

Input 4 Cast-iron bridge at Ironbridge

The brittle nature of cast-iron was well known to the first designers, and its use was initially restricted to products that needed to be primarily heat-resistant – fire backs and other fireplace goods. Large-scale production was possible in the 1750s in Britain at Coalbrookdale. The Darby family used improved and larger furnaces using a blast of air to achieve higher temperatures. The coke was mixed with the iron ore and a charge of limestone was also added, the latter forming a slag, which helped remove impurities.

Coke is mainly pure carbon, and part of it dissolved in the iron to form a solution – about 4 per cent. The high carbon content lowered the melting point of the final material, so that the output from the Darby furnaces could be tapped as molten metal directly from the base of the furnace.

Once large-scale production of the material was possible, mass manufacture of standard shapes proved feasible using sand moulds. Cooking implements were among the first such products, followed by complete stoves, assembled from pre-cast components.

The size of castings was increased, culminating in the famous cast-iron bridge crossing the Severn river at what became known as Ironbridge, near Coalbrookdale in Shropshire (**Figure C5**). Built in 1779, it was intended as a pedestrian route for workers, and had ample clearance to allow high-masted sailboats underneath.

Owing to the brittle nature of the material in tension, structural members could only be used in compression. The designers of the bridge realized that significant tension or bending stresses could not be allowed, so all of the large cast beams were used as arches, and so were put into compression at all points in the structure. In order to join the large girders, dovetailed joints and wedges were employed, borrowing the idea from carpentry (**Figure C6**).

The assembly using a kit of pre-cast parts anticipated prefabrication, an idea widely used in our own time, and enabled many other similar bridges to be erected elsewhere in Britain. The original bridge and others still stand as a testimony to the skill and foresight of the designers.

Conservation of the Coalbrookdale bridge was needed in the 1970s owing to movement of the masonry abutments, which created brittle cracks in some of the beams. The affected beams were replaced or mended with epoxy resin. The masonry was supported by a counter arch of reinforced concrete and stainless steel built into the riverbed.



Figure C5 Bridge at Ironbridge, Shropshire, England



Figure C6 Joints in the bridge at Ironbridge