iron in the industrial revolution
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cast iron

• impure: up to 4% carbon, up to 10% other elements
• poured into a mould
• crystalline texture
• good in compression
• poor in tension
• poor in bending
• brittle under change in temperature
wrought iron

- pure (to commercial standards)
- hammered or rolled
- fibrous texture
- good in tension
- good in bending
- subject to rust
steel  
(a less precise term)  
- pure (maximum 0.25% carbon)  
- hammered or rolled  
- good in tension  
- good in bending  
- stronger than wrought iron  
- even more subject to rust
the invention of the factory

the industrial revolution

rise of cotton spinning

centralised power sources (water, steam)

5 or 6 storey buildings

masonry exterior, timber interior

subject to fire
Calver Mill, between Derby and Sheffield, 1785.

MUAS 16,690
Belper North Mill, by William Strutt, 1803-4: sections, showing the waterwheel driving shafts which power the looms on each floor.

Abraham Rees [ed], *Cyclopaedia, or Universal Dictionary of Arts, Sciences, and Literature* (45 vols, London 1814)  
MUAS 16,691
Derby Cotton Mill by William Strutt, 1792-3 plan & section

MUAS16,682
Derby Cotton Mill by William Strutt, 1792-3
detail of construction, 1792, based partly on Milford and Belper West

MUAS 13,022
Benyon, Marshall & Bage Flax Mill, near Shrewsbury, by Charles Bage, 1796
the first complete iron frame

Salford Mill, for the Salford Twist Co, by Boulton & Watt, 1799-1801: part-plan and sections

deflected shape of the beam at Salford

skewbacks and flanges
beam sections at
Shrewsbury, 1796
Salford, preliminary, 1799
Salford, as built, 1800

bending moment of the beam at Salford,
showing tension in the top flange

MUAS 12,553
the evolution of beam design
1792-1804
MUAS 13,024

SHREWSBURY 1796-97
BAGE

MILFORD 1792-3
STRUTT

SALFORD 1799-1801
BOULTON & WATT

LEEDS 1802-3
BAGE

BELPER 1803-4
STRUTT
sections of cast iron beams, 1801-1837

- Philips & Lee by Boulton & Watt [1799-] 1801
- Benyon's mill, by J Farey, 1816.
- Thomas Tredgold, 1824
- Mill in Bradford, Fairbairn, 1827
- 'Ideal' by Eaton Hodgkinson, 1830.
- No 70, Old St, EC1, 1837

Fireproof floor of cast iron beams, brick arch and concrete fill, by William Fairbairn, 1854

iron rib bridges

Inverary, project, 1774

Coalbrookdale 1775-9
design for Inverary Bridge, by Robert Mylne, 1774

Giedion, *Space, Time and Architecture*, p 190
Cast iron pulpit at Bradley by John Wilkinson, c 1790

Architectural Review, CVI (November 1949), p 333
Designs by T F Pritchard 1773-5

Bridge at Stourport.

Bridge on a cast iron centre.

Bridge between Madely & Brosely (ie Coalbrookdale)

Ted Ruddock, Arch Bridges and their Builders 1735-1835 (Cambridge 1979), p 139
Pritchard’s design for Coalbookdale, compared with the timber prototype.
Pritchard’s iron centering for a stone bridge showing (incidentally) the use of circular openings in the spandrels.
Coalbrookdale Bridge as designed by Abraham Darby constructed 1775-9

Ruddock, Arch Bridges, p 134

Pritchard’s earlier design
Coalbrookdale Bridge, Rooker's painting of 1788
Ironbridge Gorge Museum Trust, *The Iron Bridge*, cover
Coalbrookdale Bridge

views
Warwick Sheffield
Coalbrookdale Bridge
details of the ironwork
Ironbridge Gorge Museum Trust slide T11


the compression arch
project for building an iron bridge of one arch from 120 to 600 French feet span, by Vincent de Maupetit [or Montpetit]], 1779

*Repertory of Arts*, XX (1812), p 351: presumably from Vincent de Montpetit, *Prospectus d'un Pont de Fer d'une seule arche. Proposé depuis vingt toites jusqu'a cent d'ouverture, pour être jeté sur une grande rivière: présenté au Roi le 5 Mai 1783* (Paris, chez l'auteur, 1783)
iron voussoir bridges

Paine's proposed iron bridge for Sunderland
bridge at Stanford Court, Worcs, by John Nash (1795)-1796
Sunderland Bridge, by Rowland Burdon, 1790-1796
Austerlitz Bridge, Paris, by M-C Lamandé, 1806
Paine's iron bridge for Sunderland, as drawn by John Soane, 1791

Ruddock, *Arch Bridges*, pp 136-7
bridge over the Teme at Stanford Court, Worcestershire, by John Nash (1795)-1796

