is heat-treated separately, all parts are welded to a sleeve, the axle placed into the sleeve and welded at one end as shown in Sec. 21.

Use of universals in landing gears, see Sec. 22, is for the prevention of damage to the main structure of the fuselage by folding back in case of accident; thus reducing the cost of repair.

Landing-gear fittings usually mean hinge designs. Sec. 23 shows the main principle of the co-ordination of all hinge axes. If the axle is fastened to a V-ee then all axes must be parallel to A-A-A; even if fitting B is moved to C and the other end of the strut is fastened to the point D, a fixed part of the shock-strut, they have to be parallel to A-A.

Nevertheless, if the hinge C is connected with E then all axes have to be parallel with F-F; adding a universal will not remedy any error. If torsional motions are present a ball and socket design must be used. For length adjustment of tubes or struts a threaded barrel, see Sec. 24, is the simplest but not the best design. ■

ON THE BASIS THAT A CHAIN IS NO STRONGER THAN ITS WEAKEST LINK, THE FITTING AND STRUCTURAL CONNECTIONS OF A PLANE ARE AMONG THE MOST IMPORTANT OF ALL THE MYRIAD PARTS AND YET ARE THE MOST NEGLECTED