Corso di ponti 2007

Tipologie e Criteri Progettuali di Ponti e Viadotti

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L’evoluzione storica dei ponti

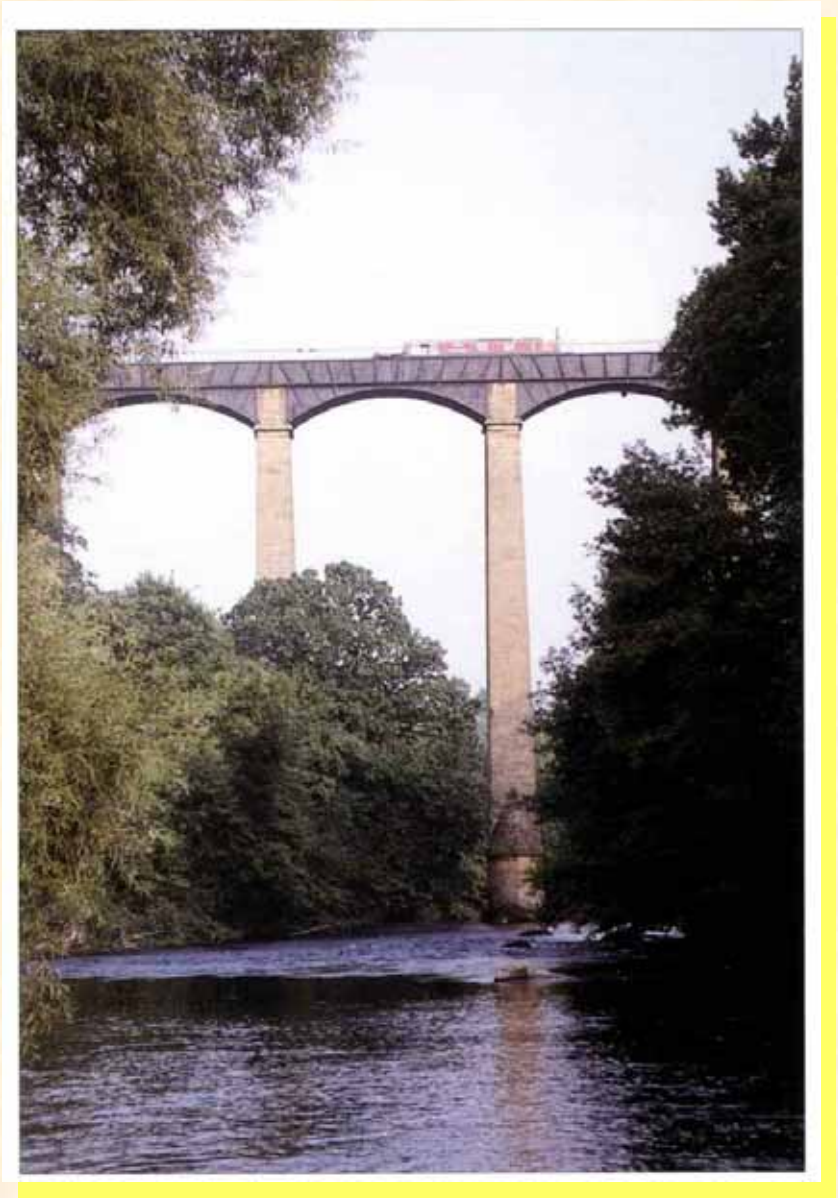
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Pont du Gard over the river Gardon. A roman acqueduct on the Nimes water supply line, France (first century BC).

Bridge Engineering :a global perspective – Leonardo Fernandez TROYANO
Thomas Telford Publishing 2003

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A barge crossing the Tontcysylle acqueduct over the river. Dee on the Ellesmere canal, Freat Britain; archer of 13,7 metres (1805). T. Tòlford

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Forth railway bridge, Scotland; two main spans of 521 metres (1890), J. Fowler and B. Baker

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Garabit viaduct over the Truyère, France; arch of 166 metres span (1884), G. Eiffel, L. Boyer and M. Koechlin

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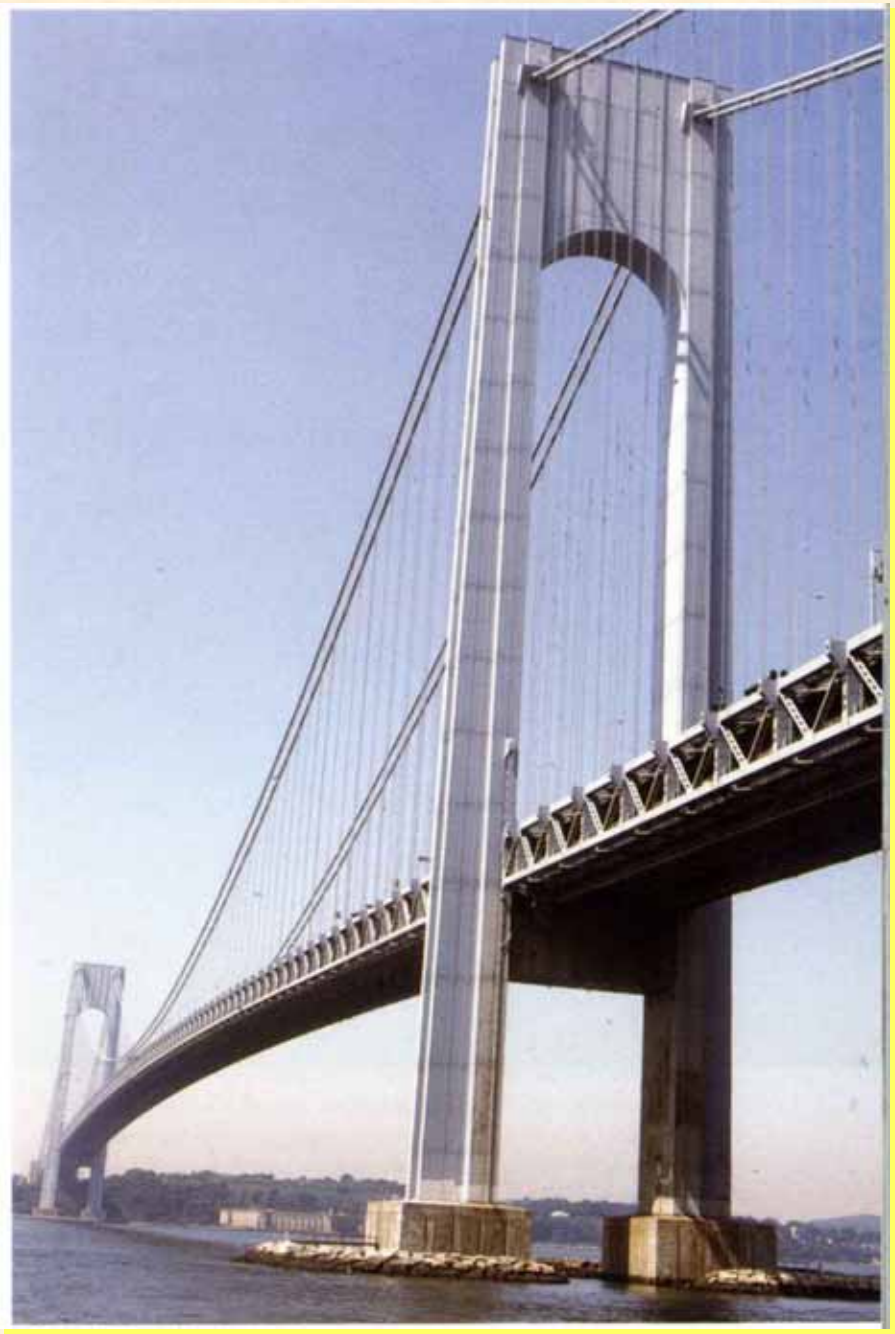
Salgina-Tobel bridge on the Schiers to Scuders road, Switzerland; arch of 90 metres span (1930), R. Maillart.

