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Appendix D

Glossary

Abutment—A concrete wall that supports the end of a bridge and holds back the soil that is filled in behind it.

Aesthetic Requirement—A design requirement that describes the desired appearance of a completed structure.

Analysis—An examination of a complex system, usually conducted by breaking the system down into its component parts.

Approach—A roadway leading up to the end of a bridge.

Bid—An estimate of the construction cost, submitted by a construction contractor as part of the design-bid-build project delivery method.

Bid Opening—A public meeting, at which all bids submitted for a construction project are opened and read aloud.

Bottom Chord—A type of structural member used in a truss. (See diagram on page 1-3.)

Brittle—A characteristic of a material that fails by rupturing suddenly and without warning, when loaded in tension. The opposite of brittle is ductile.

Buckling—A failure that occurs when compression causes a member to suddenly bend sideways, perpendicular to the direction of the applied load.

Carbon Steel—A common type of steel, composed of iron and a very small amount of carbon.

Compression—An internal force that tends to make a structural member shorter.

Compressive Strength—The maximum compression force a structural member can carry before it fails.

Conceptual Design—A preliminary design that describes the appearance and general configuration of a structure.

Concrete—A structural material made by mixing Portland cement, sand, gravel, and water. When concrete cures, it becomes a solid, rock-like substance that is very strong in compression, but relatively weak in tension.

Connection—An assembly of structural components (plates, angles, bolts, welds, etc.) that join two or more structural members together.

Cosine—A trigonometric function of an angle. The cosine of an angle in a right triangle is calculated by dividing the length of the *adjacent side* by the length of the *hypotenuse*. The cosine function is abbreviated "**cos.**" (See page 3-3.)

Construction Contractor—A company that performs the role of the Constructor, under the terms of a formal contract with the Owner.

Constraint—A design requirement that limits some aspect of the design. An example of a constraint is a requirement for a bridge to be built above some minimum specified height, so that boats on the waterway below can pass beneath the structure unhindered.

Constructor—One of the four key players in the Project Team. The Constructor is responsible for planning, managing, and performing the construction of a facility.

Cross Section—The two-dimensional shape you see when you look at the end of a structural member.

Deck—The flat surface that forms the floor of a bridge and supports the roadway. (See diagram on page 1-3.)

Deck Truss—A truss configuration for which the deck is located at the level of the top chord.

Deflection—The distance a structure moves when it is loaded.

Deformation—A change in the size or shape of a structural member that occurs when the member is loaded.

Design—To devise or create something that meets a need.

Design Professional—One of the four key players in the Project Team. The Design Professional is responsible for conceiving, planning, and providing a high-quality design solution to the Owner.

Design-Bid-Build Project Delivery—A method of project delivery, in which the Constructor is selected by a competitive bidding process.

Design-Build Project Delivery—A method of project delivery, in which a single firm is responsible for both design and construction.

Design Review—A technique used by the Owner to monitor the conduct of the design process. The Design Professional submits a complete draft of the design for review, at specified levels of completion.

Diagonal—A type of structural member used in a truss. (See diagram on page 1-3.)

Ductility—The capacity of a material to undergo very large plastic deformation before rupturing. A ductile material provides ample warning of failure. The opposite of ductile is brittle.

Elastic—Behavior characterized by the capability of a structural member to return to its original size and shape after its load is removed.

Elevation View—A drawing showing an object viewed from the side.

End Post—The diagonal member at each end of a through truss. (See diagram on page 1-3.)

Engineering Design—The application of math, science, and technology to create something that meets a human need.

Equations of Equilibrium—Equations describing the condition that the total force acting on an object in equilibrium is equal to zero.

Equilibrium—The condition that occurs when the total force acting on an object is zero. If an object is not moving, then it is in equilibrium.

Factor of Safety—A number representing the margin of safety in a structural design. The factor of safety is used to allow for uncertainty in loads, member strengths, and structural analysis results.

Failure—The condition that occurs when the internal force in a structural member becomes larger than the strength of that member.

