GLOSSARY OF BRIDGE, TRESTLE and CULVERT TERMS

Excerpted from *Hamilton's Other Railway* by Charles Cooper. Originally provided by Art Clowes.

Abutment – any kind of retaining wall at either end of a trestle or bridge which holds the abutting earth in place and provides an end-support. A "timber wall", for instance, was a series of stout horizontal planks placed on top of each other to form a vertical wall to hold back the earth. These were held in position on the inside by the fill, and on the outside by a bent that also provided an end-support to the trestle or bridge deck. More modern materials commonly used for abutments are masonry, brick and concrete. Abutments usually also have wing walls to hold back the fill on either side of the approach as well. An essential feature of abutments constructed with any of the more modern materials is an indentation, known as a bridge seat or "shelf", which receives the floor system of the bridge.
Batter – the outer piles of a trestle bent usually have an outward "batter" or slope, which provides stability to the horizontal load and counteracts sway from passing trains.
Bent – each complete set of vertical trestle supports. In the case of a timber pile trestle, a bent is simply the line of piles (usually four to six, but sometimes more) that have been driven into the ground.
Bracing – strengthening of a structure using the principle of triangular support. Bracing not only adds overall strength (especially to help withstand the secondary forces of the structure itself), but also, in the case of braced sets of piles or frame bents, counteracts the side-sway created by the passage of trains. (See also **Cross brace** and **Longitudinal brace**.)
Bridge – a structure consisting of plate girder, I beam or truss spans, intermediately supported, if needed, by piers at longer intervals than those of the closely-spaced pile, frame or steel bents of a trestle.
Bridge – deck-type – where the deck (floor system) is at the top of the structure. This design requires sufficient clearance over the water, railway or road below, and is described as a "deck plate girder" or a "deck truss" bridge.
Bridge – half-through-type – where the deck (floor system) is located somewhere between the top and the bottom of the structure. Referred to as a "half-through plate girder" bridge.
Bridge – plate girder – see **Plate Girders**.
Bridge – through-type – where the floor system is at the bottom of the structure. Referred to as a "through plate girder" or "through truss" bridge.
Bridge seat – an indentation or "shelf" in the abutment, designed to receive the deck (floor system) of the bridge.
Bridge ties – ties laid across the width of a bridge that are fastened to the stringers below with hook bolts, and support the rails on top.
Bridge – truss – truss bridges are commonly built of iron or steel (or of wood in the early days). They consist of two sets of chords, top and bottom, with a series of posts and braces as part of the truss form. See also **Truss** and **Pony truss**.
Cap – a heavy timber at the top of each frame bent or set of piles. The cap is spiked to its supporting structure, and in turn supports the stringers in the floor system.
Chord(s) – the top and bottom horizontal members of a truss. In any track-carrying structure, the top of a load-carrying member is said to be "in compression", while the bottom is said to be "in tension".
Cross brace (also X-brace) – a diagonally-crossed pair of timber or steel lengths, that brace or hold together:

- a set of piles or a frame bent; or
- longitudinally, two bents, usually on alternate spans; or
- rows of longitudinal bracing.

Culvert – a constructed opening under a railway track to allow water to flow from one side to the other, either for drainage or for unimpeded flow of a smaller water course.
Culvert – box – many early small culverts were simple box culverts. These could be built of either wood or stone. Either way, they were usually only two heavy timbers or two layers of stone high. The stone would usually be laid dry. If small and near enough to the track, they would be left open (without a top). Deeper ones would be covered, either with stone or a layer of timber, and then with fill. Some larger open top culverts would have stringers across the opening to carry the track. Since wood has a limited life, such culverts eventually needed to be replaced, usually with stone.
Culvert – stone arch – these vary considerably in size (with the larger ones resembling one-arch bridges), but all have earth fill between the arch and the railway track. Most of the better ones have a floor

in the form of a very shallow “U” to keep the water to the middle, but large ones with considerable water flow may have flat floors. The inside walls are vertical to the water line. The angle of the wing walls to the culvert mouth varies, depending on the local situation. For culverts in a more open valley, the wing walls would probably run almost parallel with the track, much like the portal of a tunnel, but they could be at almost any angle to the embankment (with 45° being very common), depending on stream conditions, water flow, and what was considered the best way of retaining the embankment. Above the water line, the stone was cut to provide a semi-circle roof with a key stone at the top. As to the stones themselves, a cut narrow flat edge around the face of the stone indicates more care, and generally a better quality job, than those having a full rough face. A uniform mortar thickness also usually attests to a more experienced craftsman (a mason or an apprentice). Some contractors included enhancements, such as a carved (marble) keystone with the date of construction, sometimes with any or all of the contractor’s, engineer’s and stonemason’s names.