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Golden Gate bridge in San Francisco bay California; main span of 1280 metres (1937), J. B. Strauss

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Verrazzano Narrows bridge at the entrance to the port of New York; main span of 1298 metres (1964), O. Ammann

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Humber esuary bridge, England; main span of 1410 metres (1981), Freeman Fox ad Partners[11]

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Storebaelt bridge over the Grand Belt, Denmark; main span of 1264 metres (1998), Cowiconsult



Akashi-Kaikyo bridge near the city of Kobe, Japan; main span of 1990 metres, Under construction

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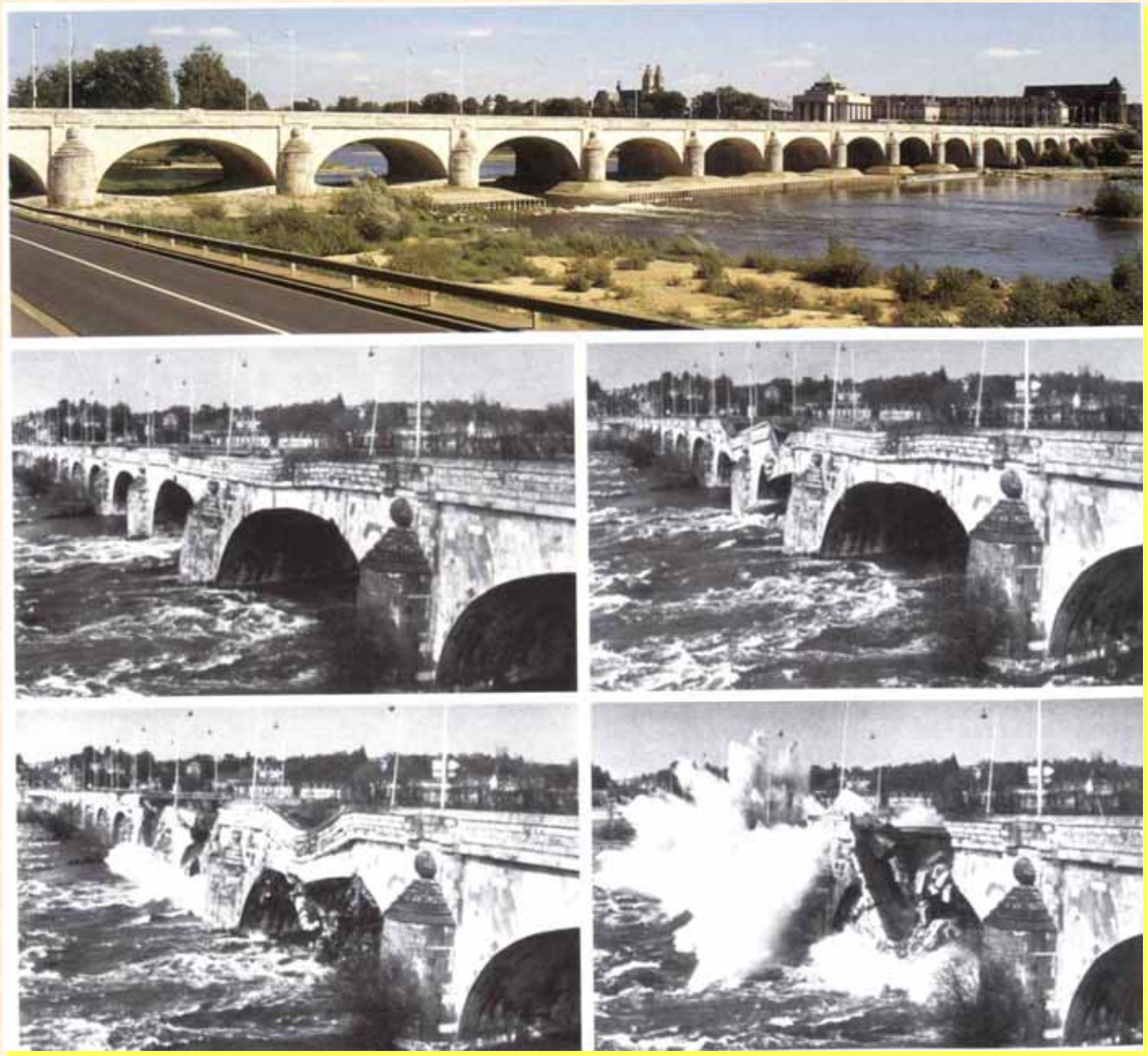
Alamillo bridge over the San Jerònimo meander on the old Guadalquivir river course, Seville; single span of 200 metres, S. Calatrava.

