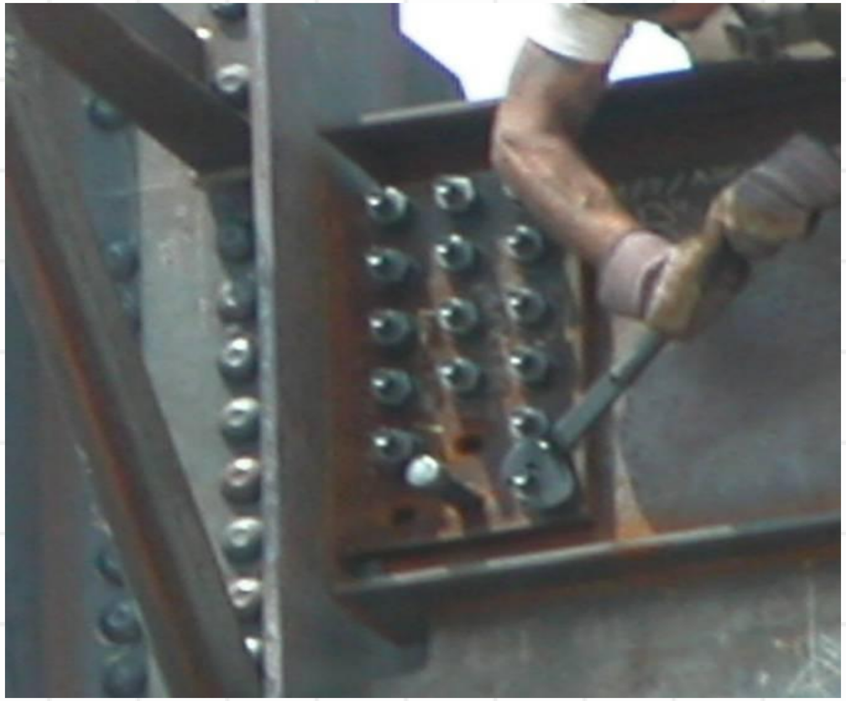
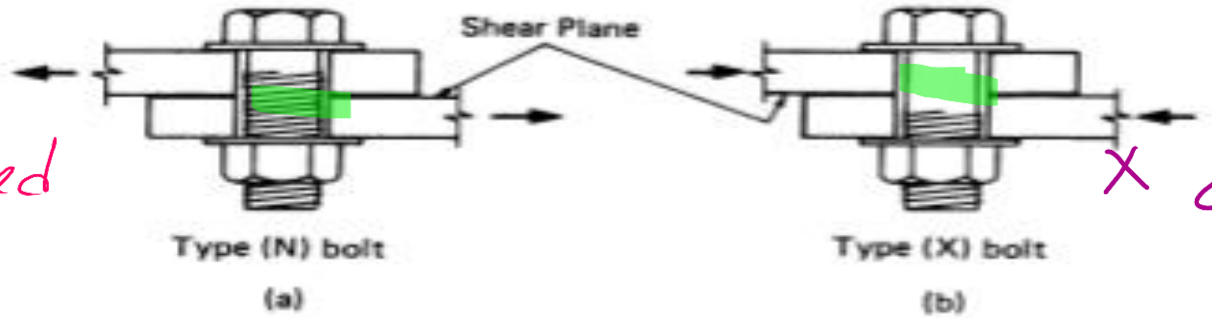


- There two basic bolted joint types:
    - Bearing
        - The load is transferred between members by bearing on the bolts
    - Slip-critical
        - The load is transferred between members by friction in the joint

shear plane

N - included

Bearing Connection



X Excluded Not in shear plane

shear Plane

Fig. 5.1. Bearing-type connections of high-strength bolts: (a) for bolts with threads included in shear plane and (b) for bolts with threads excluded from shear plane.

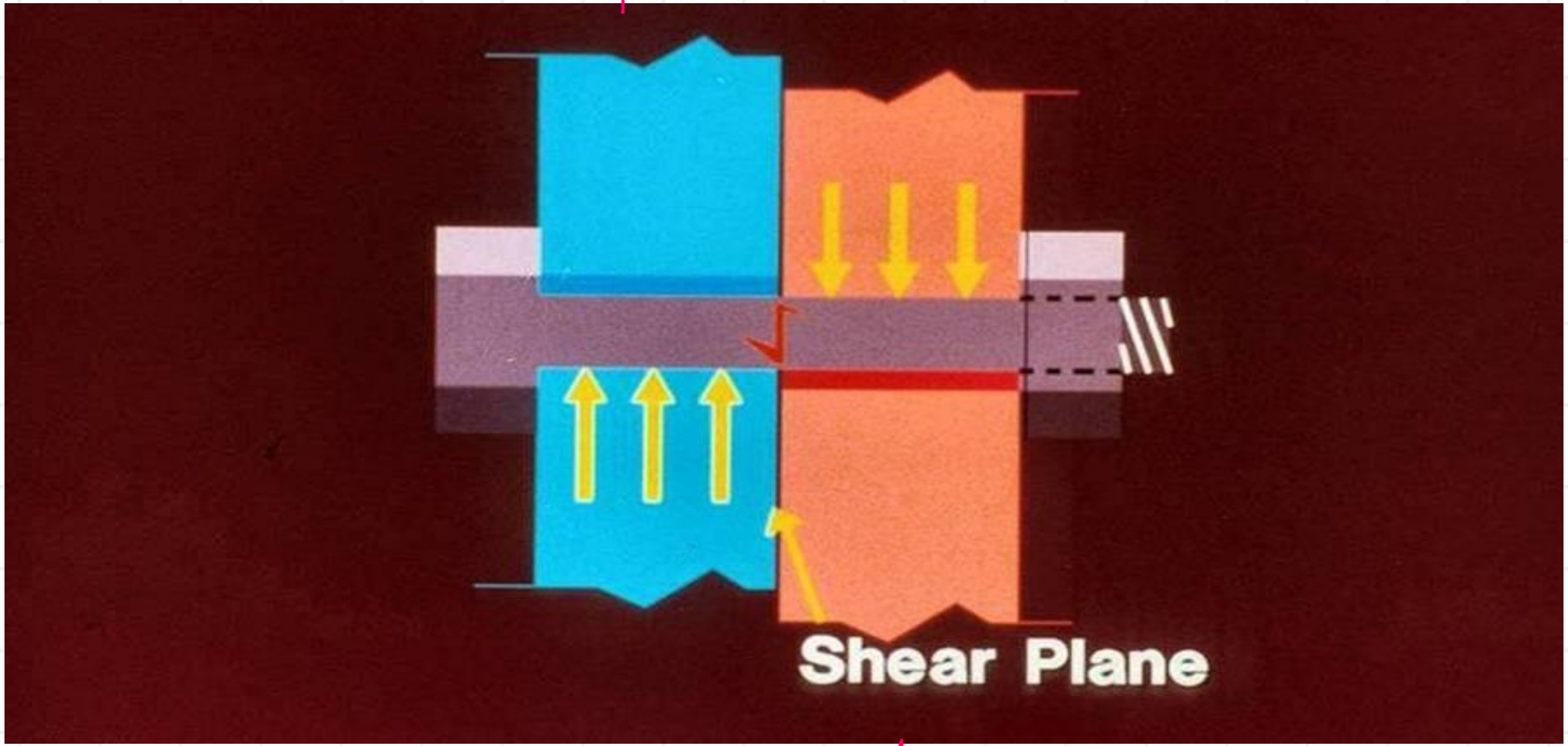
-N	This symbol indicates that the connection is a "bearing-type" connection and the bolts are installed such that threads may be included in the shear plane(s). There definitions for these terms are found in the following sections.
-X	This symbol indicates that the connection is a 'bearing-type" connection and the bolts are installed such that threads must be excluded in the shear plane(s)
-SC	This symbol indicates that the connection is considered to be slip critical. This means that the contact (faying) surfaces must meet particular requirements so as to ensure an adequate coefficient of static friction (See SCM pg 7-5 for more detail).

