

Types of Failure in Bolted Connections

In a bolted connection either the connecting plate might fail or the bolt might fail. Therefore, it becomes important to consider the "Limit States" or failure modes of both bolt and the plate. Possible limit states by which a bolted connection might fail are mentioned below.

Failure Modes of Bolts in a Bolted Connection

- Shear Failure of Bolts
- Bearing Failure of Bolts
- Tensile Failure of Bolts

Failure Modes of Plate in a Bolted Connection

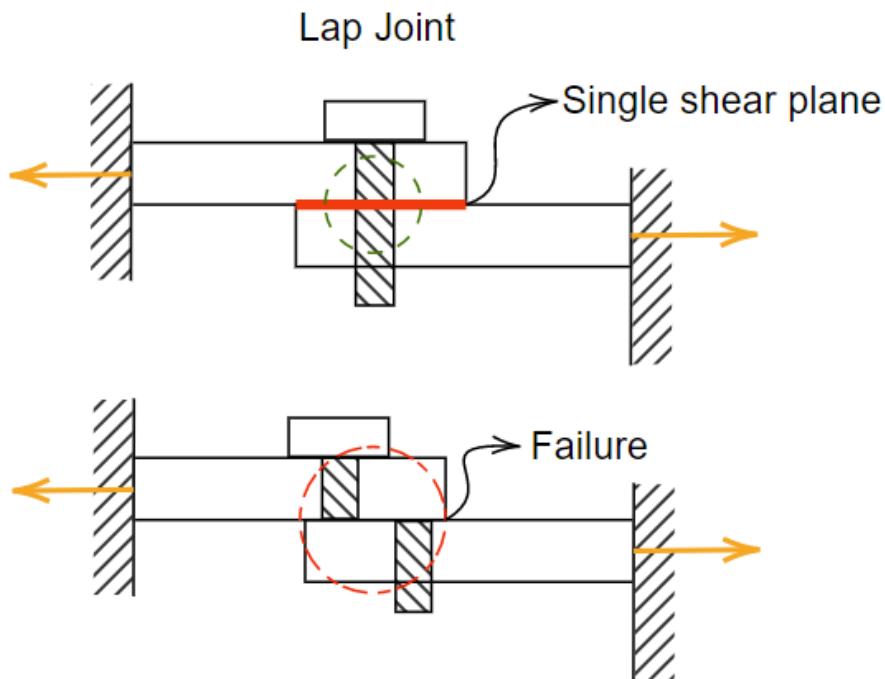
- Shear Failure of Plate
- Bearing Failure of Plate
- Tensile Failure of Plate

1. Shear Failure of Bolts

As the name suggests, this failure occurs due to shear force at the interface of surfaces in a joint. Depending on the number of shear surfaces there are two types of shear failure that could occur in a bolted connection, namely, the single shear failure and double shear failure.

Single Shear Failure

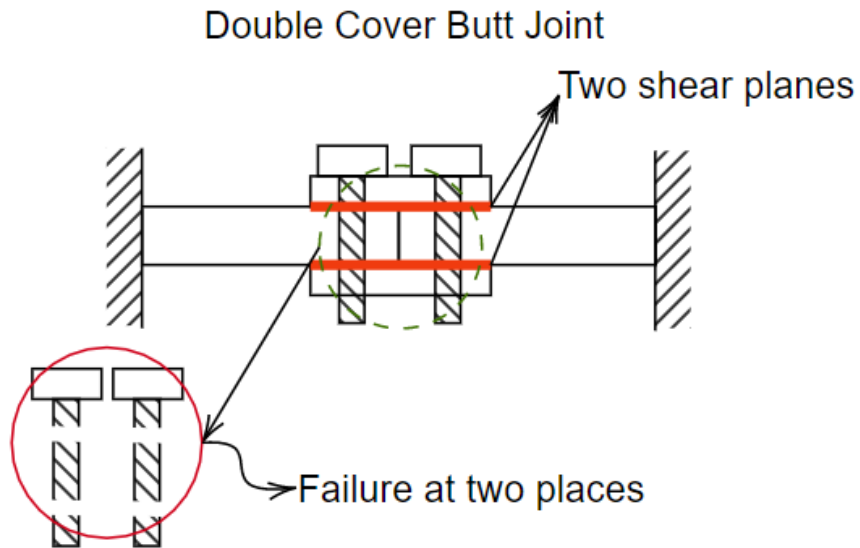
Here, the bolt is subjected to a single shear force which could cause the failure of the bolt. This type of failure occurs in single cover butt joint and lap joint.