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Crolli e insuccessi

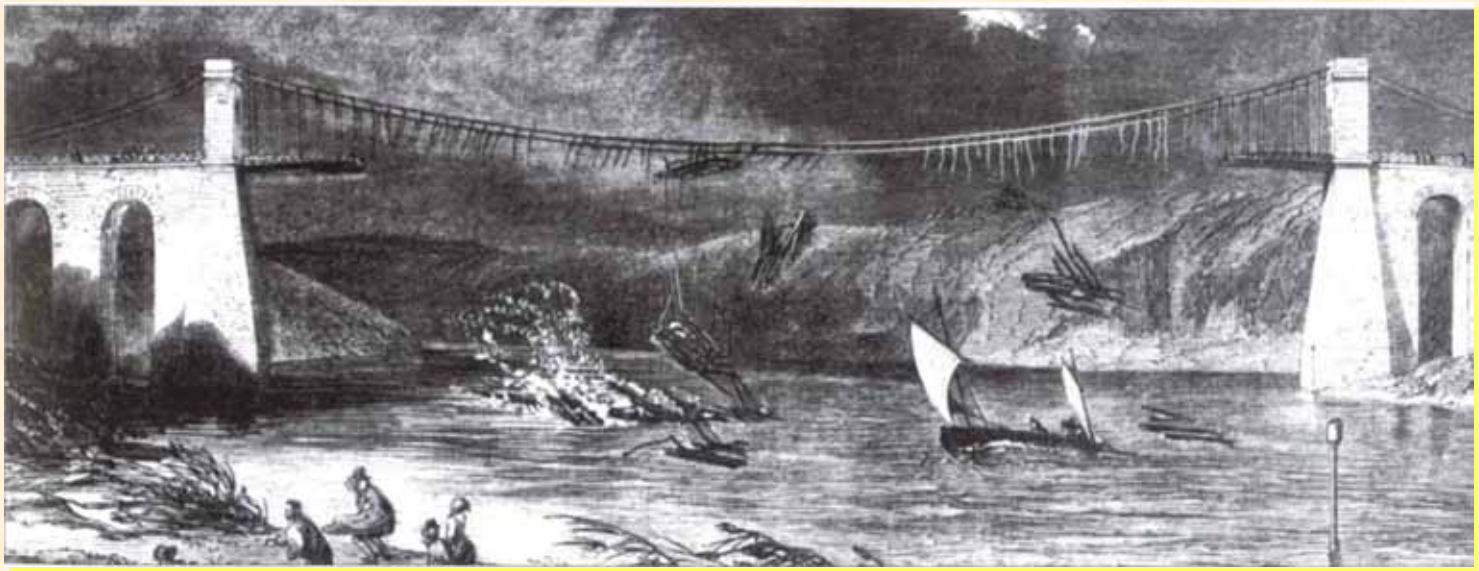
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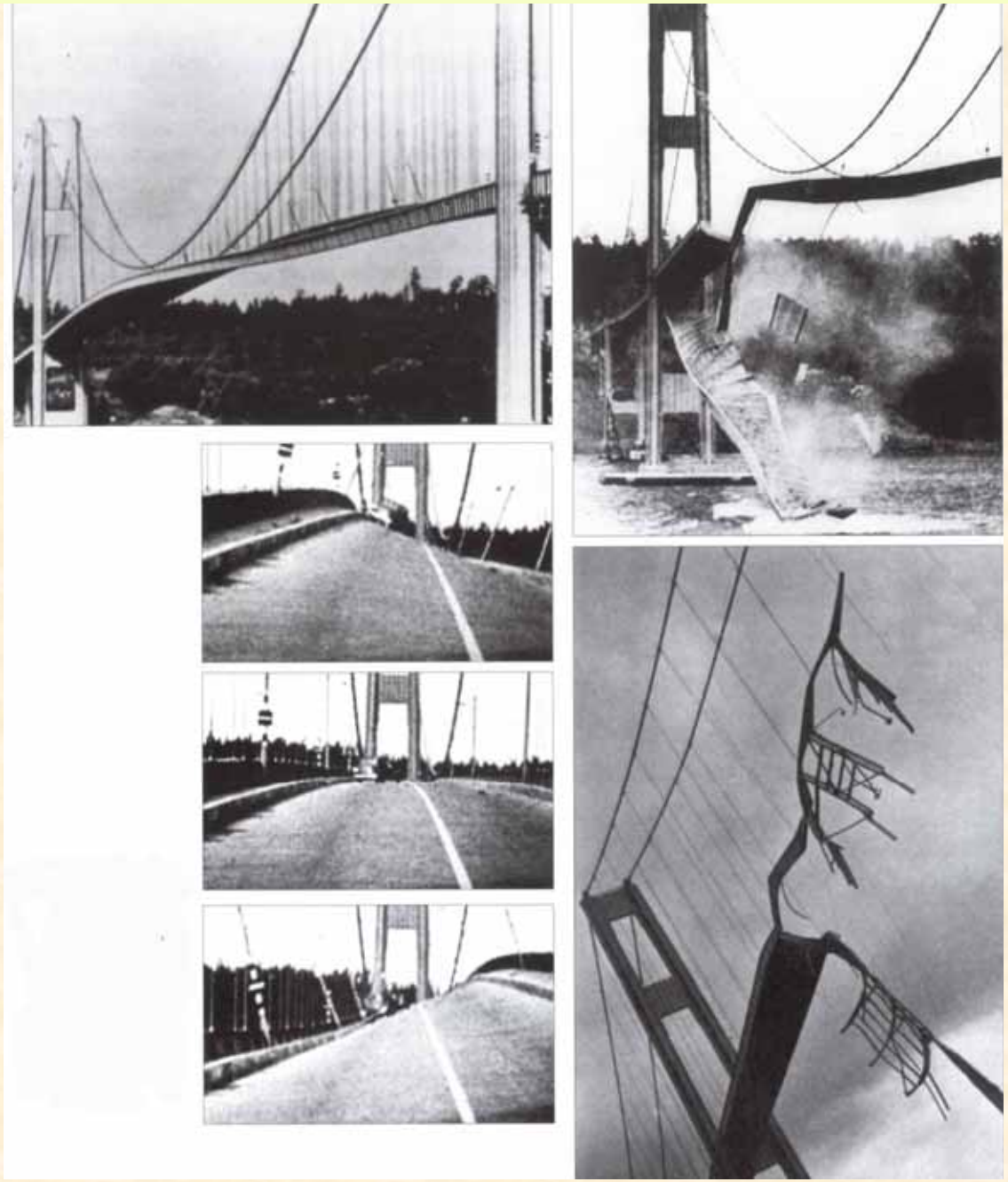
Collapse of the Wilson bridge over the river Loire in Tours, France, 15 arches of 24.36 metres psna (1777), M. Bayeux and J. De Voglie. The collapse occurred in the 9 April 1978 freshet. Top photo, as al present.

