Tension Members.

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3.1- INTRODUCTION

Where do we use?

Tension members are found in bridge and roof trusses, towers, and bracing systems, and in situations where they are used as tie rods. The selection of a section to be used as a tension member is one of the simplest problems encountered in design. As there is no danger of the member buckling, the designer needs to determine only the load to be supported, as previously described in Chapter 2.

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CHAPTER D

DESIGN OF MEMBERS FOR TENSION

This chapter applies to members subject to axial tension.

The chapter is organized as follows:

Chapter D various parts for tension members

D2. TENSILE STRENGTH

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The design tensile strength, $\phi_t P_n$, and the allowable tensile strength, P_n/Ω_t, of tension members shall be the lower value obtained according to the limit states of tensile yielding in the gross section and tensile rupture in the net section.

(a) For tensile yielding in the gross section

Tensile yielding

$$P_n = F_y A_g \tag{D2-1}$$

$$\phi_t = 0.90 \text{ (LRFD)} \qquad \Omega_t = 1.67 \text{ (ASD)}$$

(b) For tensile rupture in the net section

Tensile rupture

$$P_n = F_u A_e \tag{D2-2}$$

$$\phi_t = 0.75 \text{ (LRFD)} \qquad \Omega_t = 2.00 \text{ (ASD)}$$

where

A_e = effective net area, in.^{2} (mm^2)
A_g = gross area of member, in.^{2} (mm^2)
F_y = specified minimum yield stress, ksi (MPa)
F_u = specified minimum tensile strength, ksi (MPa)

D3. EFFECTIVE NET AREA

Effective net area

The gross area, A_g, and net area, A_n, of tension members shall be determined in accordance with the provisions of Section B4.3.

The effective net area of tension members shall be determined as

$$A_e = A_n U \quad \text{(D3-1)}$$

→ Shear lag factor

where U, the shear lag factor, is determined as shown in Table D3.1.

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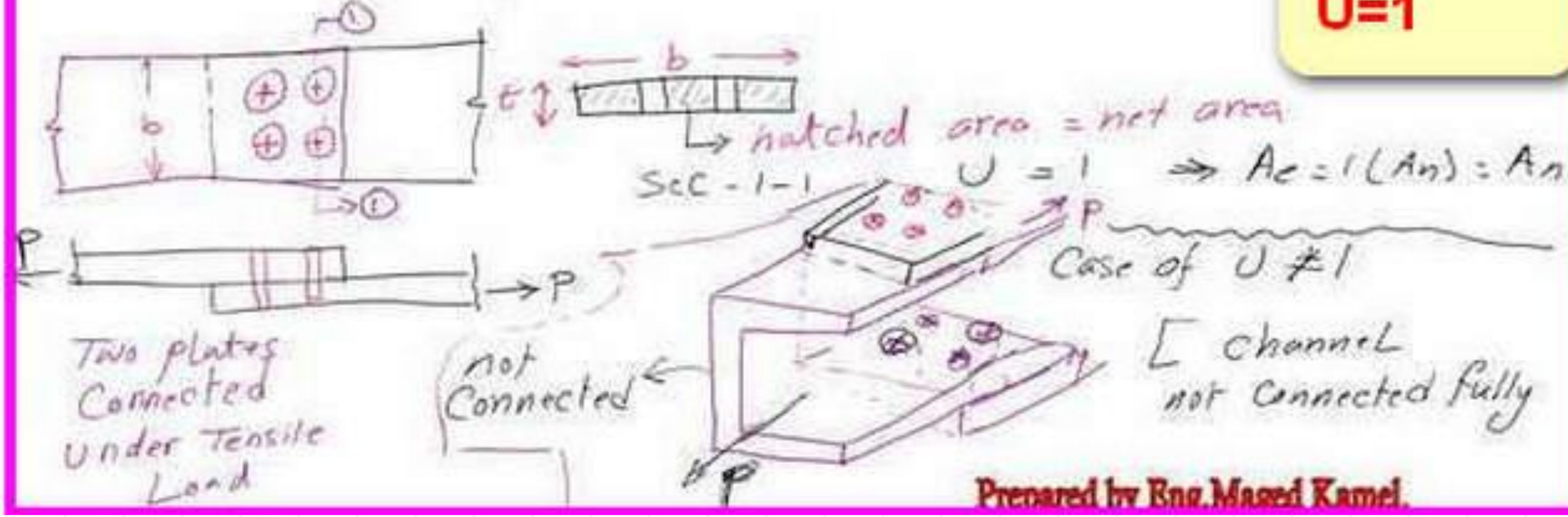
$$A_e = A_n U$$

where U, the shear lag factor, is determined as shown in Table D3.1.