Single shear failure of bolt in a lap joint

Double Shear Failure

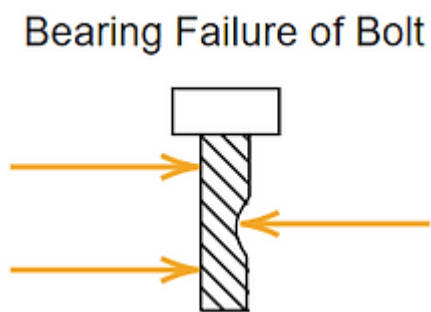
Here, the bolt is subjected to two shear forces at two separate shear planes. This type of failure occurs in the double cover butt joint.



Double shear failure of bolt in double cover butt joint

2. Bearing Failure of Bolts

In this failure, the bolt fails in bearing due to contact with the plates. This type of failure occurs in cases where a low-strength bolt is used with a plate of very high grade, which usually doesn't occur in practice.

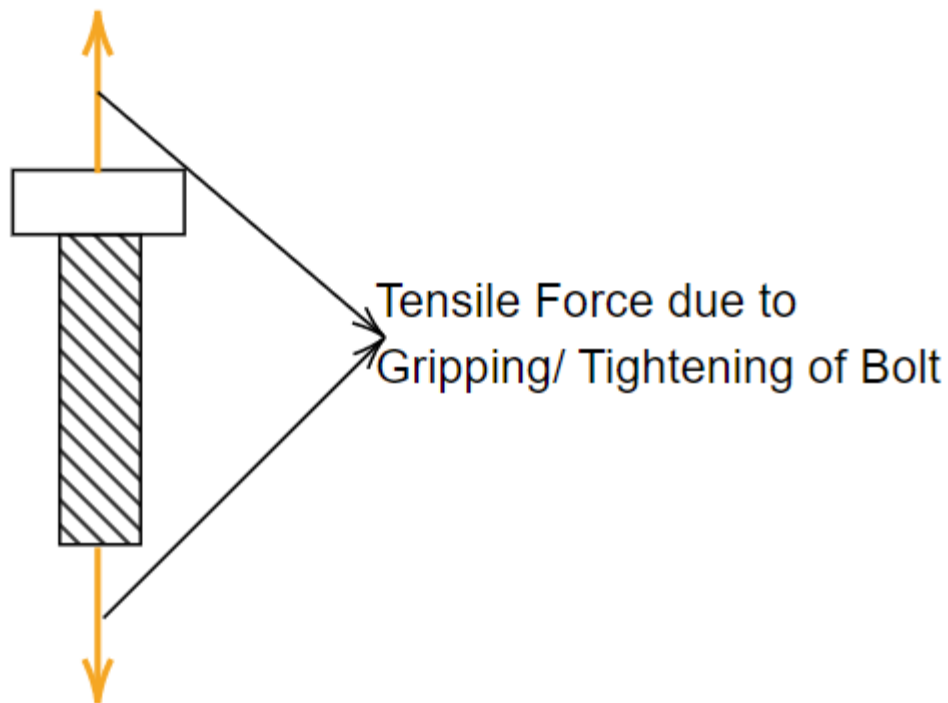


Bearing failure of bolt

3. Tensile Failure of Bolts

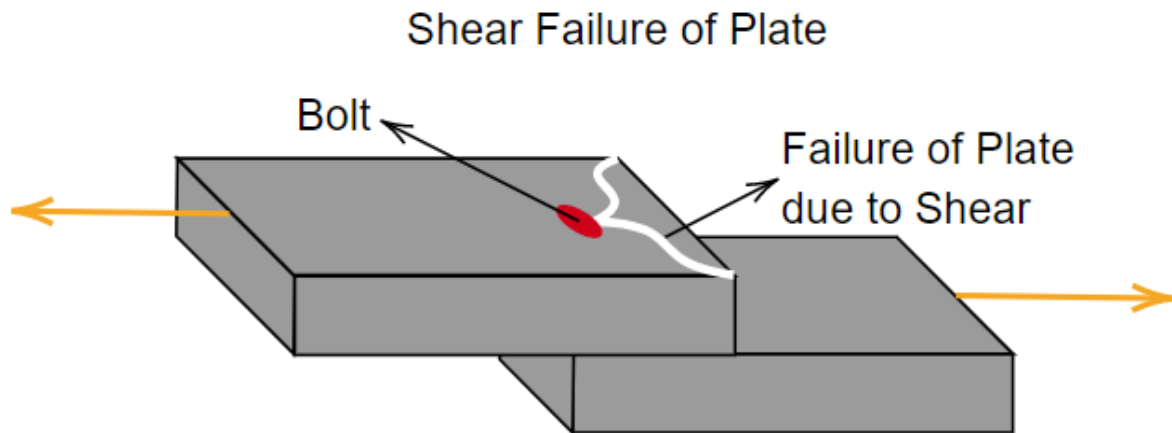
The tensile strength of the bolt is the amount of pull the bolt can withstand in the perpendicular direction to the plane of loading. If the pull on this perpendicular axis exceeds the tensile strength of the bolt, then the bolt will fail in tension.

