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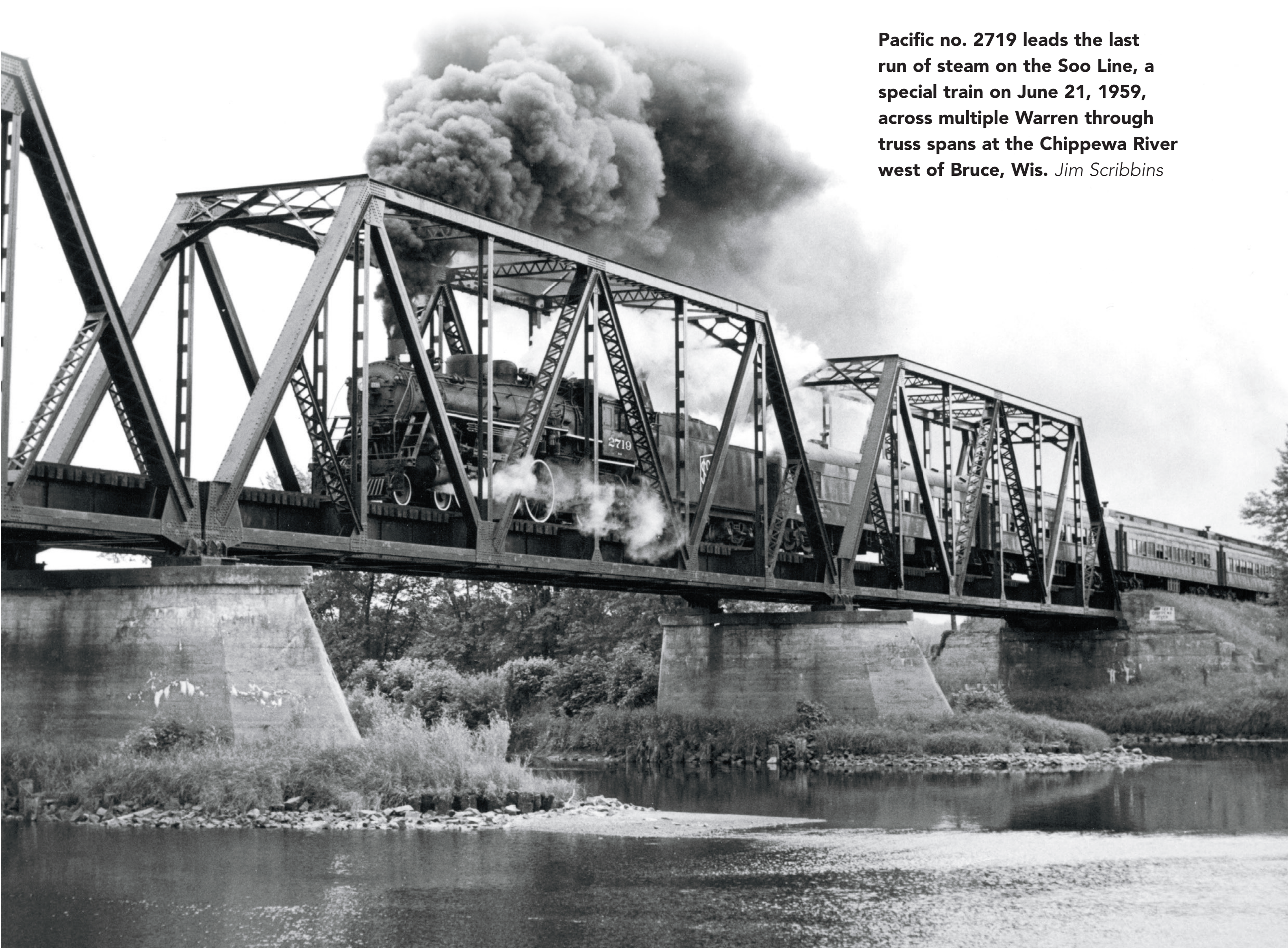


Pacific no. 2719 leads the last run of steam on the Soo Line, a special train on June 21, 1959, across multiple Warren through truss spans at the Chippewa River west of Bruce, Wis. *Jim Scribbins*

CHAPTER THREE

Wood bridges and trestles

Tall wood-frame trestles like this one on the Camas Prairie in Idaho were becoming quite rare by the 1990s, when this Union Pacific train rolled through. Most were replaced by steel structures by the mid-1900s.
Donald Sims

Wood bridges were among the first railroad spans built in the early 1800s, with open and covered truss bridges and trestles of many designs. Although wood bridges had mostly given way to iron and steel designs by the late 1800s, some covered wood bridges survived in service quite late into the 1900s, and wood trestles remain common on railroads throughout the country.

Reading built this stone bridge in Reading, Pa., in 1857, and it's still in use by Norfolk Southern. All three arches are skewed—the railroad crosses the street at an angle—uncommon for stone bridges. *Jet Lowe, Historic American Engineering Record*

The biggest challenge of stone bridges was that they were extremely time- and labor-intensive to build. By the late 1800s, as railroad construction was booming across North America, masonry bridges largely gave way to various types of wood trestles and iron truss bridges.