case of U=1



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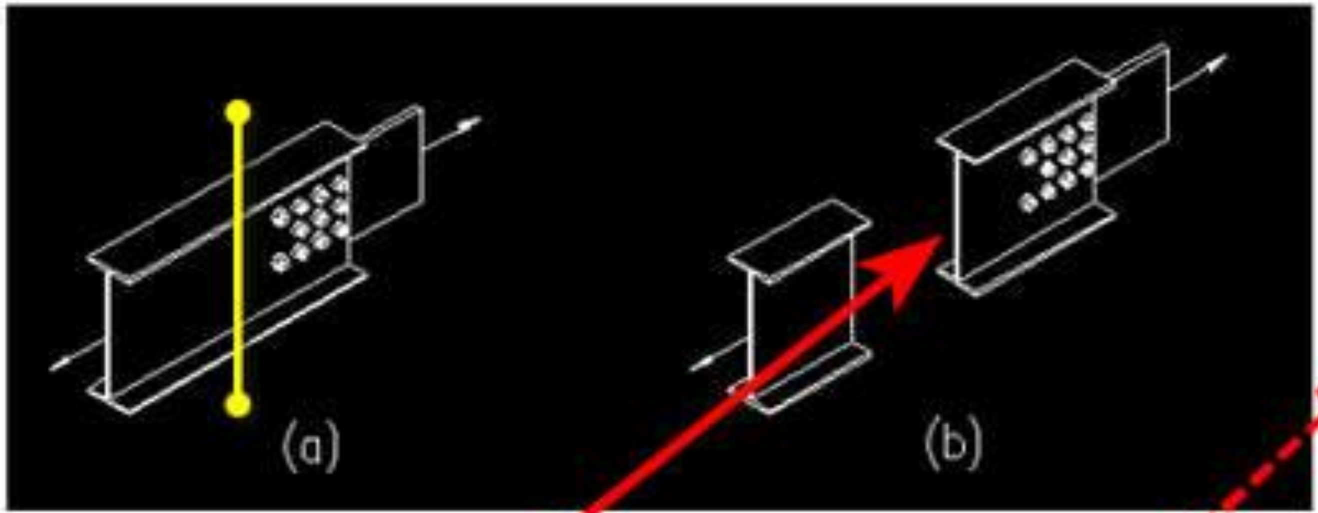
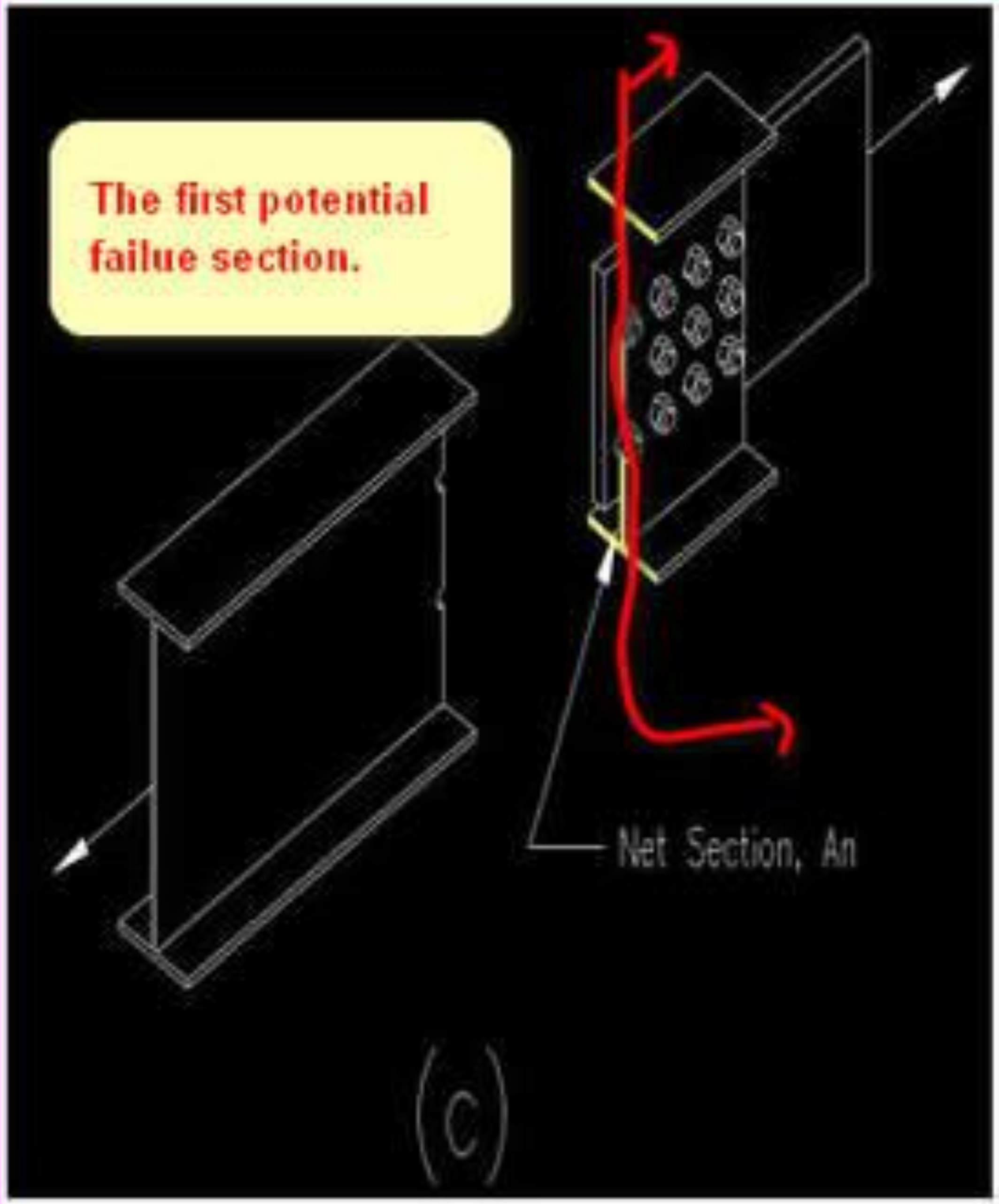