Deck (system) – the horizontal component of the trestle or bridge, designed to support the track. In the case of a trestle, the deck system consists of the caps, stringers and the bridge ties. In the case of a bridge, the deck consists of the floor beams, stringers and the bridge ties. (Today, many bridges use solid U-shaped plates over the stringers that permit the deck to be ballasted.)

Floor beams – are the equivalent on a bridge of caps on a trestle. Made of steel, they extend across the structure between the girders or trusses, and carry the weight loads from the floor system to the main girders; or, depending on their positioning, to the piers. It is rare, however, for bridge stringers to be supported on top of the floor beams. The stringers typically extend from floor beam to floor beam, and have clip angles on each side of the web at both ends. These are rivetted, bolted or welded to the web of the floor beam, in order to keep the floor system as shallow as possible.

Floor system – see **Deck (system)**.

Frame bent – a pre-assembled bent, i.e., a set of vertical, square-cut, framed, ready-cross-braced timbers, is placed on top of the prepared piles. Frame bents provide a vertical structure to carry live loads from the caps to the piles.

Grade separation – another term for a trestle or bridge crossing another railway line or highway. From the perspective of the owning railway, a railway bridge over another railway may be appropriately referred to as an “overpass”, whereas the other railway would view it as an “underpass”. In the case of a highway, one over the railway would be viewed as an “overpass”, and one under the railway as an “underpass”.

Guard rails – rails placed on the inside of the running rails on a trestle or bridge. In the event of a derailment on the structure, the guard rails would deter the wheels from running off the deck. Guard rails are of interest to the railway historian because it was a common practice to use older, lighter (worn) rails for this purpose.

Headwall – a wall (parallel with the track) often found above the ends of older culverts to hold back (retain) the earth embankment, thus preventing it from sliding into the waterway. In the case of larger culverts, the headwall was combined with wing walls to provide this retention. Because of cheaper materials, e.g., corrugated metal pipes, and today’s mechanized earth moving, newer culverts tend to be longer, and require little or nothing in the way of headwalls.

Live load – the force exerted by a train on a structure such as a bridge or turntable.

Longitudinal brace – a timber that runs longitudinally (horizontally) between bents for the full length of the structure, to help maintain the piles or bents in a vertical position. These braces are normally spaced at 8 ft to 10 ft intervals between the top and bottom of the structure. There are always braces at the battered piles, and usually a number of inside braces as well.

Overpass – see **Grade separation**.

Pier – an intermediate bridge support formerly built of masonry or, if readily available, brick. (The material used would almost invariably match that used for the abutments.) An earlier, cheaper form of construction (because of the ability to use unskilled labour), was a timber box filled with stone or rip-rap. Another early form of pier was two pile bents spaced closely together and cross-braced, so as to constitute one solid support. Today, concrete is the choice for building piers and abutments.

Pile – a round timber pole (a tree with the bark and limbs removed) driven vertically into the ground to support a structure. For trestles, piles are driven usually four, five or six in a row to form a single support, called a bent. It should be noted that most bridges have piles driven under their piers and abutments. Generally, all piles, whether used as bents or as footings, would be driven with the small end down, to help develop friction with the soil. From around the beginning of the 20th century, piles have been creosoted to help them last longer, especially where they are exposed to wet/dry cycles.

Pile driver – a very old application. The first ones used, at the start of the railway building era, were “drop hammers”. These were usually a block of iron on a pair of vertical guides. Horse-power was used to lift the iron block, which would then be allowed to fall free, driving a timber pile into the soft soil. The horse-power could be one to four horses. The slowness of this process often gave less than desirable results. As the design of the stationary steam engine improved, while the drop hammer principle was still employed, the horses were replaced. Steam power was quite well established by 1875-80. With steam-powered pile drivers, end-bearing piles (resting on bed-rock) became more common (as opposed to the earlier “friction” piles, which relied for their support on the soil around them). Today, most pile drivers are diesel-powered, consisting of a self-contained double-acting single cylinder. The cylinder can rest right on the pile as it is being driven, thus obtaining fast penetration.

Plate girders – steel mills typically roll standard shapes, i.e., various weights of rails, standard size plates, L angles and I beams. Steel mills have a maximum size of roller for forming rolled sections, and if a deeper or longer beam is required, it has to be built. Girders larger than rolled I beams are made up of plates and L angles. For many years these were riveted, but today most girders just use plates that are welded. From the early 1960s onwards, repairs to large existing structures have usually had their rivets replaced with high-tensile bolts.

