Postgraduate Certificate in Structural Steel Design

Steel Beam Design

Axis, X and Y
In steel beam design, the X and Y axes are used to define the horizontal and vertical directions of a beam, respectively. The X-axis is typically oriented along the length of the beam, while the Y-axis is oriented perpendicular to the length. These axes are used to determine the bending moments and shear forces that act on the beam, which are critical factors in the design process.

Bending Moment
A bending moment is a measure of the bending force that acts on a steel beam. It is calculated as the product of the force and the distance from the force to a given point along the beam. Bending moments can cause the beam to bend or deflect, which can compromise its strength and stability. As such, it is essential to consider bending moments when designing a steel beam.

Buckling
Buckling is a phenomenon that can occur in steel beams when they are subjected to compressive forces. When a beam buckles, it experiences a sudden and catastrophic failure, which can lead to significant damage or even collapse. To prevent buckling, engineers must consider the slenderness ratio of the beam, which is the ratio of its length to its cross-sectional depth.

Camber
Camber is the intentional curvature that is added to a steel beam during the manufacturing process. The purpose of camber is to offset the deflection that will occur when the beam is subjected to loads in service. This ensures that the beam will remain level and plumb when installed, even after accounting for deflection.

Cross-Sectional Area
The cross-sectional area of a steel beam is a measure of the amount of material that is present in the beam's cross-section. It is calculated as the product of the beam's width and height and is an essential factor in the design process, as it determines the beam's strength and stiffness.

Deflection
Deflection is the amount that a steel beam will bend or sag when subjected to loads. It is typically measured as the distance between the beam's unloaded position and its position under load. Deflection is a critical factor in the design process, as excessive deflection can compromise the beam's strength and stability.

Elastic Modulus
The elastic modulus, also known as Young's modulus, is a measure of a material's stiffness. It is defined as the ratio of stress to strain within the material's elastic range and is expressed in units of force per unit area. In steel beam design, the elastic modulus is used to calculate the deflection of the beam under load.

Eccentric Load

An eccentric load is a load that is applied to a steel beam at a distance from the beam's center of gravity. This creates a bending moment in addition to the shear force that is produced by the load. Eccentric loads can be more challenging to analyze than concentric loads, as they require consideration of both the force and the distance from the center of gravity.

Factored Load
A factored load is a load that has been multiplied by a load factor to account for uncertainties in the load's magnitude or distribution. Load factors are used in steel beam design to ensure that the beam can withstand the most severe loading conditions that it is likely to encounter during its service life.

Flange
The flange is the horizontal portion of a steel beam's cross-section. It is typically located at the top and bottom of the beam and is designed to resist the bending moments that are produced by loads. The flange is usually the widest part of the beam's cross-section and is a critical factor in the beam's strength and stiffness.

Girder
A girder is a large, heavy steel beam that is used to support the weight of a structure's floors or roof. Girder beams are typically deep and wide, with a large cross-sectional area, to provide the necessary strength and stiffness to support the loads that they will encounter.

Haunch
A haunch is a portion of a steel beam that has been thickened or reinforced to provide additional strength and stiffness. Haunches are typically located at the ends of beams or at points where the beam is subjected to high loads or moments.

Header
A header is a steel beam that is used to span an opening in a structure, such as a window or door. Headers are typically designed to be strong enough to support the weight of the structure above the opening.

Hinge
A hinge is a point in a steel beam where the beam is allowed to rotate or pivot. Hinges are typically located at points where the beam is subjected to high moments or where the beam changes direction.

I-Beam
An I-beam is a type of steel beam that has a cross-section that resembles the letter "I." It consists of two flanges connected by a web, which provides the necessary strength and stiffness to resist bending moments. I-beams are commonly used in building construction due to their high strength-to-weight ratio and ease of fabrication.

Limit State
A limit state is a condition that a steel beam must not exceed during its service life. There are two types of limit states: ultimate limit states, which correspond to the beam's failure, and serviceability limit states, which correspond to the beam's acceptable performance under normal loads.

Moment of Inertia
The moment of inertia, also known as the second moment of area, is a measure of a steel beam's resistance to bending. It is calculated as the sum of the products of the areas of each element of the beam's cross-section and the square of its distance from the neutral axis. The moment of inertia is used to calculate the deflection of the beam under load.

Neutral Axis
The neutral axis is an imaginary line in a steel beam where the bending stress is zero. It is located at the center of gravity of the beam's cross-section and is used to calculate the bending moment and shear force in the beam.

Prying Force
A prying force is a force that is created when a load is applied to a steel beam at an angle, causing the beam to rotate or pivot. Prying forces can increase the bending moment in the beam, which can lead to premature failure.

Shear Force
A shear force is a force that is parallel to the cross-section of a steel beam and acts to resist the tendency of the beam to shear or split apart. Shear forces are typically produced by loads that are applied perpendicular to the beam's length.

Simply Supported Beam
A simply supported beam is a beam that is supported by two points, such as a pair of columns or walls. The simply supported beam is free to deflect under load but is prevented from rotating or pivoting at its supports.

Slenderness Ratio
The slenderness ratio is the ratio of a steel beam's length to its cross-sectional depth. It is used to determine the beam's susceptibility to buckling and is an essential factor in the design process.

Stress
Stress is a measure of the internal forces that are produced in a steel beam when it is subjected to loads. It is calculated as the force per unit area and is expressed in units of force per square unit of area.

Torsion
Torsion is a twisting force that is applied to a steel beam, causing it to rotate or twist about its longitudinal axis. Torsion can be produced by eccentric loads or by forces that are applied at an angle to the beam's length.

Web
The web is the vertical portion of a steel beam's cross-section. It is typically located between the flanges and is designed to resist the shear forces that are produced by loads. The web is usually the thinnest part of the beam's cross-section and is a critical factor in the beam's strength and stiffness.

Web Stiffener

A web stiffener is a reinforcement that is added to a steel beam's web to increase its strength and stiffness. Web stiffeners are typically located at points where the web is subjected to high shear forces or where the beam is subjected to high moments.

Yield Strength
The yield strength is the stress at which a steel beam begins to yield or deform plastically. It is an essential factor in the design process, as it determines the beam's ultimate strength and stiffness.

Total Length
The total length of a steel beam is the distance between its two ends. It is an essential factor in the design process, as it determines the beam's deflection and susceptibility to buckling.

Uniformly Distributed Load
A uniformly distributed load is a load that is applied evenly over the length of a steel beam. It is typically expressed in units