a - original shape

Section is away from connection

1

Tension yielding is illustrated in Figure 3.1.1(b). This failure mode looks at yielding on the gross cross sectional area, A_g, of the member under consideration. Consequently, the critical area is located away from the connection as shown. Strength of the section equals the *gross area*, A_g, times the *minimum yield stress*, F_y, of the member.



1

Tensile rupture occurs in the next section of the W section at the connection. In this case we have two potential failure paths that see the full force of the member. These are shown in Figures 3.1.1(c) and 3.1.1(d). It is common to have multiple potential failure paths. Each valid path must be investigated. Tensile rupture is complicated by the need to get the forces out of the flanges, through the web, and into the bolts. This means that we need to account for the stress concentrated in and around the bolts. This will be discussed in further detail later. The capacity of each failure path equals the *effective net area*, A_e, times the *tensile stress*, F_u, of the member.

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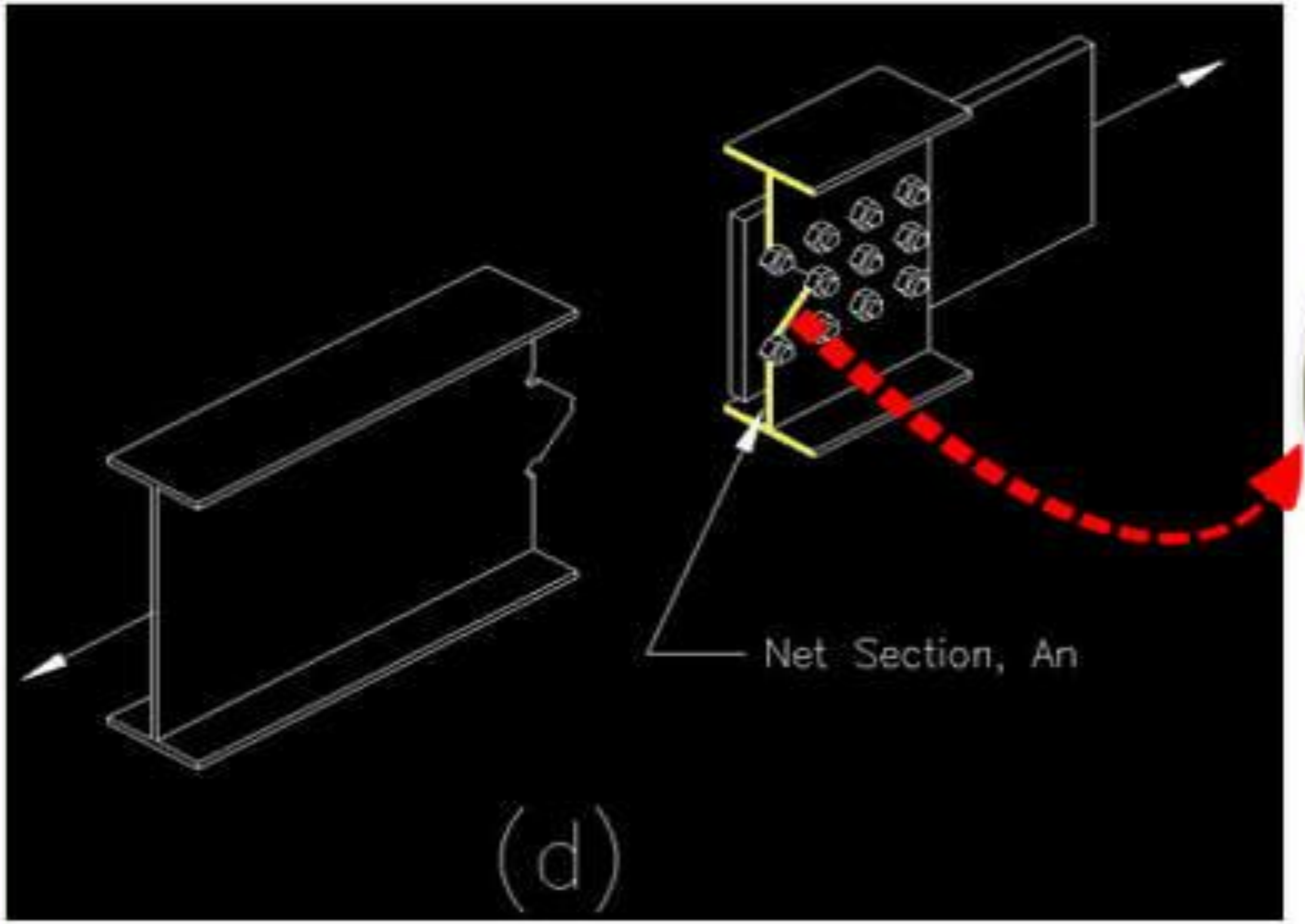
Tensile rupture by Zigzag Line