Floor Beam—A structural member that supports the deck of a bridge. On a truss bridge, floor beams also help to connect the two main trusses together. (See diagram on page 1-3.)

Free Body Diagram—A sketch of a “body” (a structure or a portion of a structure) showing all of the forces acting on it.

Force—A push or a pull applied to an object. A force always has both magnitude and direction.

Foundation—A component of a structure that distributes the weight of the structure to the soil or rock below it.

Fulcrum—The pivot about which a lever rotates.

Functional Requirement—A design requirement that describes how the completed structure will do its job. An example of a functional requirement for a bridge is the required number of traffic lanes.

Geotechnical Engineer—A civil engineer with special expertise in soils and foundations.

Gusset Plate—A metal plate used to connect structural members together in a truss.

Gusset Plate Connection—A type of connection that uses gusset plates to join two or more members of a truss together.

Hip Vertical—The outermost vertical member at each end of a Pratt through truss. The hip vertical carries tension, while all of the remaining verticals in a Pratt through truss carry compression. (See diagram on page 1-3.)

Hypotenuse—The longest of the three sides of a right triangle. The hypotenuse is always the side opposite the 90° angle.

Internal Force—The tension or compression force developed in a structural member when loads are applied to the structure.

Isometric View—A drawing showing a three-dimensional view of an object.

Iteration—A cycle of analysis and design, performed as part of the engineering design process.

Joint—The point at which two or more members are joined together in a structure.

Lateral Bracing—A series of diagonal structural members that help a bridge resist lateral loads, like wind. The lateral bracing members and struts also help to prevent the top chords of a truss bridge from buckling sideways. (See diagram on page 1-3.)

Load—A force applied to a structure.

Load-Deformation Curve—A graph that shows how a member deforms when a load is applied to it.

Lever—A simple machine consisting of a bar or rod that rotates on a pivot.

Mechanics of Materials—The scientific study of structural members and materials.

Member—A load-carrying component of a structure.

Notice to Proceed—An official authorization for the Constructor to start work on a project.

Optimize—To maximize the efficiency of a design. Generally, a structural design is optimized by minimizing its cost without compromising its safety.

Owner—One of the four key players in the Project Team. The Owner identifies the need for the project, provides funding, puts together the Project Team, and establishes the project requirements.

Pier—A foundation element that supports a bridge in the middle of the gap.

Pile—A component of a structural foundation, consisting of a long steel or concrete shaft that is driven downward through weak soil into stronger soil or rock.

Pinned Connection—A type of connection that uses a single large metal pin to join two or more structural members together.

Plans and Specifications—The products of the design process, created by the Design Professional. Plans are drawings, and specifications are highly detailed written descriptions of every aspect of the project.

Plastic Deformation—The permanent elongation of a material under load. Plastic deformation occurs after a material has yielded.

Pony Truss—A truss configuration for which the deck is located at (or slightly above) the level of the bottom chord. A pony truss looks very similar to a through truss, except it is not as high and has no struts or lateral bracing between the top chords.

Portal Bracing—An assembly of struts and diagonal bracing members that connects the end posts of a through truss bridge together. The portal bracing prevents the two main trusses from falling over sideways. (See diagram on page 1-3.)

Procurement—A phase of the design process in which a Constructor is selected and construction materials are purchased for the project.

Project Manager—One of the four key players in the Project Team. The Project Manager has overall responsibility for managing both the design and construction of the facility. The Project Manager represents the Owner and looks after the Owner's interests on all aspects of the project, to include scheduling, financial management, and construction quality.

Project Team—A team of specialists who are brought together to design and build a facility. The principal members of the Project Team are the Owner, the Design Professional, the Constructor, and the Project Manager.

Pythagorean Theorem—A mathematical relationship between the lengths of the sides of a right triangle and the length of the hypotenuse. (See page 3-3.)

Quality Control—The process of routinely inspecting and testing materials and workmanship on a project and taking corrective action when problems are found.

Reaction—A force developed at a support, to keep the structure in equilibrium.

Required Strength—The actual strength a member must be, in order to carry load safely. In structural design, the required strength can be calculated by multiplying the factor of safety by the internal member force.

