Postgraduate Certificate in Structural Steel Design

Steel Bridge Design.

Steel Bridge Design: Key Terms and Vocabulary

Steel is a popular material for bridge construction due to its high strength-to-weight ratio, durability, and ease of fabrication. In the Postgraduate Certificate in Structural Steel Design, students will learn about the key terms and vocabulary used in steel bridge design. This guide will provide a comprehensive overview of these terms, including examples and practical applications.

1. AASHTO
The American Association of State Highway and Transportation Officials (AASHTO) is a standard-setting body that provides specifications and guidelines for the design and construction of highway bridges in the United States. AASHTO's LRFD Bridge Design Specifications are widely used in steel bridge design.
2. Beam
A beam is a horizontal or sloping structural element that primarily resists loads by bending. In steel bridge design, beams are often used as girders to support the bridge deck.
3. Bolted Connection
A bolted connection is a type of connection in which two steel members are fastened together using bolts. Bolted connections are commonly used in steel bridge construction due to their ease of installation and adjustability.
4. Box Girder
A box girder is a type of beam that has a closed cross-section in the shape of a box. Box girders are often used in steel bridge construction due to their high torsional stiffness and resistance to buckling.
5. Camber
Camber is the intentional curvature of a beam or bridge deck to counteract the effects of dead load deflection. Camber is typically introduced during fabrication to ensure that the bridge deck is level when it is installed.
6. Composite Beam
A composite beam is a beam that consists of two or more different materials that act together to resist loads. In steel bridge construction, composite beams are often made by combining a steel girder with a concrete bridge deck.
7. Connections
Connections are the points where two or more steel members are joined together. Connections are critical in steel bridge design, as they must be able to transfer loads between members while also allowing for thermal movement and other forms of displacement.
8. Diaphragm
A diaphragm is a stiffening element that is used to transfer lateral loads between steel members in a bridge. Diaphragms are typically located at the ends of girders and are designed to resist twisting and other forms of deformation.
9. Fatigue

Fatigue is the process of progressive damage that occurs when a steel member is subjected to repeated cycles of loading and unloading. Fatigue is a critical consideration in steel bridge design, as it can lead to cracking and failure over time.

10. Flange

A flange is a projecting edge or rim on a steel member that is used to resist bending moments. Flanges are typically located at the top and bottom of beams and girders.

11. Fracture Critical Member

A fracture critical member is a steel member that is particularly susceptible to fracture due to its shape, size, or location. Fracture critical members must be carefully designed and inspected to ensure their safety and longevity.

12. Haunch

A haunch is a portion of a beam or girder that is thicker or wider than the rest of the member. Haunches are used to provide additional strength and stiffness in areas of high load or stress.

13. Live Load

A live load is a moving load that is applied to a bridge, such as traffic or wind. Live loads must be accounted for in steel bridge design to ensure the bridge can safely support its intended use.

14. Moment Connection

A moment connection is a type of connection that allows for the transfer of bending moments between steel members. Moment connections are typically used in steel bridge construction to connect girders to the bridge deck.

15. Plate Girder

A plate girder is a type of beam that consists of two or more flat plates that are connected together to form a stiff, strong section. Plate girders are commonly used in steel bridge construction due to their high strength and stiffness.

16. Prying Action

Prying action is a phenomenon that occurs when a force is applied to a bolted connection, causing the connected members to rotate and apply additional loads to the bolts. Prying action must be accounted for in steel bridge design to ensure the safety and integrity of the connection.

17. Rolled Section

A rolled section is a standardized shape that is produced by rolling a steel plate or strip into a desired cross-section. Rolled sections are commonly used in steel bridge construction due to their availability and ease of use.

18. Shear Connection

A shear connection is a type of connection that allows for the transfer of shear forces between steel members. Shear connections are typically used in steel bridge construction to connect girders to each other or to the bridge deck.

19. Stiffener

A stiffener is a small steel member that is used to reinforce or strengthen a larger member. Stiffeners are commonly used in steel bridge construction to provide additional strength and stiffness to beams, girders, and other structural elements.

20. Web

The web is the vertical portion of a steel beam or girder that connects the top and bottom flanges. The web provides stiffness and resistance to buckling in the beam or girder.

21. Weld
A weld is a joint that is created by fusing two or more steel members together using heat or pressure. Welds are commonly used in steel bridge construction to create strong, permanent connections between members.
22. Yield Strength
The yield strength is the maximum stress that a steel member can withstand before it begins to deform plastically. The yield strength is a critical consideration in steel bridge design, as it determines the load-carrying capacity of the member.

Examples and Practical Applications

Example 1: Designing a Steel Bridge Girder

Suppose you are designing a steel bridge girder to support a highway overpass. The girder must be 100 feet long and must support a dead load of 500 kips and a live load of 1000 kips. You decide to use a wide-flange section with a yield strength of 50 ksi.

To begin the design process, you would first calculate the maximum bending moment in the girder, which can be determined using the following formula:

M = (wL^2)/8

where w is the total load (dead load + live load) and L is the length of the girder.

Next, you would calculate the required moment capacity of the girder, which can be determined using the following formula:

M_req = M / (f_y * S)

where f_y is the yield strength of the steel and S is the section modulus of the girder.

Finally, you would select a wide-flange section that meets or exceeds the required moment capacity, taking into account factors such as web shear, flange buckling, and connection design.

Example 2: Designing a Bolted Connection

Suppose you are designing a bolted connection between two steel girders in a steel bridge. The connection must be able to transfer a shear force of 200 kips and a bending moment of 1000 kip-inches. You decide to use high-strength bolts with a yield strength of 120 ksi.

To begin the design process, you would first calculate the required number of bolts, which can be determined using the following formula:

n = F_shear / (0.75 * f_y * A_bolt)

where F_shear is the shear force, f_y is the yield strength of the bolts, and A_bolt is the cross-sectional area of the bolt.

Next, you would check the connection for prying action, which can occur when the connected members rotate and apply additional loads to the bolts. Prying action can be accounted for by using larger bolts, increasing the number of bolts, or using plates to distribute the loads.

Finally, you would design the connection details, taking into account factors such as bolt spacing, edge distance, and hole size.

Challenges

Designing a steel bridge is a complex and challenging task, requiring a deep understanding of steel properties, structural behavior, and fabrication techniques. Some of the