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Roche-Bernard bridge over the river Vilaine, France, 198 metres span, collapsed on 26 October 1852.



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Tacoma Narrows bridge, Washington State, United States, 853 metres span. Collapsed on 7 November 1940 from wind effect in a 68-kilometres-per-hour wind. L. Moisseiff

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Cypres Viaduct in San Francisco, California, United States, The viaduct's second storey fell onto the first during the 1989 Loma Prieta earthquake

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Viaducct pier in Los Angeles, which collapsed in the 1994 California earthquake

Kobe viaducts, Japan, overturned during the 1995 Hanshin.Awaji earthquake





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Bouble railway viaduct on the Commentry-Gannat line, Central Massif, France, Trussed metal grider with six spans of 50 metres (1869), W. Nördling and F. Moreaux

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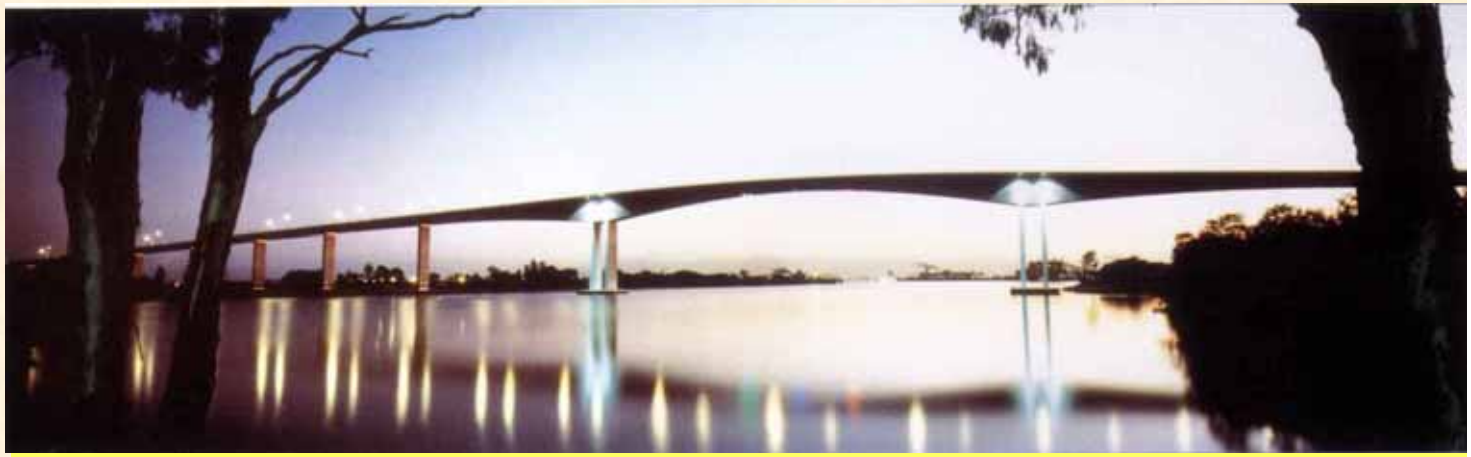
Langwies viaduct on the Chur to Arosa railway line, Switzerland, Reinforced concrete arch, 100 metres span (1914), E. Zublin



Dorémaz bridge over the Rhône, Switzerland, Reinforced concrete beam bridge with spans of 30.5+45+30.5 metres (1933), A. Sarrasin

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Gateway bridge in Brisbane, Australia, Prestressed concrete beam with a central 260 metres span (1985).

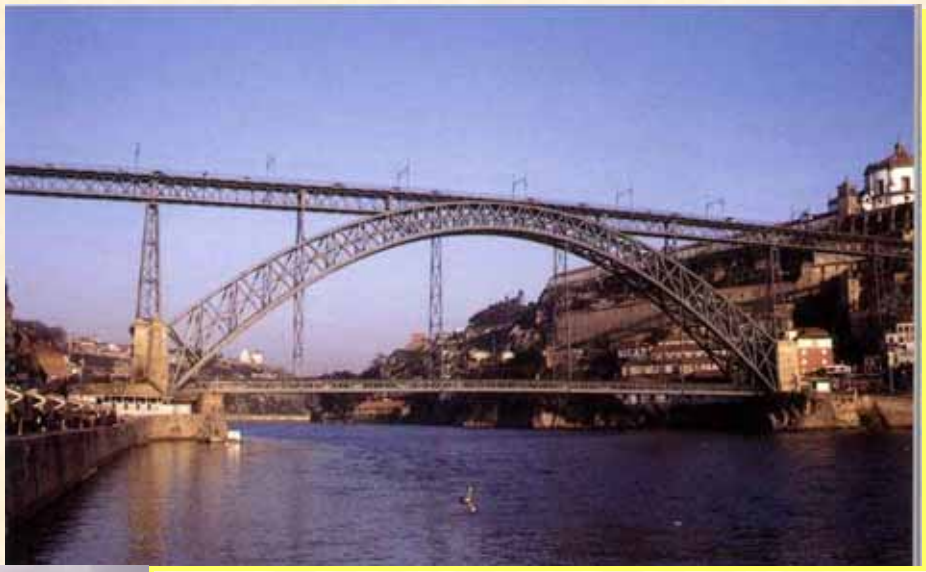




Aberfeldy stayed footbridge over the river Tay in Scotland, The deck, towers and stays are composite materials, 63 metres spna (1992), Maunsell Structural Plastic

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Uniom Bridge over the river Tweed, Great Britain, Suspension bridge of 137 metres psna (1820), S. Brown





Luis I bridge over the river Douro in Oporto, Portugal, metal arch of 174.5 metres span (1885), T. Seyrig

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Mannheim-Ludwigshafen bridge over the Rhine, 287 metres span (1971), F. Leonhard

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Normandie bridge at the mouth of the Seine, France, Cable-stayed bridge with metal deck of 856 metres span. Current world record (1995), M. Virgoleux

