

8 Riveted Joints

8.1 Introduction

Riveting was the standard method of joining plates and structural parts before welding began to replace it with increasing rapidity. are widely used in many engineering application. Now a days welding is replacing riveting for its economical advantage and ease of manufacturing.

Riveting applications:

1. Pressure vessels, boilers
2. tanks
3. Bridges
4. Hulls of ships
5. Airplanes
6. Cranes
7. buildings
8. Machinery in general

Rivets

A rivet is a round bar consisting of an upset end called the *head* and a long part called the *shank*. The rivet blank is heated to a red glow and inserted into one of the holes; and while the head is held firmly against the plate, the projecting end is formed into a second head, called the *point*, by means of a hand machine hammer and a forming tool called a set.

Rivet material:

Rivets are made of tough and ductile low carbon steel or nickel steel. Brass rivets are used only cold and in small sizes

8.2 Types of riveted joints:

Two arrangements used in joining plates by means of rivets are equally well adapted to all mentioned applications; namely, *lap joints* and *butt joints* see fig. (8.1)

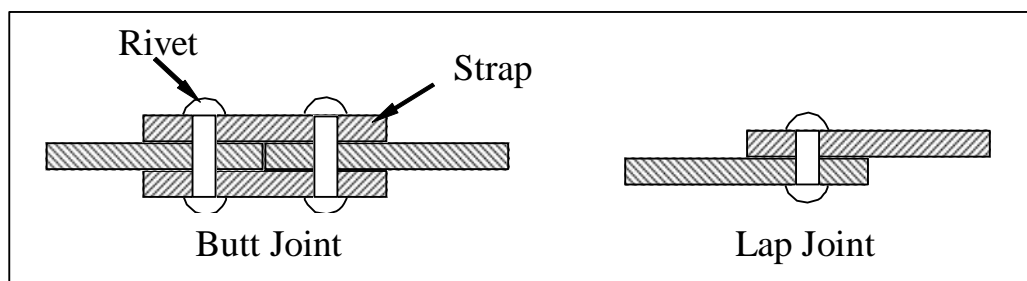
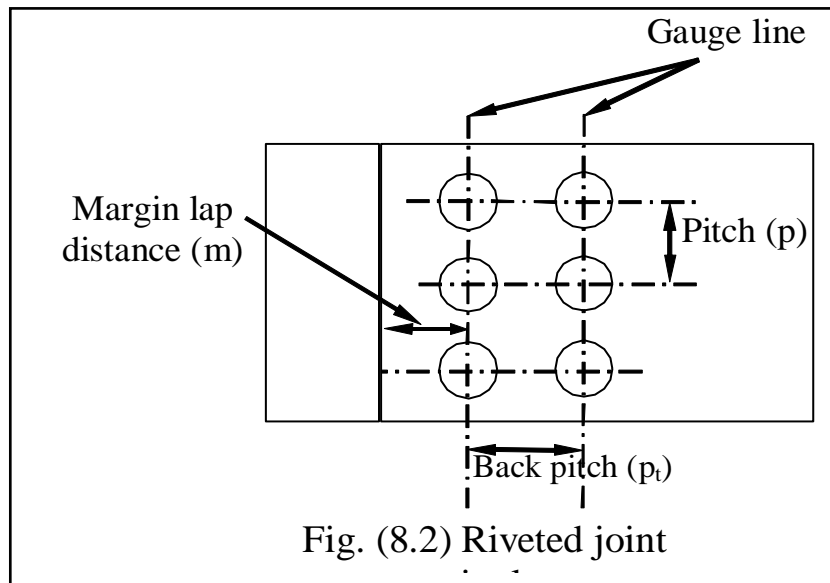


Fig. (8.1) types of riveted joints

Fig.(8.2) explains some of the terminology relevant to riveted joints.



8.2 Failure of riveted joints:

Riveted joints may be designed to resist *tension*, *shear*, or *combined tension and shear loads*.