For example, an A325-X bolt would be a bolt made from A325 steel and would be installed such that the threads are excluded from any shear plane(s).

A A490-SC bolt is a bolt made from A490 steel and would be installing on a slip critical connection where the faying surfaces must meet special requirements.

Bearing Joints

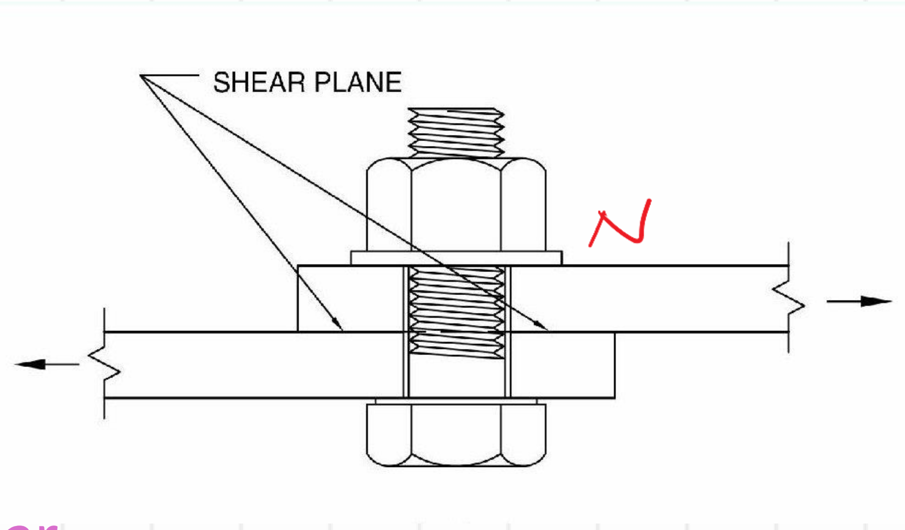
Load



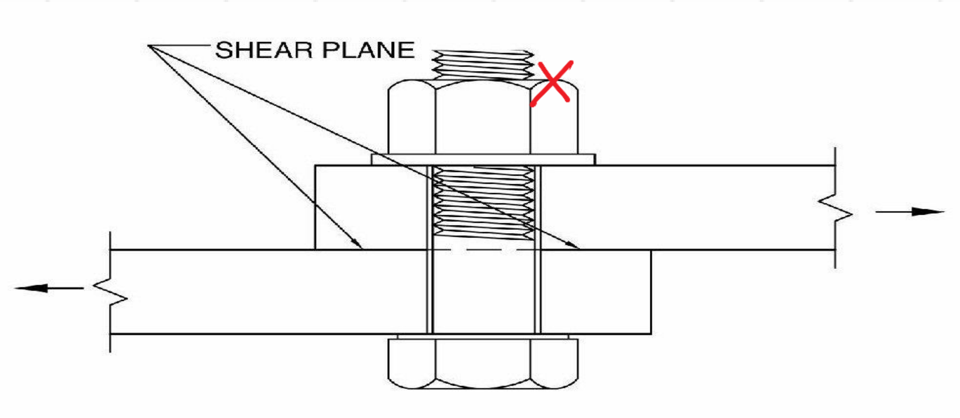
acting Load

Threads in the Shear Plane

- The shear plane is the plane between two more pieces under load where the pieces ter to move parallel from each other, but opposite directions
- The threads of a bolt may either be included the shear plane or excluded from the shear plane
- The capacity of a bolt is greater with th threads excluded from the shear plane
- The most commonly used bolt is an ASTI A325 3/4” bolt with the threads included i the shear plane (AISC & NISD 2000)



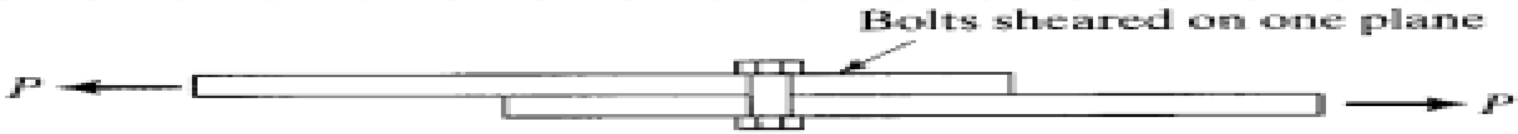
Threads Included In The Shear Plane



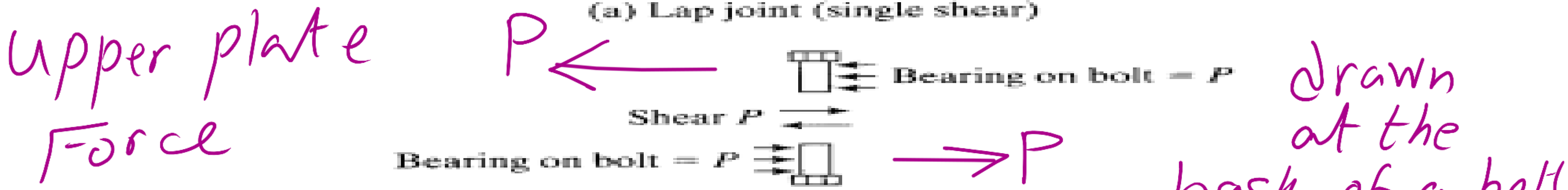
Threads Excluded From The Shear Plane

For this initial discussion, the reader is referred to part (a) of Fig. 12.1. It is assumed that the plates shown are connected with a group of snug-tight bolts. In other words, the bolts are not tightened sufficiently so as to significantly squeeze the plates together. If there is assumed to be little friction between the plates, they will slip a little due to the applied loads. As a result, the loads in the plates will tend to shear the connectors off on the plane between the plates and press or bear against the sides of the bolts, as shown in part (b) of the figure. These connectors are said to be in *single shear and bearing* (also called *unenclosed bearing*). They must have sufficient strength to satisfactorily resist these forces, and the members forming the joint must be sufficiently strong to prevent the connectors from tearing through.