Plate girder bridges have the girders built up from various-sized plates. Typically, a plate girder frame consists of vertical web plates and horizontal top and bottom plates, called “flange plates”. The flange plates work on the same principle as the chords of a truss. They are connected in the middle by the vertical web plates. The whole girder is held together with L angles, rivets and, today, smaller welded plates or stiffeners. Girders get considerable extra support from these L angle or stiffener plates that are fastened and extend between the top and bottom flanges along the web. In addition to stiffening the structure to prevent buckling, these L angles and stiffeners also provide support for internal bracing.

As noted, the deck (floor system) of a bridge, because of its design and location, provides one layer of horizontal bracing between the two outside girders, or trusses.

Pony truss – where, because of site conditions (e.g., lack of clearance) a truss is built with extra strength but less height, it is known as a “pony truss”. Where the deck is at the top of the structure, it is known as a “deck pony truss”. Where the deck is located at the bottom, it is usually known simply as a “pony truss”. Pony trusses are often used for spans shorter than those requiring a full through truss, therefore their depth (the distance from the top to the bottom chord) does not need to be as great as that of a through truss.

Refusal – the point at which a driven pile strikes rock.

Released girders – girders “released” from a bridge at the time of its reconstruction and re-used elsewhere, usually for a smaller structure on a railway line with less or lighter traffic. (Many of them also were re-used for highway structures.)

Shelf – see **Bridge seat**.

Span – the distance between the series of supports (bents) on a trestle, or piers on a bridge. Since a bridge span is usually much longer than a trestle span, the materials needed to support the live loads on bridges need to be considerably stronger than those for trestles. This entails more substantial piers, girders or trusses, as well as heavier abutments.

Stiffeners – see **Plate girders**.

Stringers – the longitudinal component of the deck (system) of a trestle or bridge. In the case of a trestle, originally heavy squared timbers, later replaced by plate girders or I beams. In the case of a bridge, plate girders and I beams. Stringers carry the live load from the rails and bridge ties and spread it to the piles, girders or trusses and then downward to the foundation. See also **Deck (system)** and **Floor beams**.

Trestle – a structure consisting of short, roughly equidistant spans. In the early days, timber trestles were light, often built with local timber, and the piles were generally carried up to the deck level (a timber pile or pile trestle). As with all structures, trestles evolved in their design and the materials used. Soon, better and treated piles were used. In the period of the trestles’ reconstruction, the piles were often cut off near the ground level, and frame bents were used between the ground and the deck structure where the distance in-between warranted this (thus, a timber frame bent, or frame bent trestle). The frame bent trestle design was also used where the piles had to be driven very deep, and the timbers were not long enough to reach the deck height; and also in the case of higher trestles that necessitated two or more layers of bents, giving the structure the appearance of a multi-storied building. Because of decay and fire, many trestles were replaced with culverts, bridges or fill. In more recent times, steel piles and floor systems came into common use.

Truss – any assembled support frame constructed from timber, iron or steel that provides sufficient support for a span longer than that afforded by a girder. Trusses do not have solid webs, but are made up of a series of posts and braces. There are two basic truss styles, the King Post (for shorter spans) and the Queen Post.
Advanced truss designs are, for example, Howe, Bollman, Whipple, Lattice (or Town), Warren, Pratt, Baltimore, and so forth). They all work on the same basic Queen Post truss principle, with top and bottom horizontal members, called "chords", and various patterns of "posts" and diagonal bracing, from which the various designs are determined. The most common advanced design of the earlier era was a Howe truss. For lesser bridge works, 50 ft span Queen Post trusses were often used.
Underpass – see **Grade separation**.
Viaduct – in Canadian railroading, viaducts are generally structures supported by steel towers. These towers consist of two bent-like structures linked by bracing to each other to form a separate self-supporting structure. However, this term is also commonly used to describe a long bridge with piers, or a steel frame trestle that is usually, but not necessarily, of great height. There are also many examples of arched viaducts built of masonry or brick. Some structures are a classic viaduct, but others may be better classified as bridges, although also referred to as viaducts.
Wall – timber trestles generally have a wooden wall at each end, called a back wall or dump wall. The term "wood wall" or "timber wall" describes a vertical wall that holds back the earth and provides support for the deck, performing the same function as a bridge abutment.
Web – the steel plate that defines the height of a girder, and provides support for the stiffeners, etc. See also **Plate girders**.
Weight load – see **Live load**.
Wing walls – walls at any angle around the bridge abutment or culvert to support or hold back the earth fill of the embankment. See also **Headwall**.