Figure (8.3) shows a lap connection loaded in shear. The riveted joint may fail in one of the following modes:

a) Bending of rivet or plate, see fig.(8.3 a)

In Lap connections the offset creates a moment equal to approximately $M=Ft/2$. This bending moment can cause complex deformations and stresses in the connection that affect the overall connection strength. In most cases this offset moment is neglected and a suitable factor of safety is used.

b) Shearing of the rivets, see fig. (8.3 b) and fig.(8.3 c):

The load distribution among upon the rivets depends on so many factors. The conventional assumption is that the load is distributed equally among all rivets. The general expression for the resistance to shear of all the rivets in a unit strip is:

$$F_s = (2n_2 + n_1) \frac{\pi d^2 S_s}{4} \quad (8.1)$$

Where,

n_1 :: number of rivets in *single shear*

n_2 : number of rivets in *double shear*

S_s : allowable shear stress

d : diameter of rivet

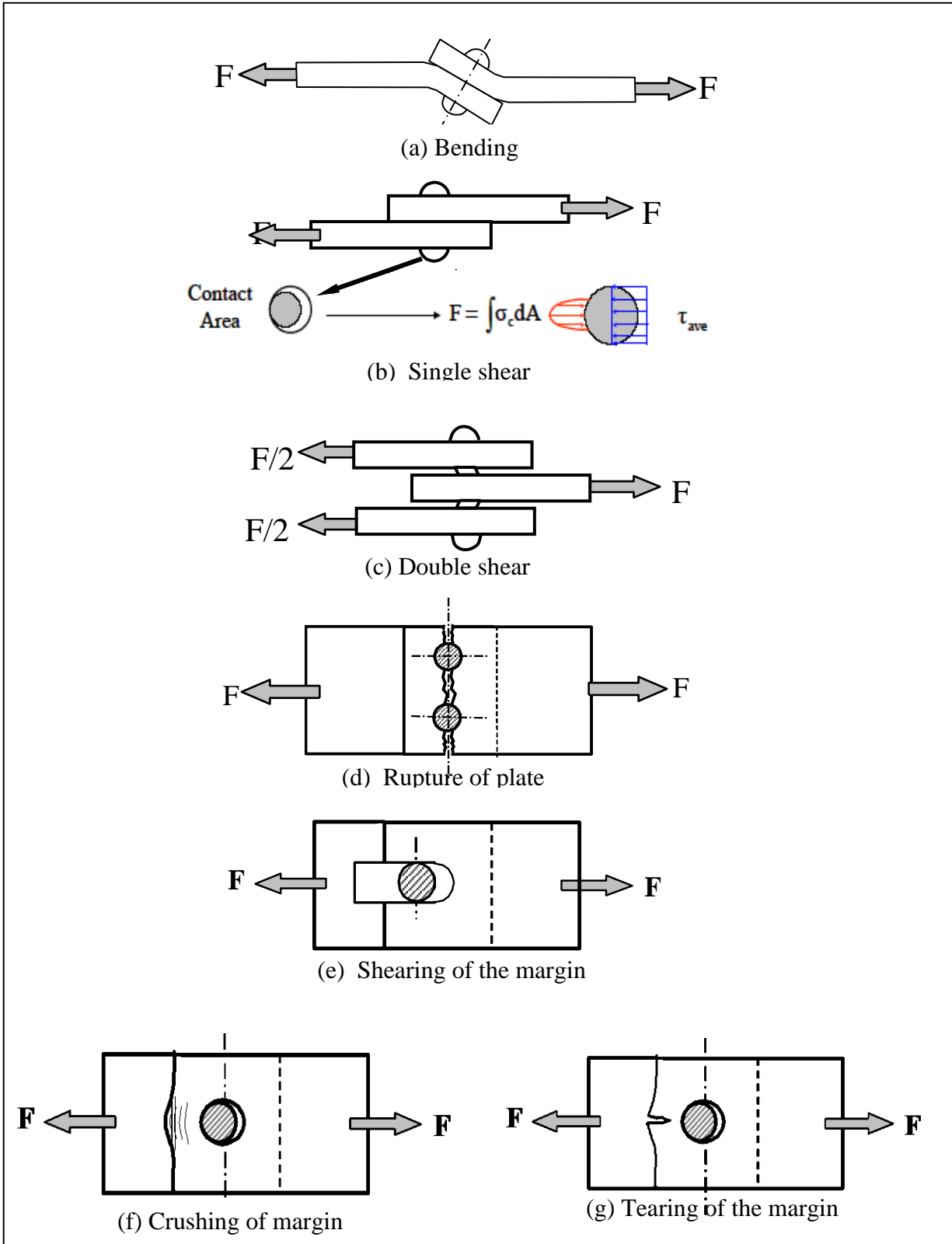


Fig. (8.3) Failure of riveted joints

c) Crushing of the rivets or the plates, see fig.(8.3 g):