When rivets were used instead of the snug-tight bolts, the situation was somewhat different because hot-driven rivets would cool and shrink and then squeeze or clamp the connected pieces together with sizable forces that greatly increased the friction



(a) Lap joint (single shear)



(b) Load transfer in lap joint

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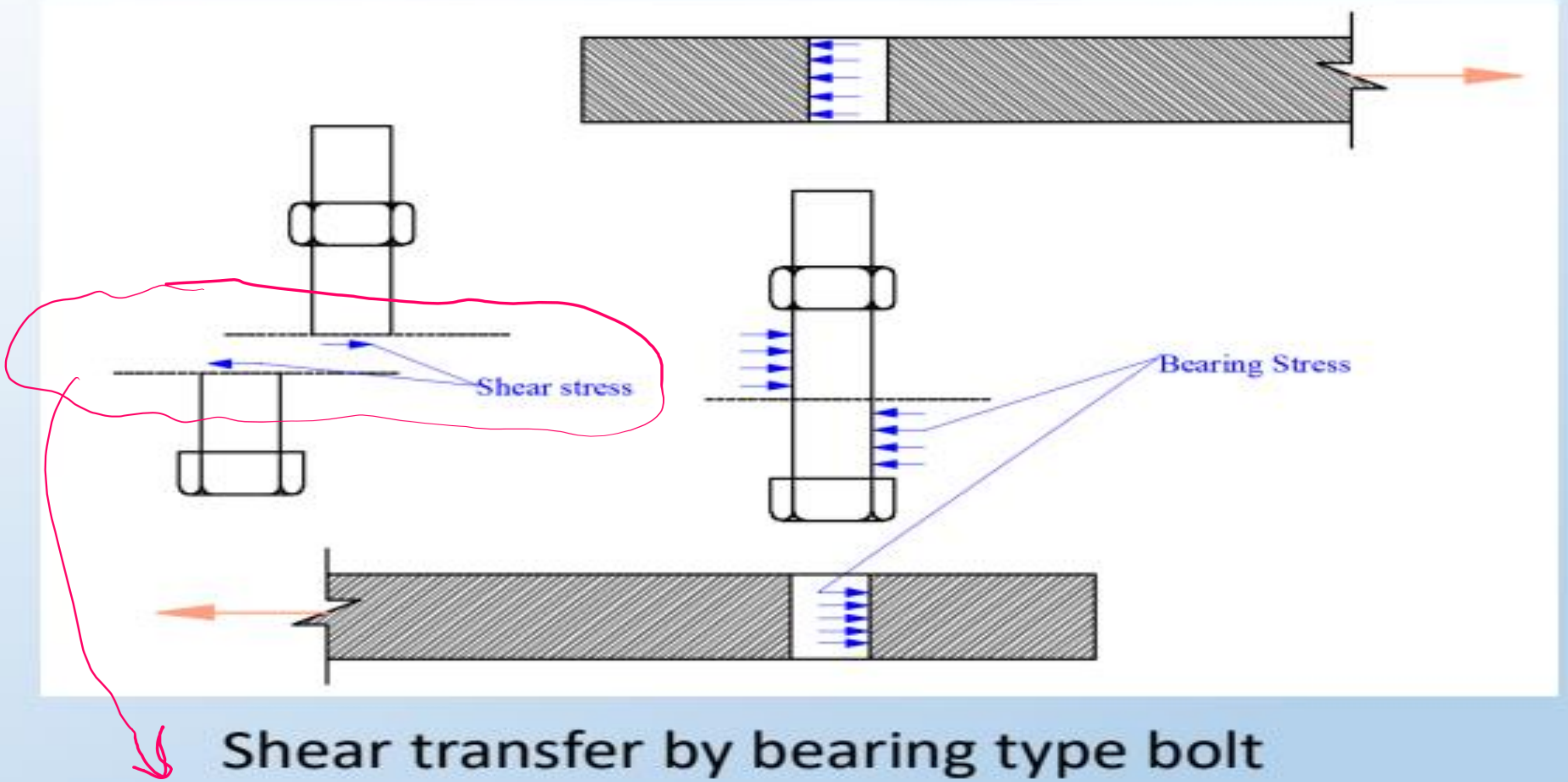