Concrete became a viable option for railroad bridges by the early 1900s. Early uses included large arch bridges, including multiple-arch viaducts, and today concrete beams are used in many types of railroad bridges.

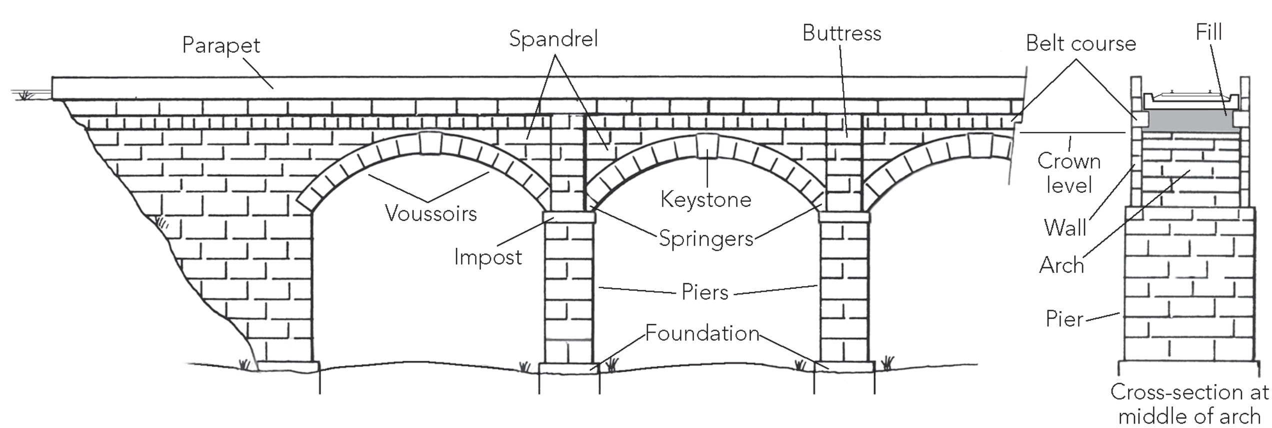
Let's start with a look at stone bridges, then see how concrete bridge construction evolved from the early 1900s to today.

Stone bridges

The principle of a stone-arch bridge is allowing gravity to aid the inherent strength of stone in compression. By arranging stones into an arch (with the final keystone at the top center), the stones' heavy weight pulls them downward, forcing them tightly together. This transfers the weight of the load above the arch downward to abutments and piers and ultimately the foundation or footings.

These bridges range widely in size. Stone bridges can be a single arch to clear a waterway, road, or railroad, or they can comprise several arches to cross a wide river or valley (multi-

Stone bridge construction and components



This illustration shows the components of a stone arch bridge. Length (overall and arch length), width, overall height, and pier height vary widely among bridges.

A Marquette Rail train crosses a Pratt truss swing bridge over the Grand River in Grand Rapids, Mich., in 2012. The 180-foot rim-bearing span, built in 1903 by the Pere Marquette, only served as a moving bridge for a few years following its installation. *James Guest*

A ship passes a Canadian National double-track Warren swing bridge (with the operator's shack in the middle) in the 1930s. Swing spans provide a clear channel, but can be a navigation hazard because of their position in the waterway. *Canadian National*

Safety is of course a major consideration. All moving bridges have some type of mechanism that locks the bridge structure and rails in place before traffic can cross it. Most are equipped with signals and derails on approach tracks that are interlocked mechanically or electrically to the bridge mechanism.

All opening and closing operations must occur in a prescribed order for the bridge to open or for traffic to cross. If during any of these steps any part of the bridge mechanism jams or fails to engage, the problem must be cleared for the succeeding operations to occur.

Movable bridges often have lights as markers to indicate bridge status. Their use has varied by era and location, but generally red lights mark piers and obstructions and green lights mark the centerline of channels. Marker lights can also indicate whether a bridge is open or closed.

Bridge piers or abutments may also have clearance gauges painted on them, with horizontal lines and numbers indicating the height from the water level to the lowest obstruction on the bottom edge of the bridge span ("low steel").

Let's look at the various types of movable spans.

Swing bridges

Swing bridges were the first movable bridge type used by railroads, starting with floating (pontoon) designs in the 1840s-1850s. The first center-pier-mounted permanent swing spans began appearing in the 1850s, and swing bridges became the moving bridge of choice until just after 1900.

Swing bridges rotate horizontally about a vertical axis, with a balanced bridge pivoting on a bearing mounted atop a pier in the waterway. An advantage to the swing design is that it provides an unlimited vertical clearance to water traffic. Swing spans also were reasonably easy to operate using manual power, with the operator turning a crank at the middle of the span.

Disadvantages include the bridge (and surrounding fender) being a potential waterway hazard to boats and ships, and the risk of damage from collisions, flooding, and water-borne hazards (particularly ice). Swing spans also take longer to open and close compared to other moving bridges.