Reinforced Concrete—Concrete that has been strengthened for structural applications by embedding steel reinforcing bars inside it, before the concrete cures. The steel reinforcement compensates for the low tensile strength and low ductility of plain concrete.

Right Triangle—A triangle with one of its three angles measuring exactly 90 degrees.

Rupture—A failure mode that occurs when a member subjected to a tension force physically breaks into two pieces.

Schedule—A tabular listing of members, connections, or other components of a structural design, normally provided as part of the plans and specifications for a project.

Shop Drawings—Detailed drawings of every component that will be part of a completed structure. Shop Drawings are normally prepared by the Constructor and approved by the Design Professional.

Sine—A trigonometric function of an angle. The sine of an angle in a right triangle is calculated by dividing the length of the *opposite side* by the length of the *hypotenuse*. The sine is abbreviated “*sin.*” (See page 3-3.)

Spread Footing—A type of foundation consisting of a flat slab of concrete placed directly on firm soil or rock.

Stable—A rigid structural configuration in which no member or members can move or rotate freely. A structure must be stable to carry load. A truss is generally stable when it is composed entirely of interconnected triangles.

Statically Determinate—A structural configuration that can be analyzed using the equations of equilibrium alone. Only statically determinate trusses can be analyzed with the Method of Joints.

Statically Indeterminate—A structural configuration that cannot be analyzed using the equations of equilibrium alone. Statically indeterminate trusses cannot be analyzed with the Method of Joints.

Steel Fabricator—A company that specializes in prefabricating steel structural members and connections before they are delivered to the construction site. The steel fabricator cuts all structural components to size, drills or punches holes for bolts, and bolts or welds some of the components together to form subassemblies. The steel fabricator is a member of the Construction Team.

Strength—The largest internal force that a structural component can experience before it fails.

Structural Analysis—A mathematical examination of a structure to determine its reactions, internal member forces, and deflections.

Structural Engineer—A civil engineer with special expertise in structural analysis and design.

Structural Model—A mathematical idealization of a structure, including a series of simplifying assumptions about the structure’s configuration and loading that allow us to predict its behavior mathematically.

Strut—A structural member that connects the two main trusses together on a truss bridge. The struts work together with the lateral bracing to resist lateral loads, like wind, and to prevent the top chords of a truss bridge from buckling sideways. (See diagram on page 1-3.)

Subcontractor—A company hired by a construction contractor to perform a specialized part of a construction project.

Subsystem—A part of a larger system. If a truss bridge is considered to be a system, then its subsystems include the deck, the main trusses, the lateral bracing, the foundations, the approaches, and others.

Support—A point at which a structure is physically in contact with its surroundings.

Tensile Strength—The maximum tension force a member can carry before it fails.

Tension—An internal force that tends to make a structural member longer.

Through Truss—A truss configuration for which the deck is located at the level of the bottom chord. A through truss looks very similar to a pony truss, except it is higher and has struts and lateral bracing connecting the top chords together.

Trigonometry—The mathematical study of the properties of triangles.

Truss—A structure composed of members connected together to form a rigid framework.

Top Chord—A type of structural member used in a truss. (See diagram on page 1-3.)

Type Study—A report that describes the alternative configurations considered in a bridge design and explains the advantages and disadvantages of each one. The Design Professional prepares the type study for the Owner.

Unstable—A structural configuration that cannot carry load because one or more members can move or rotate without restraint. A truss is generally unstable when it is not made up entirely of interconnected triangles.

Ultimate Strength—The absolute maximum internal force a member can carry in tension before it fails.

Vector—A quantity that has both magnitude and direction.

Vertical—A type of structural member used in a truss. (See diagram on page 1-3.)

West Point Bridge Designer—A computer aided design program that will introduce you to the engineering design process and demonstrate how engineers use the computer as a problem-solving tool.

Yielding—The phenomenon that occurs when a ductile material undergoes very large plastic deformations with little change in load.

Yield Point—The point on a load-deformation curve at which yielding begins.

Yield Strength—The internal member force at which yielding occurs.