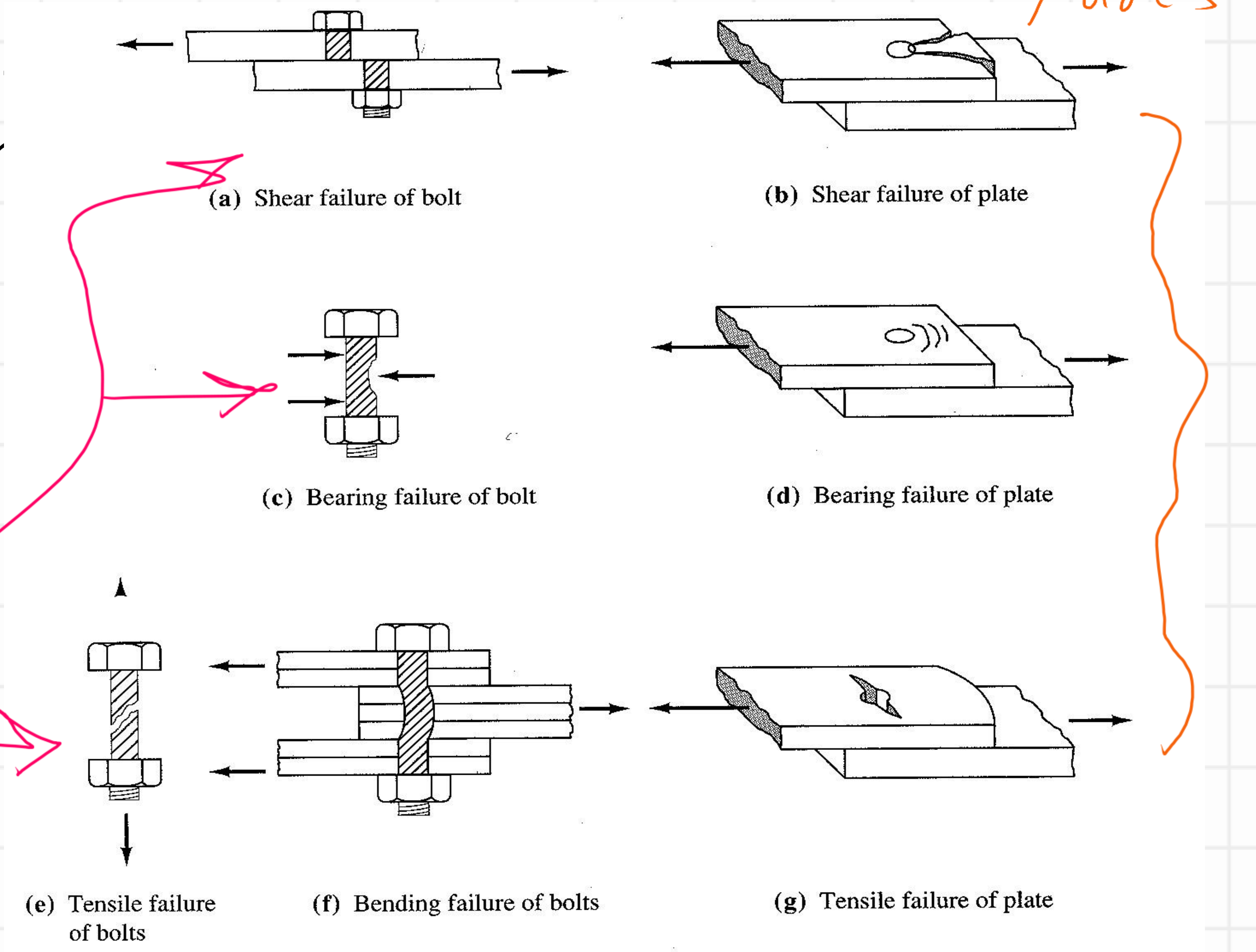
Shear transfer by bearing type bolt

Failure Mode of Bolted Shear Connections

Two types of bolted connec
failure are considered in th
section

- Failure of the connector
- Failure of the connected parts

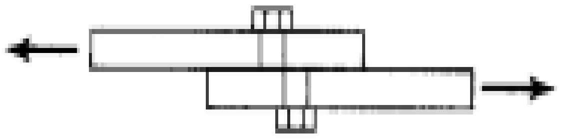
Bolt (Connector)



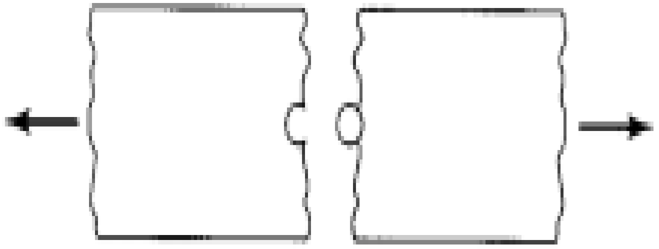
12.11 FAILURE OF BOLTED JOINTS

Figure 12.3 shows several ways in which failure of bolted joints can occur. To design bolted joints satisfactorily, it is necessary to understand these possibilities. These are described as follows:

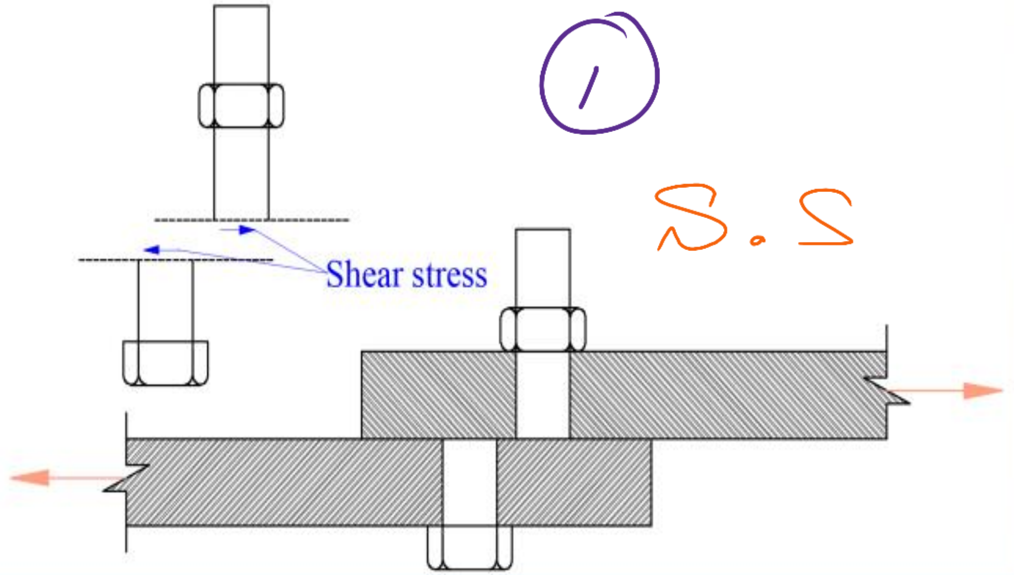
1. The possibility of failure in a lap joint by shearing of the bolt on the plane between the members (single shear) is shown in part (a).
2. The possibility of a tension failure of one of the plates through a bolt hole is shown in part (b).
3. A possible failure of the bolts and/or plates by bearing between the two is given in part (c).
4. The possibility of failure due to the shearing out of part of the member is shown in part (d).
5. The possibility of a shear failure of the bolts along two planes (double shear) is shown in part (e).