crushing of the rivet or plate may occur due to the pressure on the cylindrical surface of the rivet and the plate The general expression for the resistance to crushing of rivets is,

$$F_c = (n_2 h + n_1 h_2)dS_c \tag{8.2}$$

where

h: thickness of main plate

h₂ : wider strap thickness

S_c : allowable crushing stress

d) Rupture of plate by tension:

Rupture of plate occurs at the section between the rivets and perpendicular to the acting force. The resistance of rupture ca be obtained from the expression:

$$F_t = (L - nd)hS_t \tag{8.3}$$

Where:

L: plate width

h: plate thickness:

S_t : allowable tensile stress

n : number of rivet holes at the section

If rupture occurs in the undrilled section then the following expression can be applied:

$$F_t = LhS_t \tag{8.4}$$

Where

L : width of plate

d) Tearing and shearing of the margin, see fig.(8.3e) and fig.(8.3g)

For the riveted joint to resist tearing and shearing of the margin, the margin (m), see fig.(8.2), is to be taken equal to 1.5 d for double shear and 2d for single shear.

Table (8.1) allowable stresses in structural riveting (psi)

Load carrying member	Type of stress	Rivet-driving power	Rivets acting in single shear	Rivets acting in double shear
Rolled steel, SAE 1020	Tension	18000	18000
Rivets, SAE1010	Shear	Power	13500	13500
	Shear	Hand	10000	10000
	Crushing	Power	24000	30000
	Crushing	Hand	16000	20000

Rivet alloy	Procedure of driving	Allowable stresses	
		Shear (psi)	Bearing (psi)
2S (pure aluminium)	Cold as received	3000	7000
17S	Cold immediately after quenching	10000	26000
17S	Hot, 930 F to 950 F	9000	26000
61S-TS	Cold as received	8000	15000
53S	Hot, 960 F to 980 F	6000	15000

Design procedure for structural joints:

The following sequence of steps applies to the calculations for structural joints:

- The load transmitted by each member is determined analytically or graphically
- The shape and size of each member is determined from the magnitude of the load that it takes.
- The diameter of the rivets is determined by the thickness of the structural shapes apply the equation:

$$d = \sqrt{2h} - \frac{1}{16}$$

- The number of rivets required in each member is based upon the shearing or crushing stress which ever determine the cause of failure.
- The rivets in the joint are spaced and arranged in such a manner as to utilize the material in the most economical way avoiding eccentric loading as far as possible
 - Pitch limit: $16h \geq p \geq 3d$, where h is the thickness of the thinnest plate used in the joint.
 - The margin of the edge parallel to the load $m1 \geq 1.5d$
 - The margin of the edge normal to the load $m2 \geq 2d$

Example:

Fig.(3) shows a lap riveted joint, consists of two Rolled steel plates, SAE 1020, of 0.5 in thickness. The plates are riveted together with **four** rivets 0.375 inch in diameter of low carbon steel, SAE 1010. Estimate the maximum value of the force F that the joint can stand while considering a factor of safety equals 2 and the rivets are driven by hand hammer.

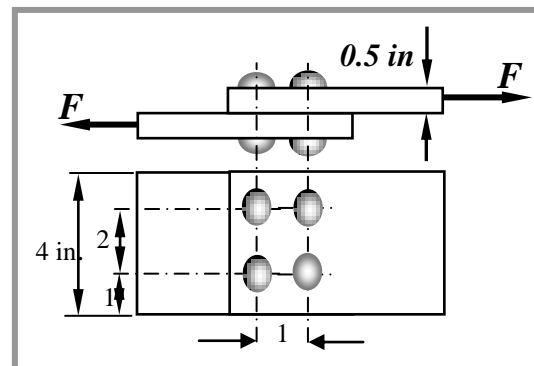


Fig. (3)

