Postgraduate Certificate in Structural Steel Design

Design of Steel Plate and Box Girders

Steel plate and box girders are essential components in steel bridge and building construction. This explanation will cover key terms and vocabulary related to the design of steel plate and box girders in the Postgraduate Certificate in Structural Steel Design. The focus will be on delivering comprehensive and practical content, with examples and challenges, using and tags sparingly to emphasize important terms or concepts.

1. Plate Girder: A plate girder is a horizontal structural element that primarily resists bending and shear forces. Plate girders are fabricated from steel plates and are commonly used as bridge girders, building floors, and roofs.
2. Box Girder: A box girder is a hollow, closed structural element, typically rectangular or trapezoidal in cross-section. Box girders are used in bridge construction, offering high torsional stiffness and resistance to shear and bending forces.
3. Flange: The flange is the vertical part of a plate or box girder that resists bending moments. Flanges are typically connected to the web by fillet welds.
4. Web: The web is the vertical or diagonal part of a plate or box girder that resists shear forces. Webs are connected to the flanges by fillet welds.
5. Haunch: A haunch is a thickened portion of the flange near the support of a plate or box girder, designed to resist high local bending moments.
6. Stiffener: A stiffener is a vertical or diagonal plate or angle member attached to the web or flange to increase its resistance to local buckling and increase overall stiffness.
7. Effective Flange Width: The effective flange width is the portion of the flange that effectively contributes to the bending resistance of a plate girder.
8. Shear Centre: The shear centre is the point in a cross-section through which the resultant shear force acts. The location of the shear centre is crucial for designing statically determinate structures.
9. Bending Stress: Bending stress is the stress experienced by a material due to bending moments. It is calculated using the formula: $f = My / I$, where M is the bending moment, y is the distance from the neutral axis, and I is the moment of inertia.
10. Shear Stress: Shear stress is the stress experienced by a material due to shear forces. It is calculated using the formula: $\tau = V / A$, where V is the shear force, and A is the cross-sectional area.
11. Local Buckling: Local buckling is a phenomenon where a slender plate or web member deforms under compressive stress, reducing its load-bearing capacity.
12. Fillet Weld: A fillet weld is a weld used to connect two members at a right angle, typically used to connect the web and flange of a plate or box girder.
13. Yield Strength: Yield strength is the stress at which a material begins to yield or deform plastically under load.
14. Ultimate Strength: Ultimate strength is the maximum stress a material can withstand before failure.
15. Plastic Hinge: A plastic hinge is a point in a structure where the material yields, allowing for large

deformations and energy dissipation.
16. Serviceability Limit State: The serviceability limit state is a condition where a structure's performance is compromised, but not to the point of failure. Examples include excessive deflections and vibrations.
17. Ultimate Limit State: The ultimate limit state is a condition where a structure is on the verge of collapse.
18. Fire Resistance: Fire resistance is a measure of a material's ability to withstand exposure to high temperatures, ensuring the safety of occupants and structural integrity.
19. Fatigue: Fatigue is the weakening of a material due to repeated loading and unloading, eventually leading to failure.
20. Durability: Durability is a measure of a material's ability to withstand environmental factors such as corrosion, wear, and tear over time.

Examples:

* A simply supported plate girder with a span length of 40m and a uniformly distributed load of 20kN/m. The effective flange width is calculated using the formula: b_eff = (L / 9) + (2 * h), where L is the span length, and h is the depth of the girder.
* A box girder bridge with a skew angle of 30°. The location of the shear centre is calculated using the formula: e = (h / 2) * tan(θ), where h is the height of the box girder, and θ is the skew angle.

Challenges:

* Design a plate girder for a simply supported bridge with a span length of 50m and a uniformly distributed load of 30kN/m, ensuring fire resistance and durability.
* Design a box girder for a skewed bridge with a span length of 60m and a skew angle of 45°, ensuring adequate torsional stiffness and resistance to shear and bending forces.

Conclusion:

This explanation has covered the key terms and vocabulary related to the design of steel plate and box girders in the Postgraduate Certificate in Structural Steel Design. By understanding these concepts, learners can design safe, efficient, and durable structures, ensuring the safety of occupants and the longevity of the structure. The examples and challenges provided can help learners apply these concepts in real-world scenarios, further solidifying their understanding of steel plate and box girder design.