(a)



(b)



Design of Steel Structure

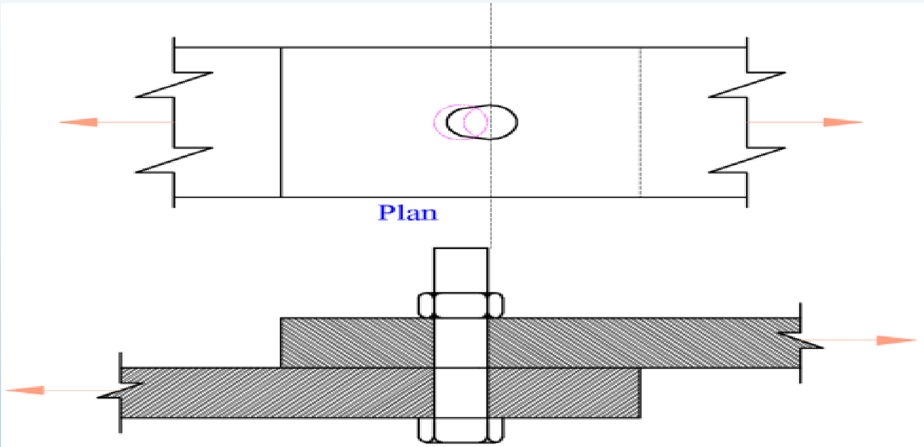


Fig 2: Shear failure of Plate.

Er. MD Abrar Aalam (Structural Engineer)

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Figure 12.3 shows several ways in which failure of bolted joints can occur. To design bolted joints satisfactorily, it is necessary to understand these possibilities. These are described as follows:

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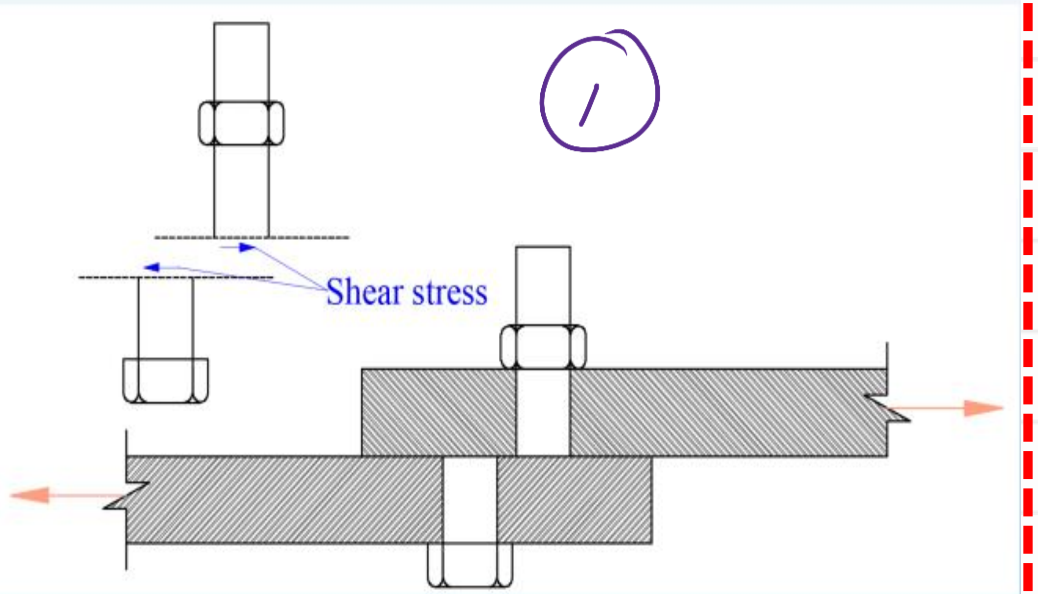
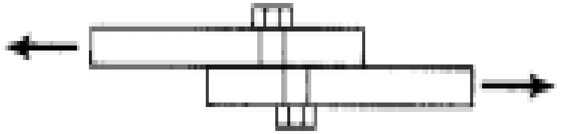
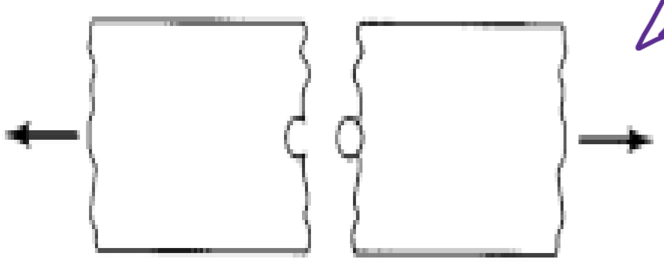




(a)



(b)

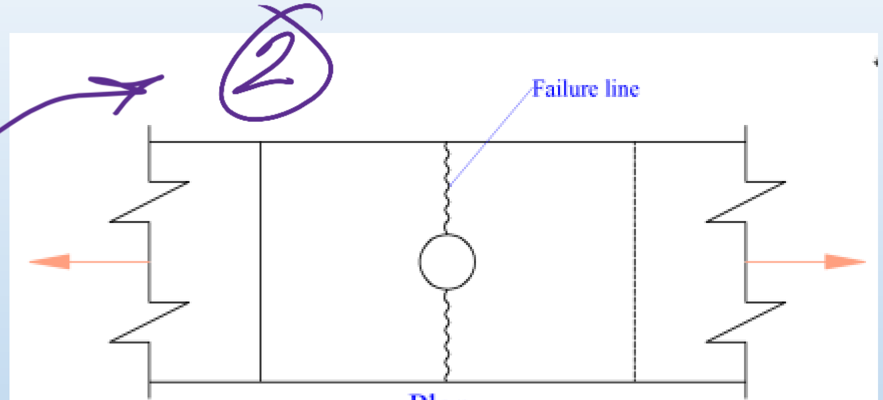


Fig 6: Tension failure of Plate.

3. A possible failure of the bolts and/or plates by bearing between the two is given in part (c).
4. The possibility of failure due to the shearing out of part of the member is shown in part (d).
5. The possibility of a shear failure of the bolts along two planes (double shear) is shown in part (e).