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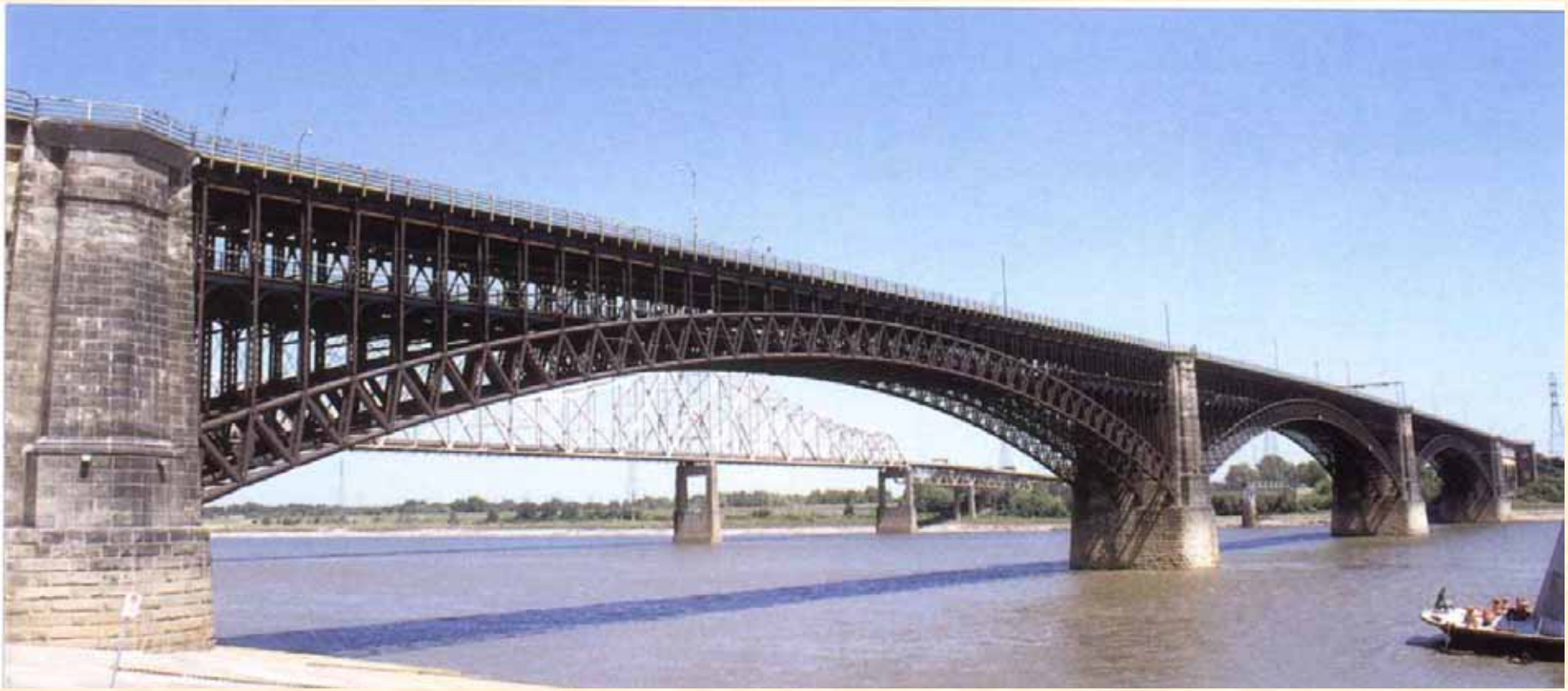
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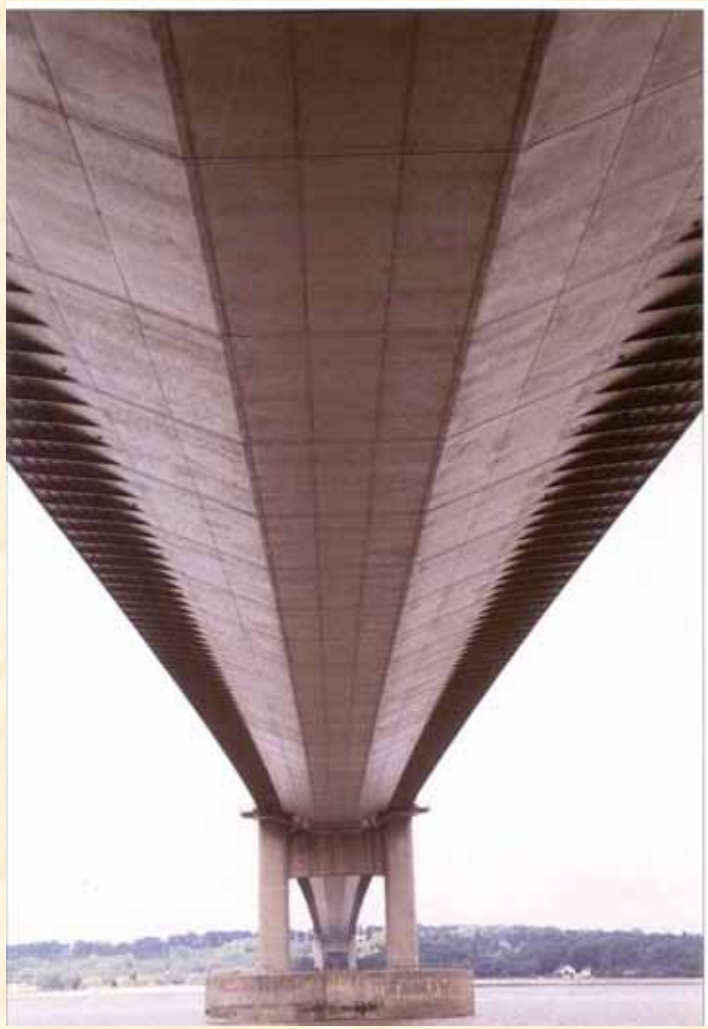
Coalport cast iron bridge over the river Severn, England, 31 metres span (1818).

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St. Louis bridge over the Missisippi river, United States, Also called Eads Bridge, largest arch 157 metres span (1874), J. Eads.

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Welded and bolted structure, Humber bridge deck in England, 1410 metres span (1981), Freeman, Fox and Partners.

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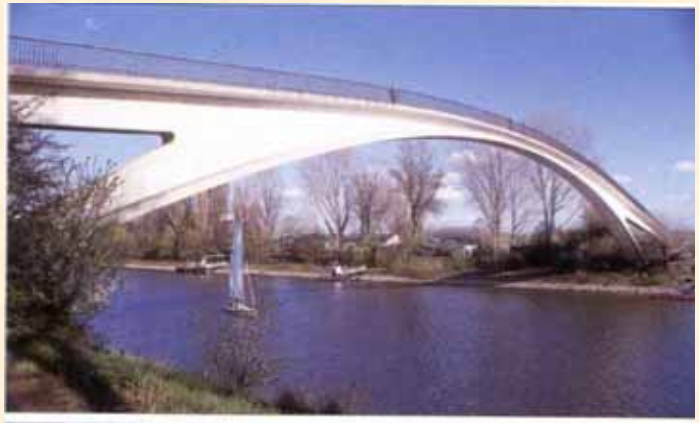
Orthotropic slab of Severin bridge over the Rhine in Cologne, with open stiffeners, main span of 230 metres (1962).

