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Mechanics of Materials

Project 1 - 3

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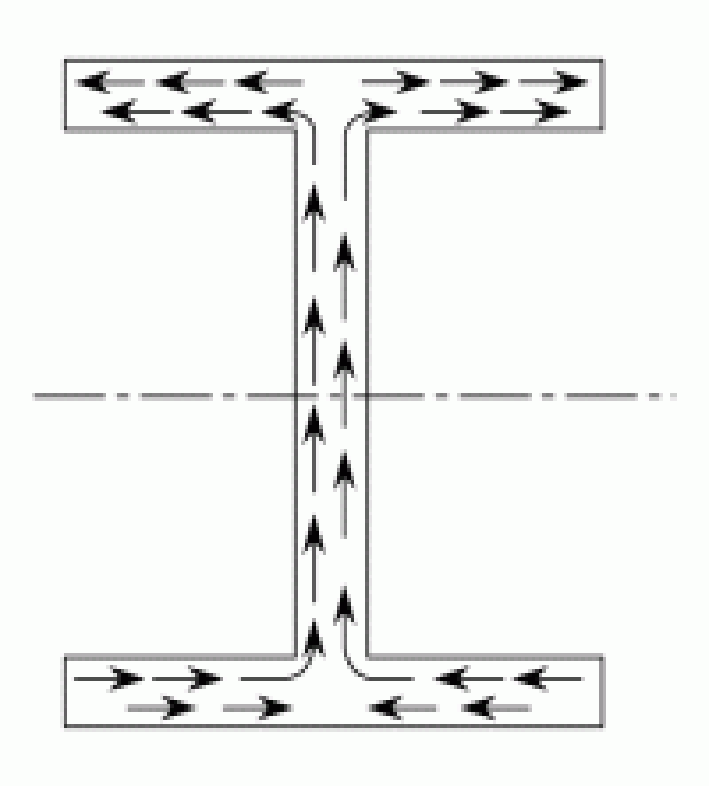
DISCUSSION

- Beam undergo torsion, shear force and bending moment. When the loads act normal to the plane of bending, it causes bending moment and shear force, while when the loads away from the plane of bending, it causes bending moment and torsional moment.
- The unaligned forces is called shearing forces, where it push one part in one direction, and another part in the opposite direction. The aligned forces, is called compression forces.
- The distribution must be in the form of horizontal at the flanges, because the shear stress has to follow the direction of the boundary. Thus, the shear stress in the flanges is on longitudinal planes, which is perpendicular to the neutral axis. Also, the "width *z*" is replaced by the flange thickness.

FREE BODY DIAGRAM



- Based on the diagram shown, the shear stress in the flanges had differ, with a max at the top web, to a zero at the outer tips. However, most of the shearing force (95%) is carried by the web and the shear force in the flanges is negligible.
- It is convenience in design and deflection calculation due to shear for the web variation is comparatively small (25%), as assuming all the shearing force is carried by the web and is uniformly distributed. Though, it can also be assume at first approximation, for the bending moment is carried wholly by the flanges.
- In a rigid body, the moment of force applied will cause a pure rotation. However, when the deformable body is constrained, it will causes internal forces in response to the external force, as to maintain the equilibrium, with an example shown below. The body will had local deformations due to the internal forces.
- Also, for the equilibrium, the internal force vectors is equal to the applied external force, while the moment vectors created by the internal forces is equal to the moment of the external force. The internal force and moment vectors are oriented, where the total force and moment of internal and external of the system is zero.

- The bending moment is the internal moment vector, and although it is used to determine the stress states in arbitrary shaped structures, the computed stresses of the physical interpretation is problematic.
- However, it have a straightforward interpretation for the physical interpretations of bending moments in beams and plates, as the stress resultants in a cross-section of the structural element.
- There are a few reading error between the calculated and the experimental value of the bending moment and shear force, which may be cause by the disturbance of load when applying the force, that had made the force became inaccurate.
- The member is subjected to non-uniform torsion as shown in the figure below, when the warping deformation is constrained, Non-uniform torsion is when a 'I' shaped section is fixed at one end and undergo torsion at the other end. It is restrained from warping freely, which causes bending deformation of the flanges in the plane, as well as twisting. The bending deformation is coincide with a shear force in each flange.