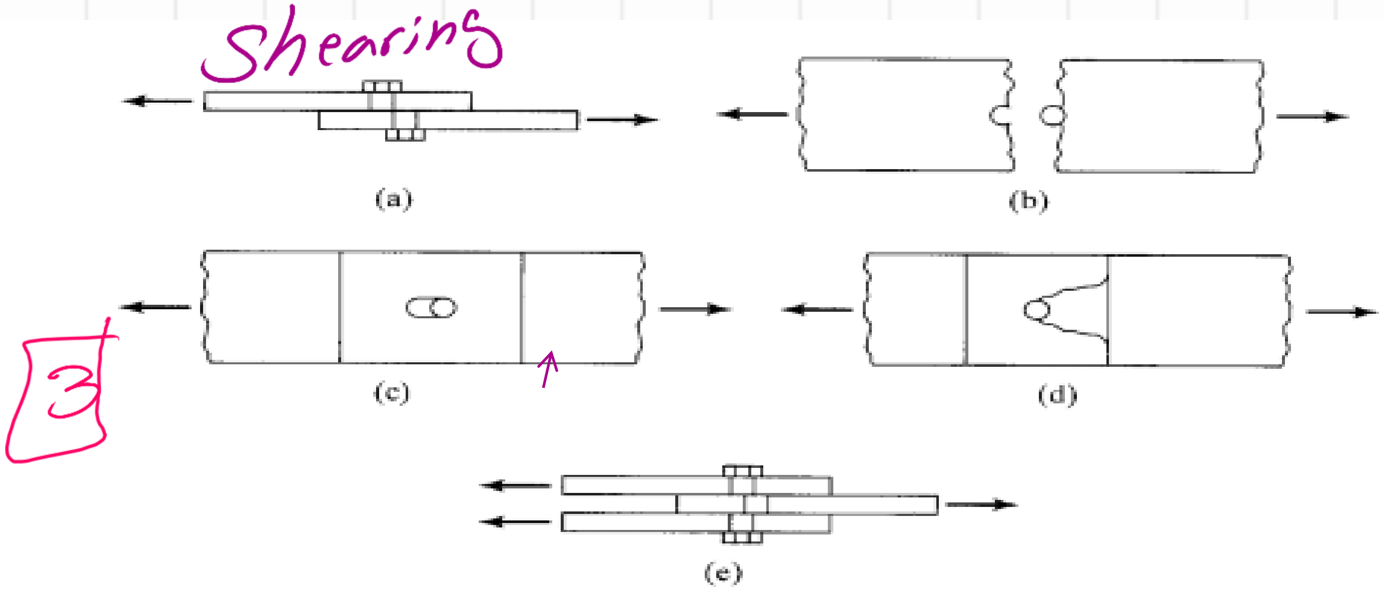


FIGURE 12.3

(a) Failure by single shearing of bolt. (b) Tension failure of plate. (c) Crushing failure of plate. (d) Shear failure of plate behind bolt. (e) Double shear failure of a butt joint.

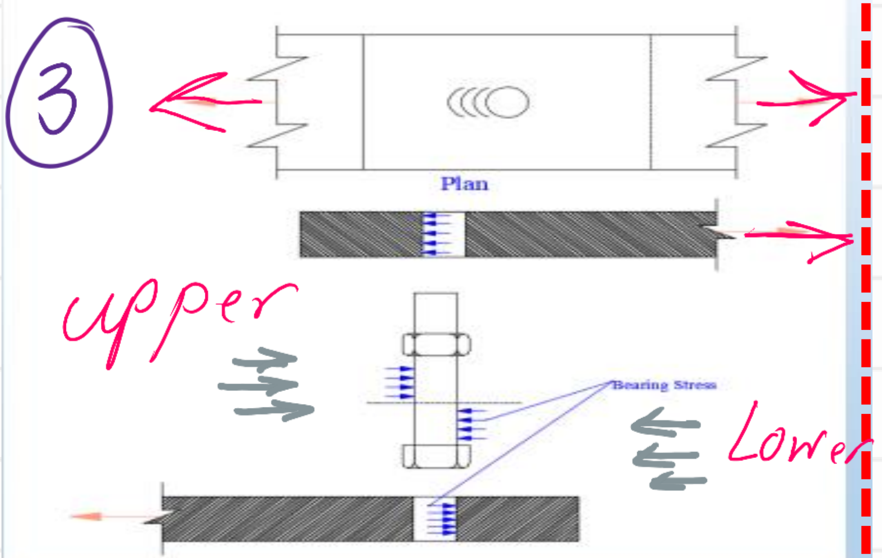


Fig 4: Bearing failure of Plate.

Design of Steel Structure

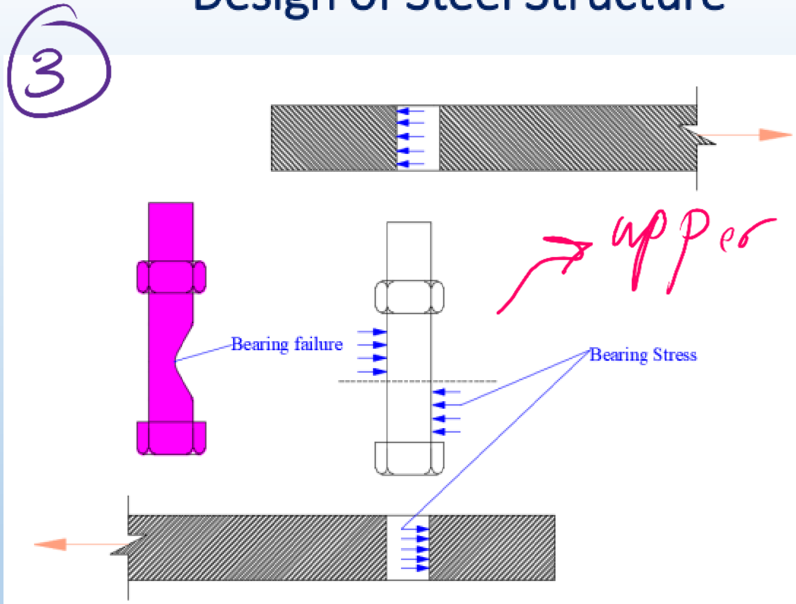


Fig 2: Bearing failure of Bolt.

3. A possible failure of the bolts and/or plates by bearing between the two is given in part (c).
4. The possibility of failure due to the shearing out of part of the member is shown in part (d).
5. The possibility of a shear failure of the bolts along two planes (double shear) is shown in part (e).