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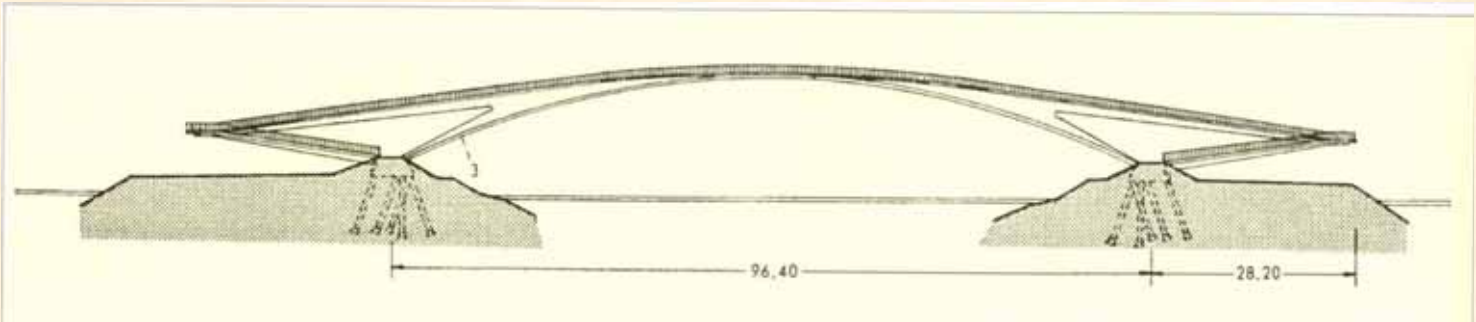
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Dyckerhoff footbridge in Wisbaden-Shierstein, 96 metres span (1967), U. Finsterwalder and G. Lohmer





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Active reinforcement of Horremer bridge, Germany, 85 metres span. U. Finsterwalder

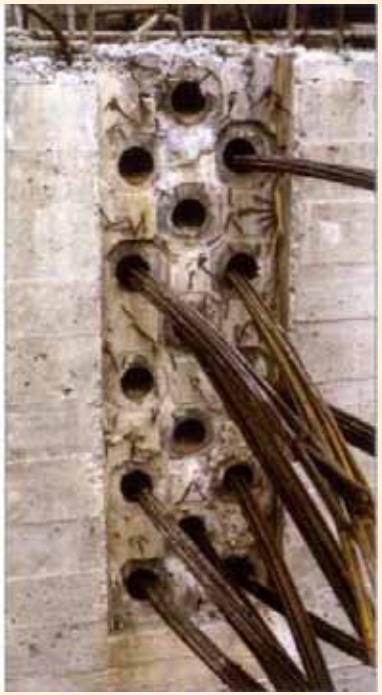


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Freyssinet microconcrete anchorages. The anchoring with twelve 7-illimetre diameter wires. Anchorages of Castjón bridge before tensioning, 101 metres span (1967).

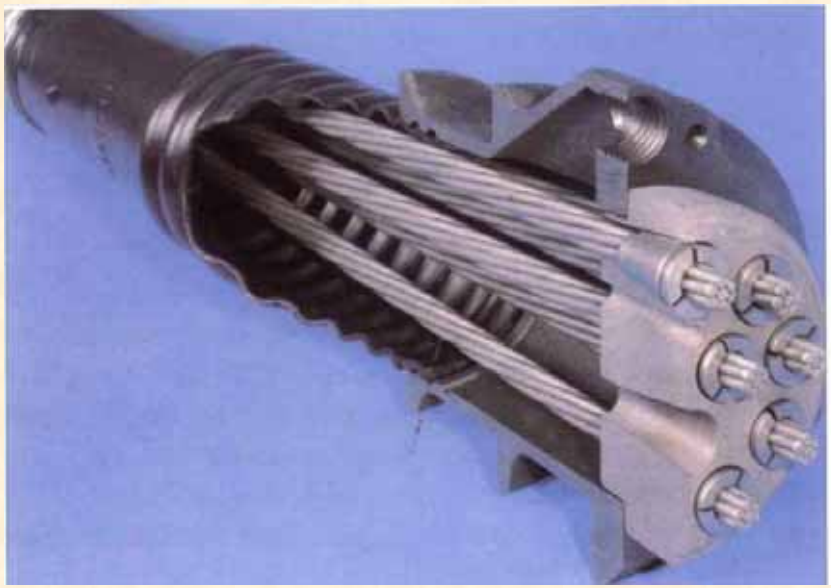


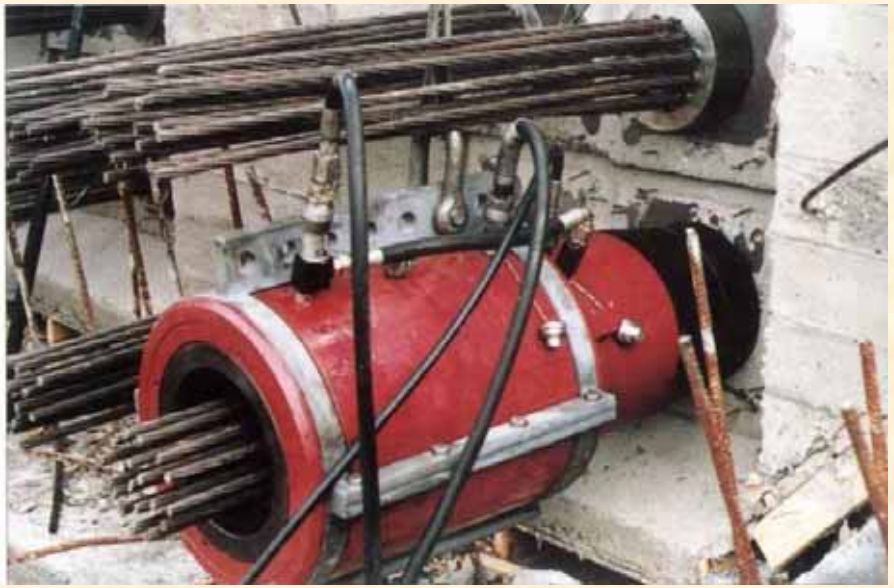




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Present-day anchorages with individual chucks per cable. Anchorage of one unit (Dywidag). Anchorages on site and tensiong jack (MK4).