Tensile Failure of Bolts



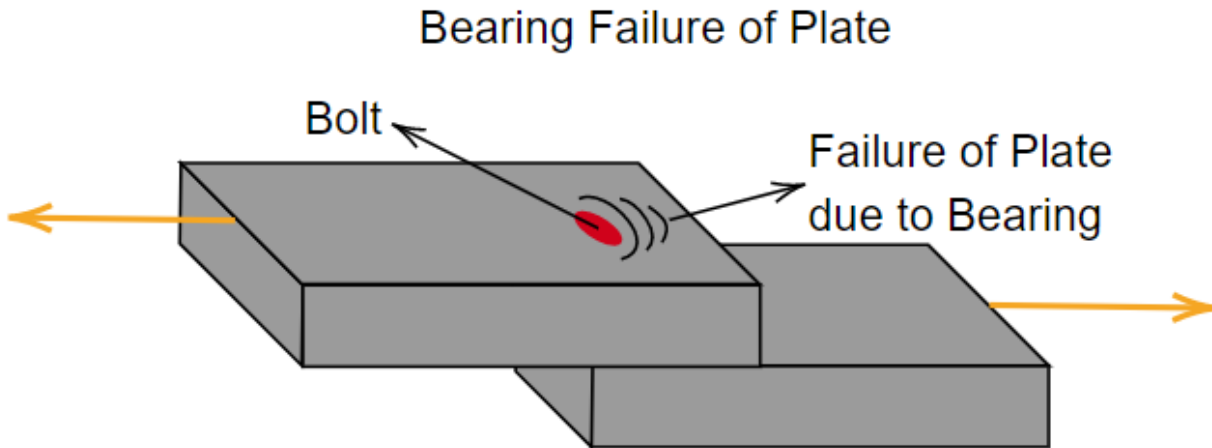
Tensile failure of bolt

4. Shear Failure of Plate



Shear failure of plate

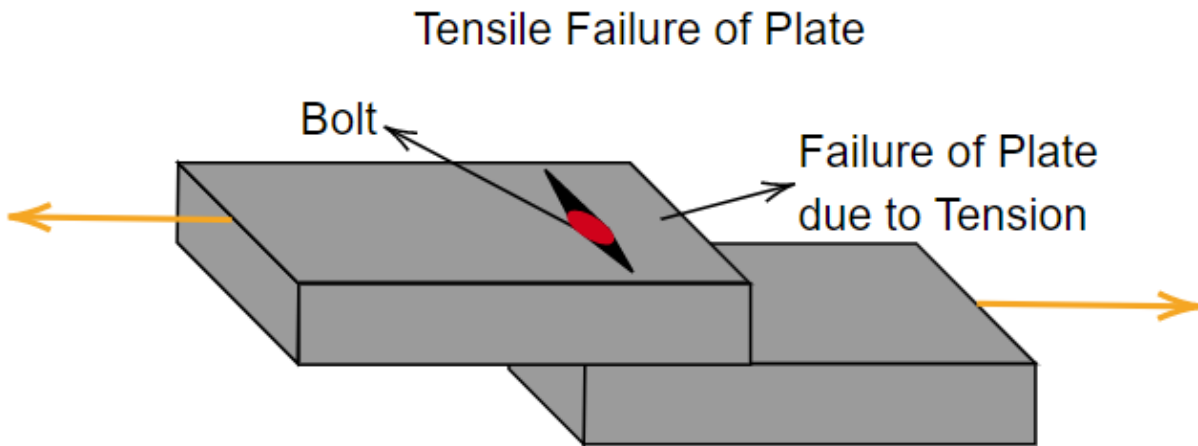
5. Bearing Failure of Plate



Both shear and bearing failure of the plate can be avoided by providing sufficient centre to centre distances between the bolts as mentioned in section 10 of [IS 800: 2007](#).

6. Tension Failure of Plate

Due to a reduction in the net area (i.e., due to bolt holes) of the plate along the bolt line, the tensile strength of the plate will be lesser than the actual value at this section. Because of this, the plate might fail under tension. Therefore, it becomes important to calculate the least net area among different bolt lines to find the least tensile strength of the plate and check it for safety for the applied load.



Tensile failure of plate