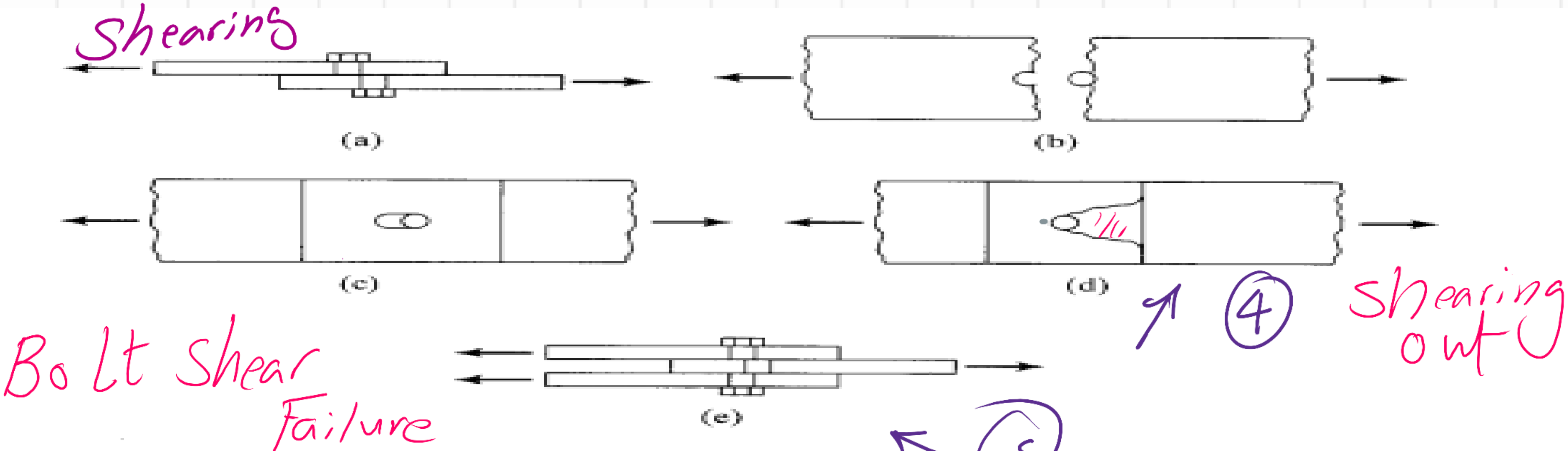


FIGURE 12.3

(a) Failure by single shearing of bolt. (b) Tension failure of plate. (c) Crushing failure of plate. (d) Shear failure of plate behind bolt. (e) Double shear failure of a butt joint.

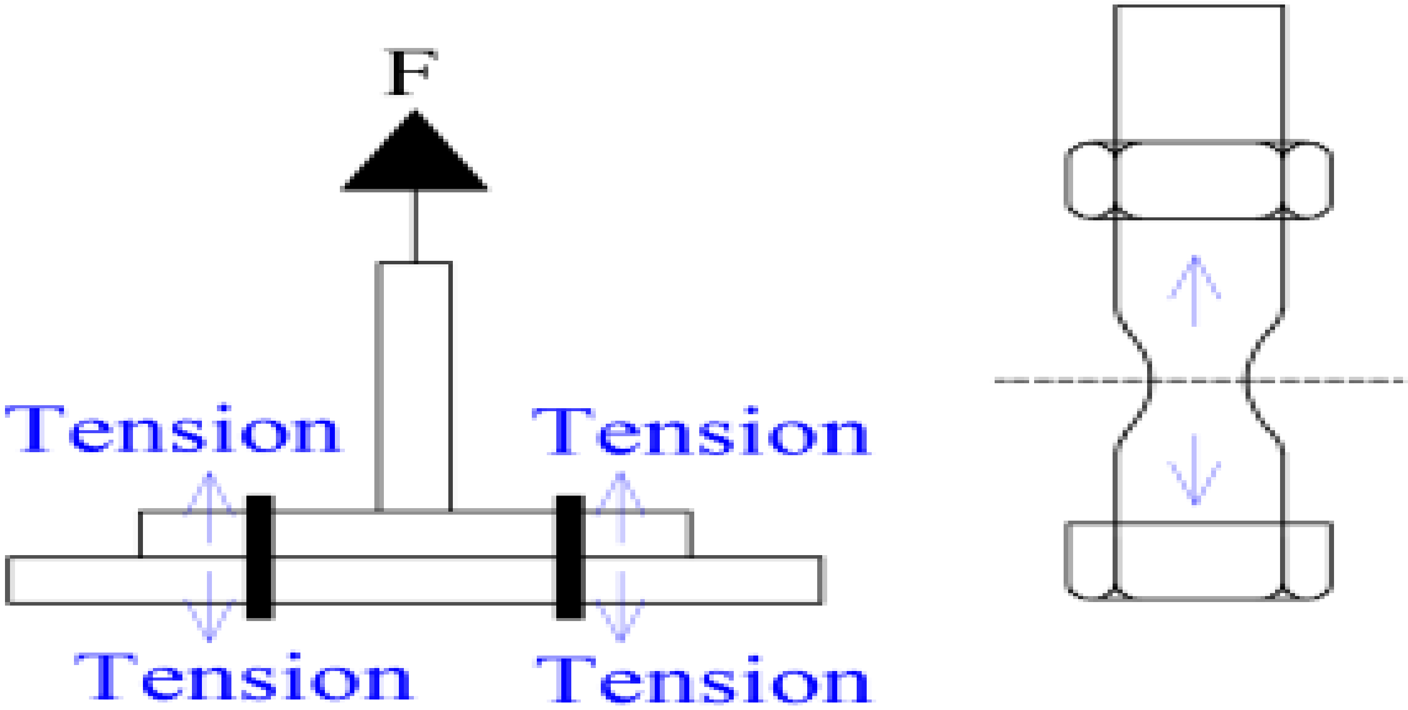
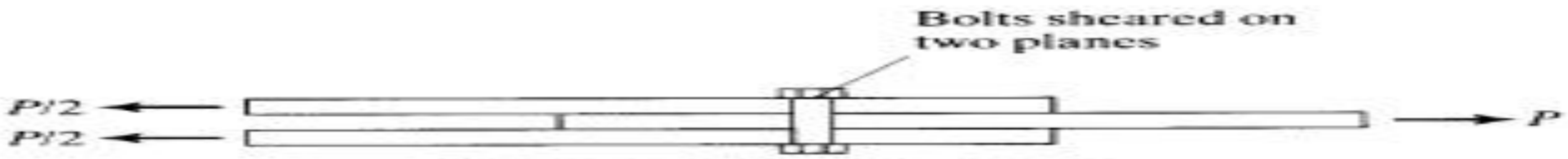
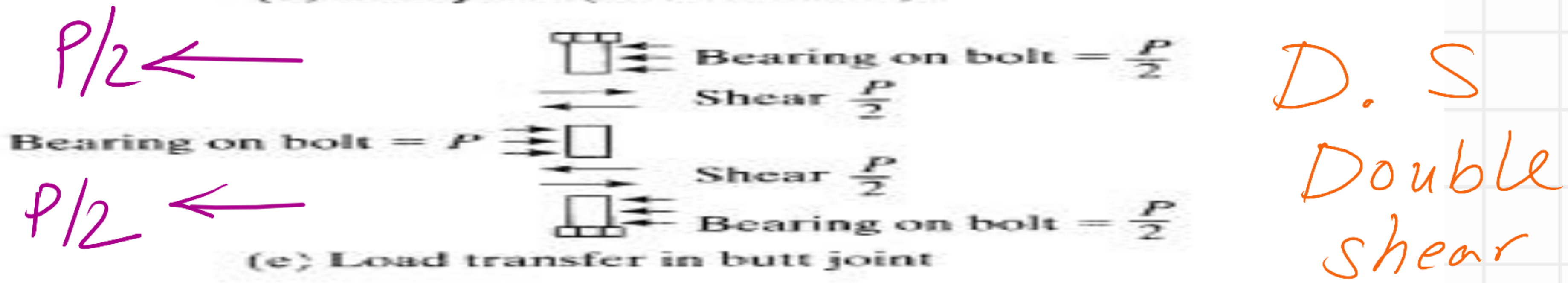


Fig 5: Tension failure of Bolt.