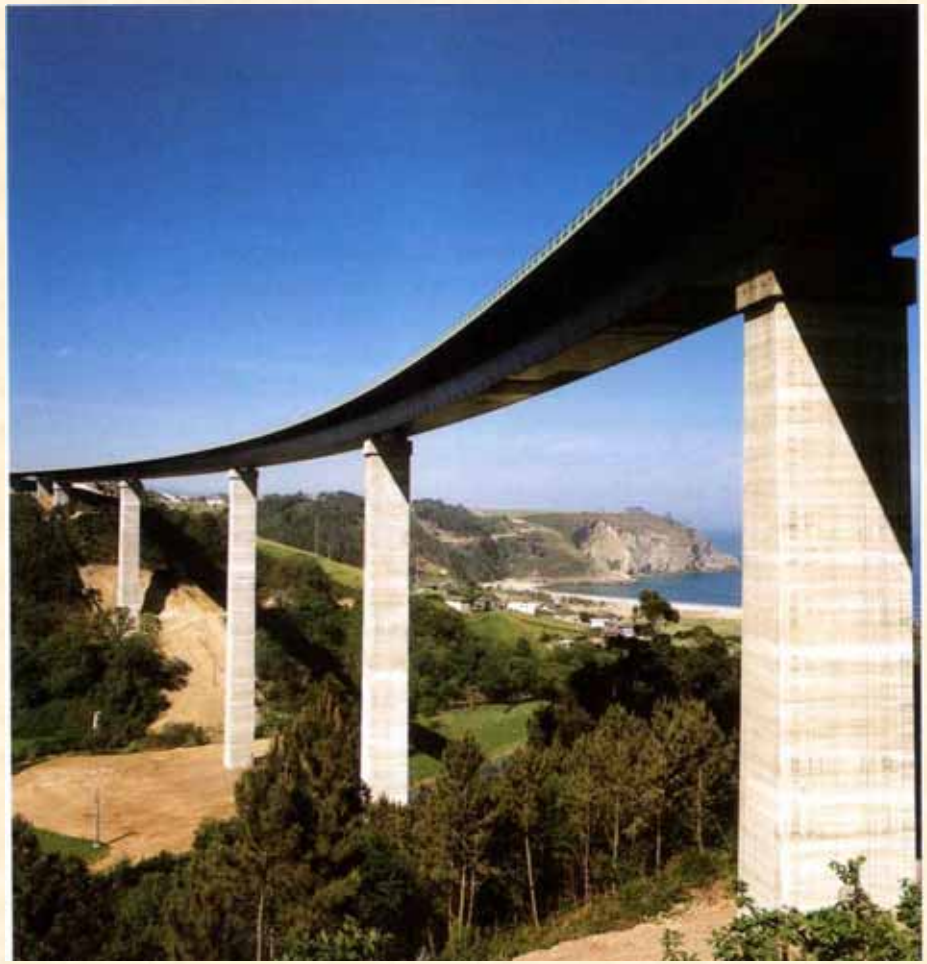


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Canero viaduct Asturias. Composite structure with 110 metres spans (1966), Iberinsa, entrecanales

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Composite structure with precast concrete deck, Albufera viaduct, Madrid, 31 metres span, Carlos Fernández Casado, S. L. Metal girders with their connectors. Precast slab with spaces for bousing the connectors. The finished deck.

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Nautenbach bridge over the river Main, Germany, 208 metres span (1994). Leonhardt Andrä and Partner

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Lo schema strutturale e il procedimento costruttivo

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Sandö arch bridge over the river Angerman, near Stockolm, Sweden, 264 metres span (1942).

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Beam bridge. Kochertal viaductc neard Geislingen, Germany spans 138 metres long, pier height in 180 metres (1980).

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Suspension bridge over the river Severn estuary, England, 987.5 metres span (1966), Freeman, Fox and Partners.

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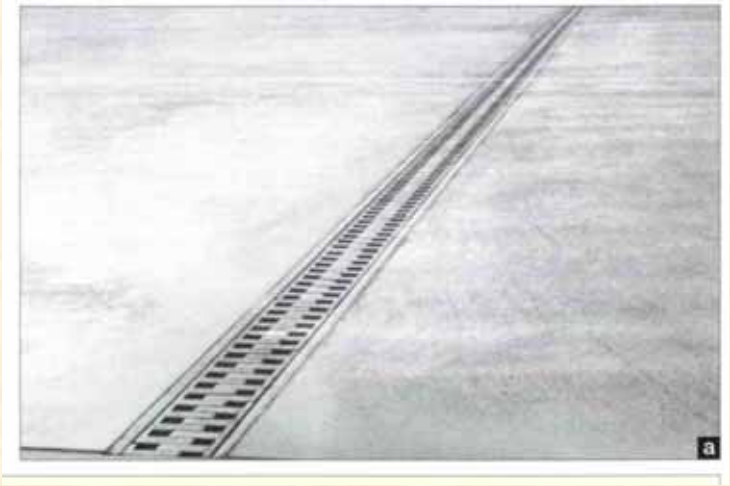
Cable-stayed Bonn North bridge over the Rhine, Germany, 280 metres span (1966), H. Homberg.

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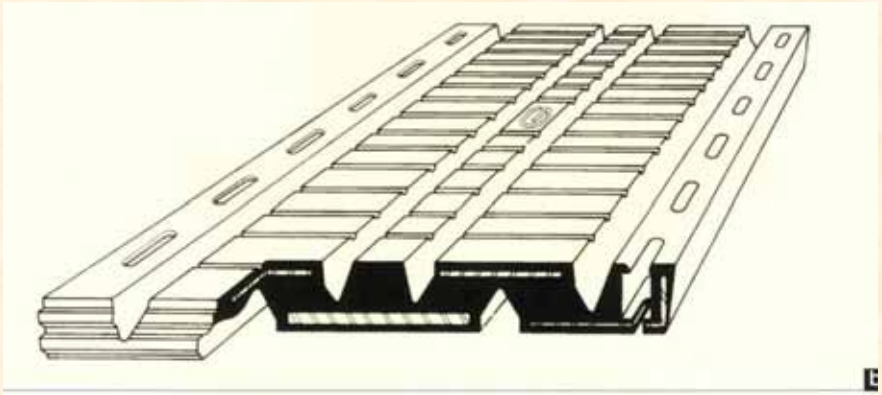