The second potential failure line.

Add 1/8 inches to db due to punching damage.

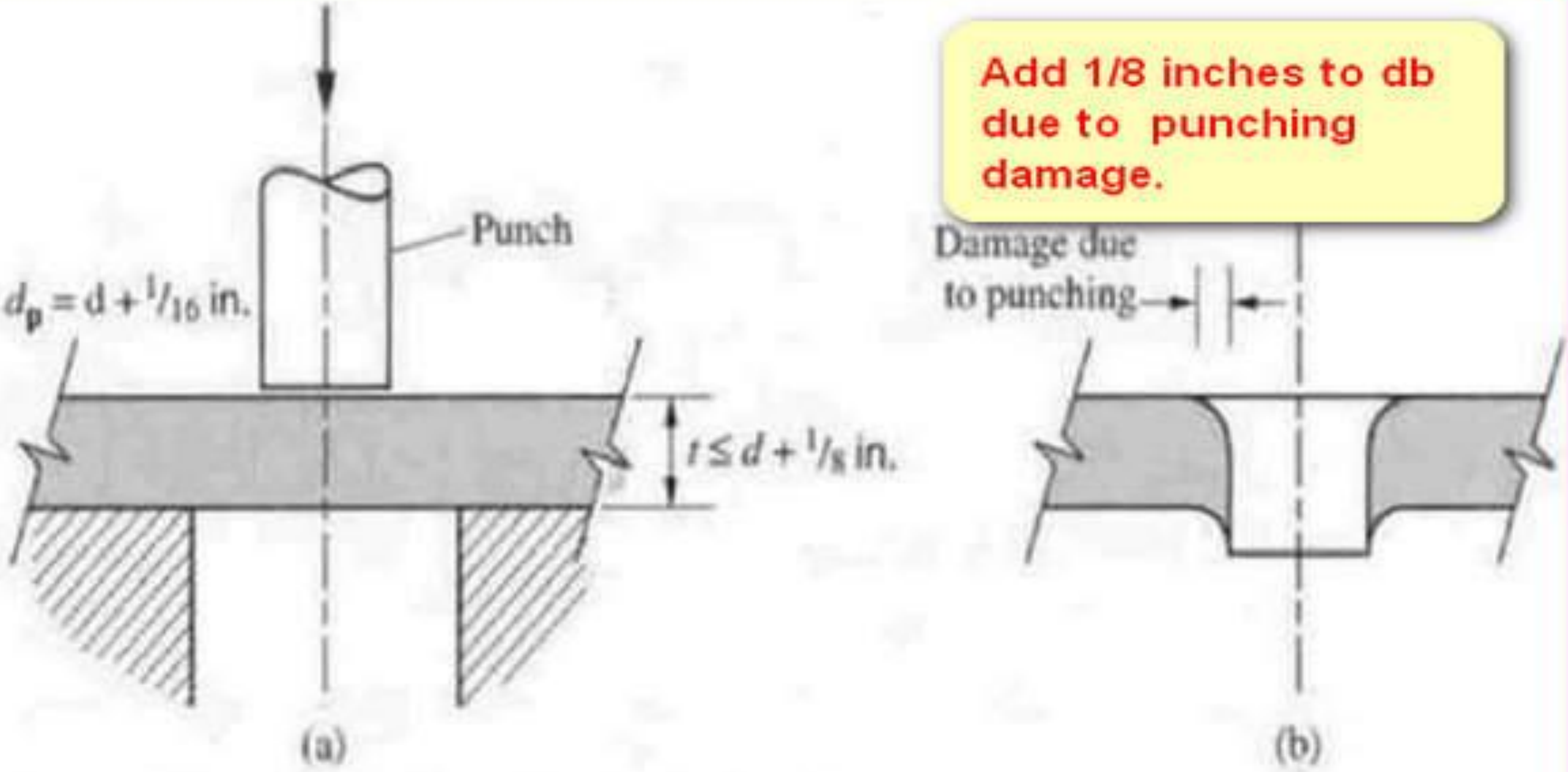


Figure 4.12 Damage Caused by Hole Punching.

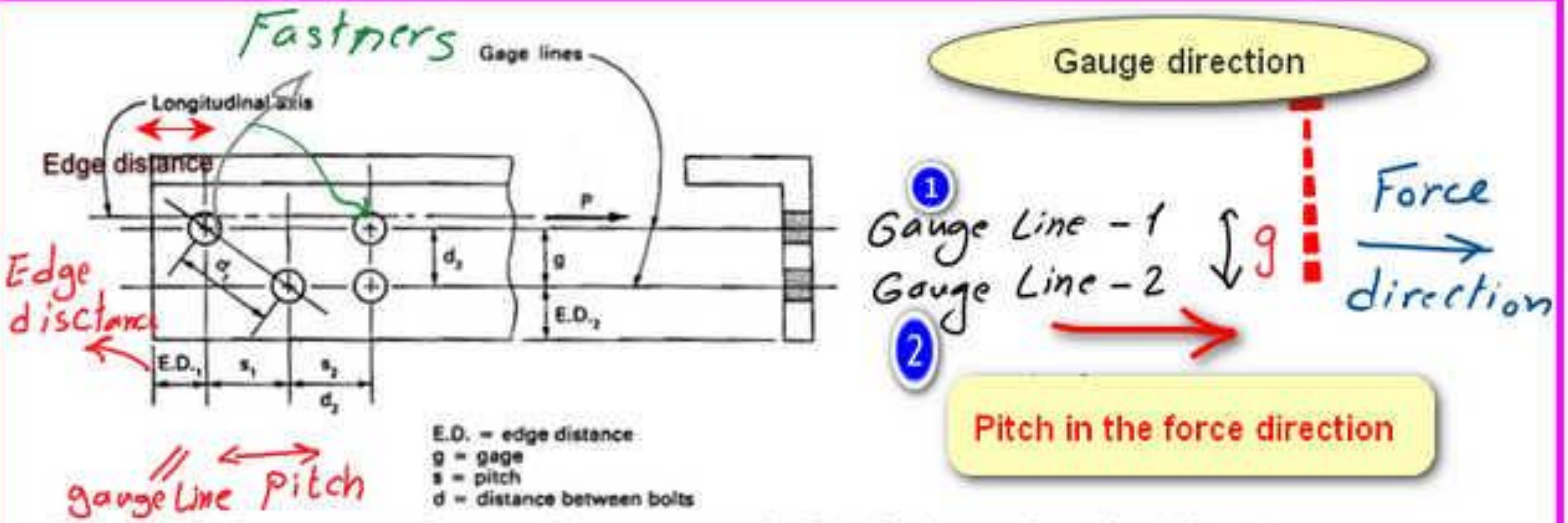


Figure 2-3 shows a tension member composed of a single steel angle with a 4-bolt connection. The tensile load P is assumed to be applied parallel to and coincident with the longitudinal axis of the member. The bolt holes are located on *gage lines* that are also parallel to the longitudinal axis. The dimension g between the gage lines is called the *gage*. The dimension s parallel to the gage line and taken between centers of bolt holes is called the *pitch* (or the *bolt spacing*). The *distance between bolts* is a straight line distance between any two bolts. The *edge distance* is the perpendicular distance from the *center of a hole* to the nearest edge.