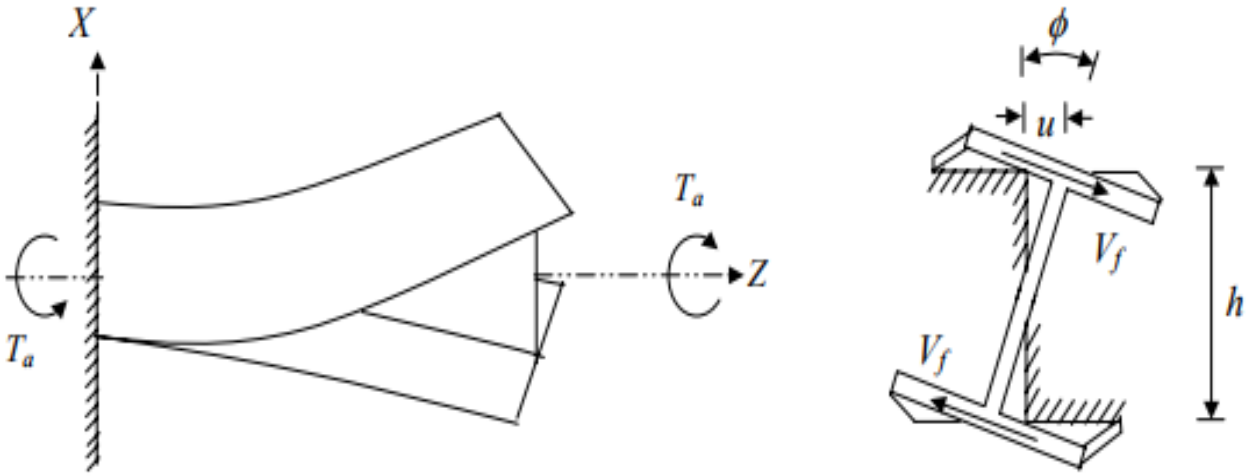


Fig. 5 Non uniform Torsion:Twisting of Non-Circular Section restrained against free warping (Constant Torque : End warping is prevented)

- When the bending moment is sufficient to cause tensile stresses greater than the yield stress of the material, it will result in the failure in bending, of extension or compression. Though, shear failure may occur before that.
- The ‘I’ shaped beam will have a slightly smaller area moment, like a cut out of the rectangular beam, with its profile fitting inside. However, the much smaller mass, provide a lighter and stiffer structure, which is a result of the relatively large area far from the neutral line.
- The ‘I’ shaped beam is one of the beam that have a higher area moments of inertia, and it generally preferred in construction, unlike other beams.

CONCLUSION

- Some of the ways to determine the principle of stresses, strains, direction and the maximum of shear stress at locations of a structure under combination of loads, is by using the three-element rosette strain gage.
- Also, Mohr's circle can be used in graphical approach. Firstly, it is achieve by calculating the stresses and tau. Then, measuring the angle of maximum and minimum values based from the illustration. Though, it is not required to calculate it beforehand.
- In addition of the method, calculations from the analysis of results can provide a direct values for the maximum and minimum stresses and strains, as well as, the angle.

RECOMMENDATION

- The material of beam is important because of its properties, such as, aluminum, where it is light, strong and resistant to rust.
- It is also lighter than steel, where steel is three times heavier. They also had almost the same strength, but aluminum has more malleability as it has more bending density. Also, aluminum had ease to cut and form than steel.
- Four items are important in the design of beam. Some of the items are, firstly, the beam required a bending strength adequate to resist the bending moments. Secondly, it must have no failure due to shear force. Thirdly, the deflection of the beam, as excessive deflection under the calculated safe load, can cause cracking. Lastly, it must have no failure of sideway buckling.
- It is stated that the deepest beam is the most suitable, as it resist given bending moment and small deflection.

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