A majority of swing bridges feature truss superstructures, although many abutment is the toe. The flat surface atop the breast wall (where the bridge pedestals or beam ends rest) is the bridge seat (also sometimes called the beam seat or bearing shelf). The wall behind the bridge seat that holds back the roadbed and earth fill is the back wall; the top portion is the ballast wall. Side walls that extend backward from the breast wall are wings or wing walls.

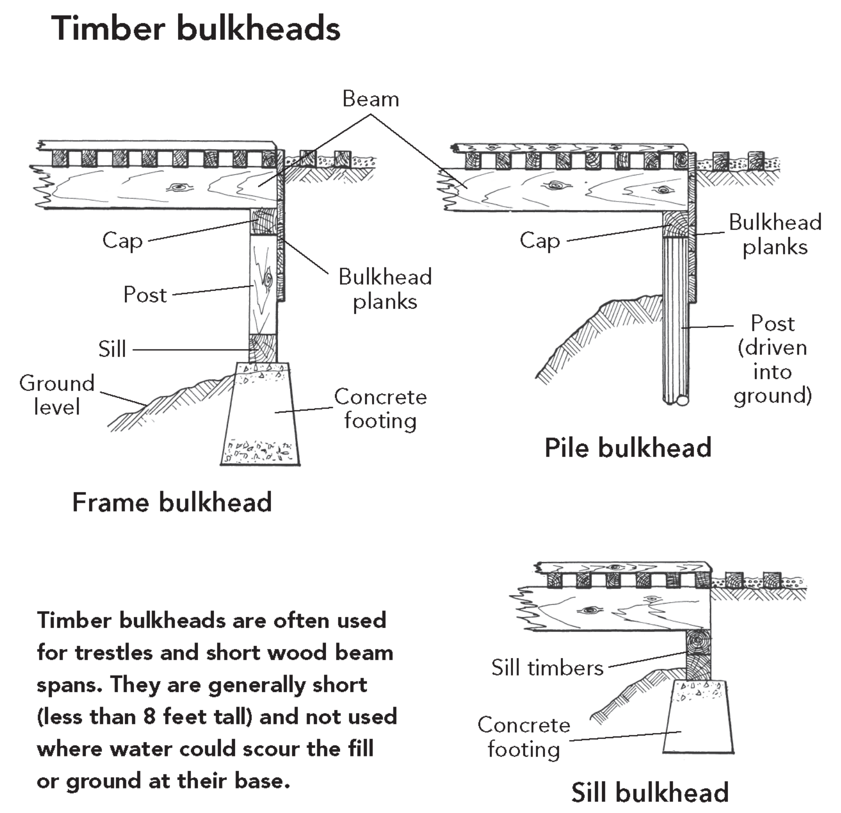
In most cases, there's a lot more to an abutment than what's visible. The footing is often entirely buried below ground level, and can be quite deep (below the frost line). If it can't be located on bedrock, pilings are often driven down first to provide a stable base (as shown in the drawing of the breast abutment).

The most common abutment is the breast, with or without wing walls. These are commonly used when crossing roadways, waterways, or other railroads. The wing walls can be parallel to the breast wall, or angled backward. They are usually tapered to match the angle of the adjoining fill. They can also remain the full height of the breast wall, becoming a retaining wall—this is common in urban areas where the breast wall abuts a street or sidewalk.

The U-shaped abutment has side walls extending rearward at 90 degree angles from the breast wall. It's also sometimes called a "pulpit" abutment (especially if the side walls don't extend far to the rear). These are used where the roadbed profile is tall, especially where the abutment doesn't immediately contact a waterway or road. Typically only the very top of the abutment is visible.

The buried abutment uses tall, separated pillars atop the footing to support the bridge seat. This type of abutment is installed where a tall breast wall isn't needed. This design minimizes stress caused from fill behind the breast wall (especially where the approach fill is high). As the slope line in the drawing indicates, this is all invisible to a viewer, with just the top of the wall and bridge seat visible.

The box or hollow abutment is a large variation of a box culvert,



Timber bulkheads are often used for trestles and short wood beam spans. They are generally short (less than 8 feet tall) and not used where water could scour the fill or ground at their base.

This simple skewed-end beam bridge over a gravel road on the Camas Prairie in Idaho is supported by a simple concrete breast abutment with tapered wing walls that match the fill behind them. Also note the warning stripes (on both the wall and beam) and sign. *Glenn Rudolph, Historic American Engineering Record*

CHAPTER NINE

Bridge track, signs, and details

Bridge track on open-deck spans, such as this deck truss, features longer ties and tighter tie spacing than conventional track. Guardrails were common (but not universal) on bridges and trestles. Note how the rails pass over the narrow ballast wall on the abutment in the transition from standard track to bridge track. This bridge is on the Boston & Maine at Crawford Notch, N.H., in 1955. *Jim Shaughnessy*

Modeling bridges accurately means getting details correct. This includes bridge track (which differs from standard track), signs, walkways, communication lines, and other items. Keeping an eye to the prototype will result in more-realistic models. Let's start with a look at the track.