Ruddock, Arch Bridges, p 141
Sunderland Bridge, 1790-6

view during erection

framing as shown in the patent specification

Ruddock, *Arch Bridges*, pp 139, 140
Sunderland Bridge
isometric section

Charles Tomlinson [ed],
*Cyclopaedia of Useful Arts and Manufactures* (in parts, London, no date, c 1851-4), sv Bridge.
Sunderland Bridge

Giedion, Space, Time and Architecture, p 169
Austerlitz Bridge, Paris, by M-C Lamandé, 1806, detail

Mandé-Corneille Lamandé, *Pont de l'École Militaire, construit sur la Seine,* à Paris en face du Champ de Mars.
iron box aqueducts

design by Robert Fulton, 1796

Longden Aqueduct, by Thomas Telford, 1795
Cast iron aqueduct designed by Robert Fulton, 1796

Architectural Review, CVI, 631 (July 1949), p 17
Aqueduct of the Shrewsbury Canal, over the Tern near Longden, by Thomas Telford, 1795, view from the south

Miles Lewis
Longden Aqueduct

south side
top view
Miles Lewis

Engraving
Stuart Smith, A View from Iron Bridge (Ironbridge Gorge [Shropshire] 1979), p 36
Longdon Aqueduct, north side
Miles Lewis
Thomas Telford’s arches

proposal for London Bridge, 1801

Craigellachie Bridge, 1814-15

proposed bridge over the Menai Straits 1810
Telford's proposal for London Bridge, 1801: view & detail

Giedion, *Space, Time and Architecture*, p 188
Ruddock, *Arch Bridges*, p 156
Craigellachie Bridge, near Banff, Scotland, by Telford, 1814-15
contemporary and modern views

Samuel Smiles, *Lives of the Engineers with an account of their Principal Works, comprising a new History of Inland Communication in Britain* (London 1862), III, p 387

Craigellachie Bridge, detail and diagram of ironwork

Ruddock, *Arch Bridges*, p 163
Telford's proposed cast iron bridge over the Menai Straits, Wales

Telford's proposed suspended centering for constructing the cast iron bridge over the Menai Straits as proposed in 1810

Peter Nicholson, *An Architectural Dictionary, containing a correct nomenclature and derivation of the terms employed by architects, builders, and workmen ... and the lives of the principal architects: the whole forming a complete guide to the science of architecture and the art of building ...* (London 1819), plates.
suspension bridges

Union Bridge by Captain Samuel Brown, constructed 1819-20

Menai Suspension Bridge, Wales, by Telford (1815), 1819-24
Union Bridge, near Berwick-upon-Tweed, by Captain Samuel Brown, constructed 1819-20: prospective view prior to construction

Journal of the Royal Society of Arts, CXXIV, 5361 (August 1986), back
Menai Suspension Bridge, Wales, by Telford (1815), 1819-24
Menai Suspension Bridge
links and details of connection

Hopkins, *Span of Bridges*, p 187

Pont de Cubzac (at Cubzac-les-Ponts Bourdeaux) by Emil Martin, 1839 [destroyed 1872]

Emile Martin, *Pont de Cubzac: Dessins et Description des Piliers en Fonte de Fer* (Schneider & Langrand, Paris 1841), pl II
self-contained spans
(beams, girders, tied arches, bowstrings)

Gaunless Bridge, attributed to George Stephenson, 1823-4

High Level Bridge, Newcastle, by Robert Stephenson, c 1845-9

Britannia Bridge, by Robert Stephenson and Francis Thompson, 1845-50
Iron railway bridge over the Gaunless, attributed to George Stephenson, 1823-4.


Derrick Beckett, Bridges (London 1969), p 38
Gaunless Bridge, now in the York Railway Museum

Walters & Seeley, 'The First Iron Railway Bridge', p 190
Gaunless Bridge, elevation of one span

Walters & Seeley, 'The First Iron Railway Bridge', p 191
High Level Bridge, Newcastle, by Robert Stephenson, c 1845-9

Smiles, *Lives of the Engineers*,
III, frontispiece
High Level Bridge, Newcastle

Miles Lewis
High Level Bridge, Newcastle: details of one span

Miles Lewis

Encyclopædia Britannica, 9th ed, sv Bridges
Britannia Bridge, Menai Straits, Wales, by Robert Stephenson and Francis Thompson, 1845-50: isometric section

Hitchcock, *Early Victorian Architecture*, II, XV, 36
Britannia Bridge

wrought iron

- pure (to commercial standards)
- hammered or rolled
- fibrous texture
- good in tension
- good in bending
- subject to rust
Britannia Bridge

diagrams of bending moment, with and without continuity

the process of erection

Miles Lewis
Beckett, *Bridges*, p 38
Britannia Bridge, method of placing the girder so as to obtain the effect of continuity

Britannia Bridge
Menai Suspension Bridge
Newcastle High Level Bridge

*Encyclopædia Britannica*, 9th ed, sv Bridges