Lecture 26, Nov 16, 2021

Shear Stresses in Complex Shapes

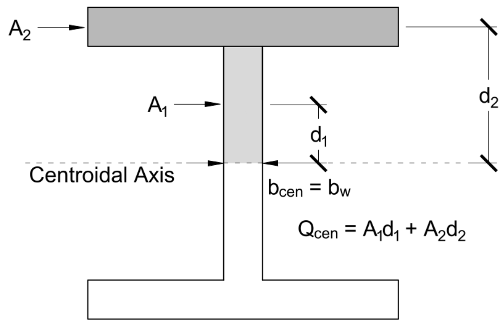

Figure 1: Calculation of sshear stresses in an I beam

- Jourawski's equation can still be used: $\tau = \dfrac{VQ}{Ib}$
- Q must now account for the geometry more carefully; complex shapes can be broken up into pieces, and $Q = \sum_{i=1}^{n} A_i d_i$, where A_i is the area of each piece and d_i are the distance between the centroid of the piece and the centroid of the cross-section
  - While A is always positive, d is signed
  - However in the end Q will always be positive since we don't care about the direction of shear stress
- b is the width of the cross section at the location of interest
- Since Q can be calculated from either the top or the bottom, we can do either one; it's not always the easiest to calculate Q from the side it's the closest to
- Q has units of mm^3

Glued Components

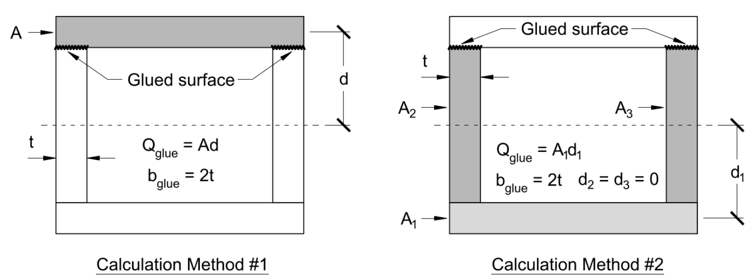

Figure 2: Calculating shear stresses for horizontal glued surfaces

- Larger cross sections are often created by fastening together smaller components, so shear resistance at the joint is crucial
- For horizontal glued surfaces, the same procedure is used for Q, and b is taken to be the combined width of the interfacing surfaces
- For vertical glued surfaces, b is taken to be the total width of the vertical glued surfaces, but now Q is calculated for the area of the cross section which will slide longitudinally if the glue fails
  - In the example, since the piece will slide on both glue joints if it fails, we consider b to be the total width of both of the joints
- Shear flow: imagine if you poured water down the shape, how does it go to the bottom? Shear stresses point in the same direction

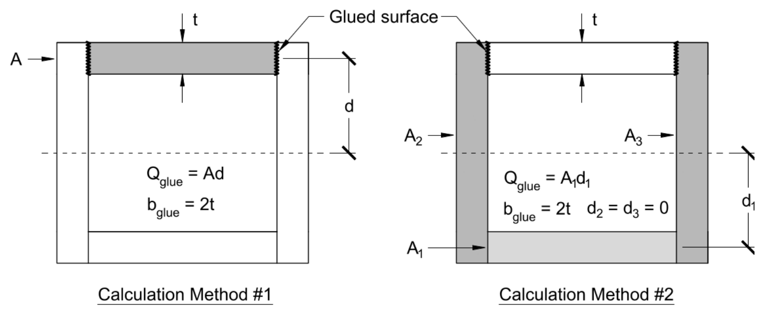

Figure 3: Calculating shear stresses for vertical glued surfaces

- Example: For an I beam the shear flow goes horizontally when in the flange and then vertically down the stem
- If the direction of shear flow goes perpendicular through the glue section then we need to consider shear stresses in that direction (vertical or horizontal)

Shear Stress Distribution

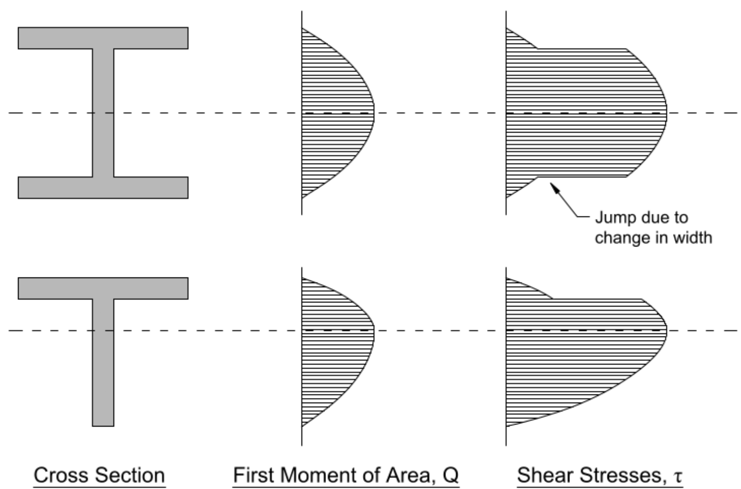

Figure 4: Shear stress distributions for an I beam and T beam

- τ increases when Q increases or when b decreases, so a sudden decrease of width in the cross section will result in a sudden jump in τ
- When determining the maximum shear stress in members with the varied length, check both the centroid, where Q is maximized, and the narrowest location, where b is minimized