(d) Butt joint (double shear)



(e) Load transfer in butt joint

12.10.2 The Butt Joint

A *butt joint* is formed when three members are connected as shown in Fig. 12.1(d). If the slip resistance between the members is negligible, the members will slip a little and tend to shear off the bolts simultaneously on the two planes of contact between the members. Again, the members are bearing against the bolts, and the bolts are said to be in *double shear and bearing* (also called *enclosed bearing*). The butt joint is more desirable than the lap joint for two main reasons:

1. The members are arranged so that the total shearing force, P, is split into two parts, causing the force on each plane to be only about one-half of what it would be on a single plane if a lap joint were used. From a shear standpoint, therefore, the load-carrying ability of a group of bolts in double shear is theoretically twice as great as the same number of bolts in single shear.
2. A more symmetrical loading condition is provided. (In fact, the butt joint does provide a symmetrical situation if the outside members are the same thickness and resist the same forces. The result is a reduction or elimination of the bending described for a lap joint.)

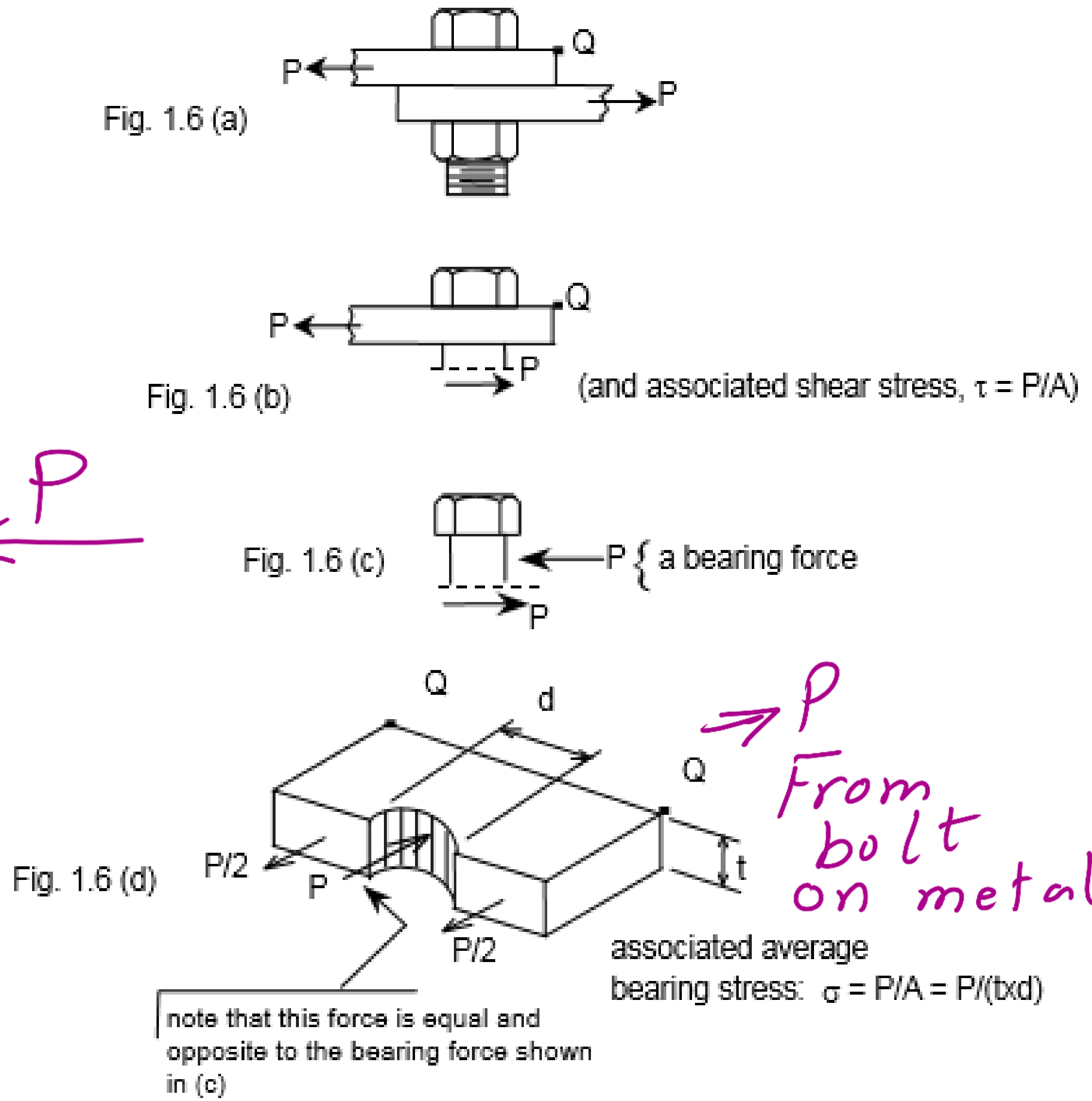


Fig.1.6 Bolt Forces and Bearing in Plate

P

P

From bolt on metal

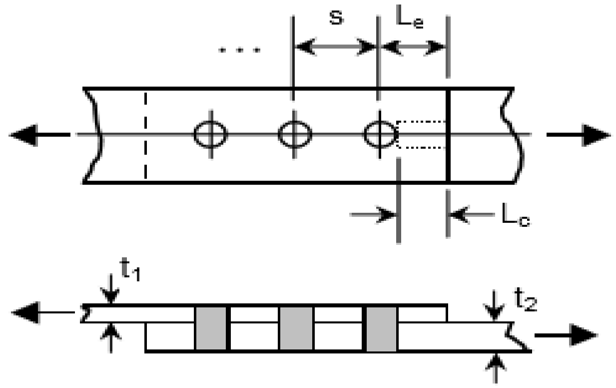


Fig. 5.4 Bearing Nomenclature

t is the thinner of t_1 & t_2

- In a bearing joint the connected elements are assumed to slip into bearing against the body of the bolt.
- If the joint is designed as a bearing joint the load is transferred through bearing whether the bolt is installed snug-tight or pretensioned. (AISC)