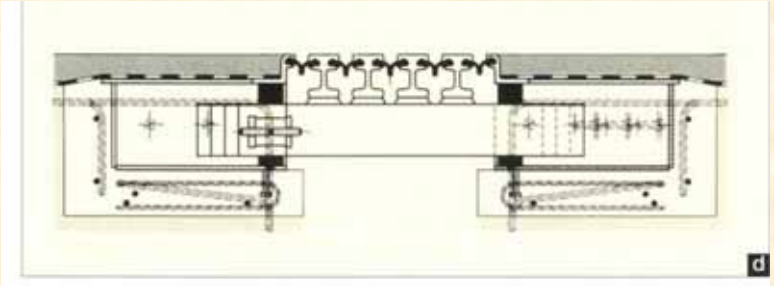
Frame bridge. Martigues viaducts over the Caronte canal, France, 210 metres span (1972).

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Roadway espansion joints to allow bridge deck movements.
(a) Comb espansion joint
(b) Neoprene joint
(c) and (d) Persioan bling joint (Maurer)

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Metal bridge hinges:

(a) Central hinge of the three-hinged structure for suspending the side spans of Tower Bridge in London (1894)

(b) Support hinge of the Garabit arch bridge, 166 metres span (1884), G. Eiffel, L. Boyer and M. Loechlin,

(c) Support hinge of the Tyne viaduct in Newcastel, England, 162 metres span (1928), Mott, Hay and Anderson.

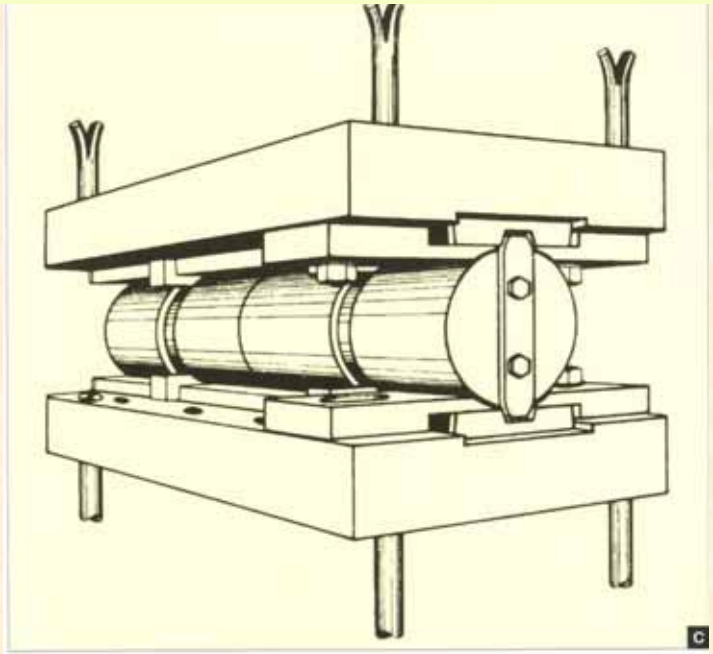


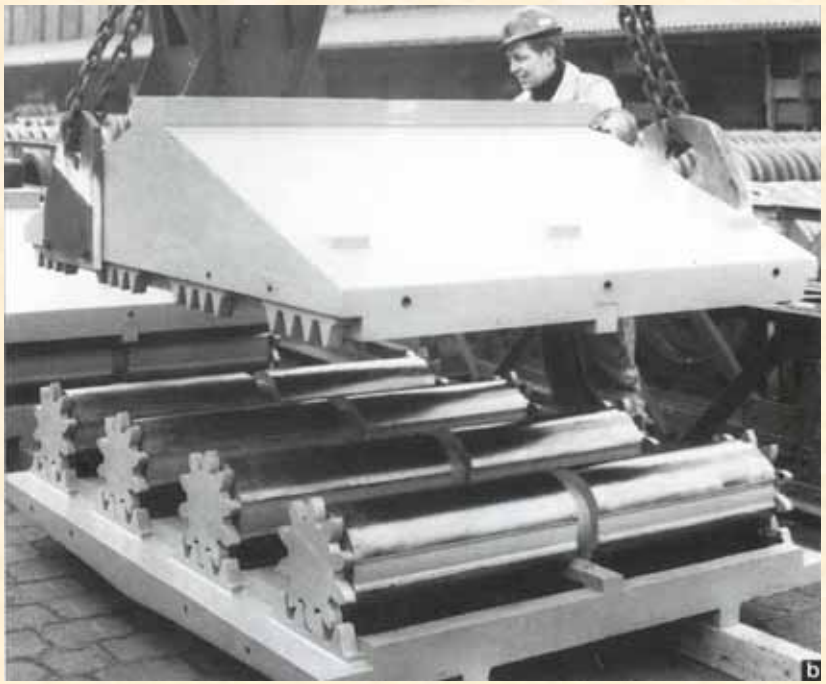




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Roller supports:

(a) Support with hinge and displacement by means of a ball hinge and roller train. Arganda bridge over the river Jarama (1910).

(b) Multiple roller for large longitudinal movements (GHH)

(c) Simple roller for gyration and longitudinal movements.

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Reinforced concrete hinges:

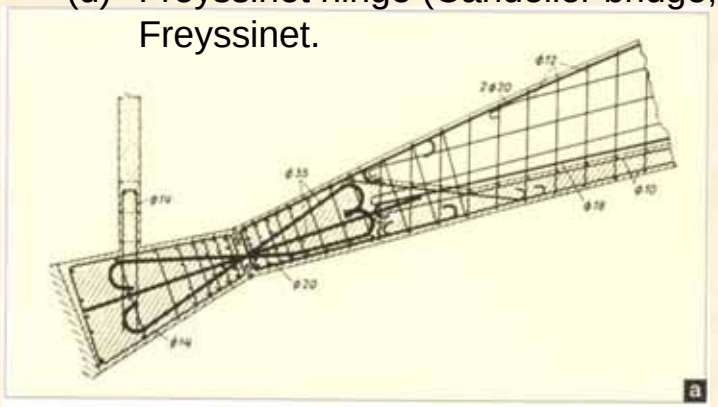
(a) Messnager hinge Vessy bridge over the river Aare, 56 metres span (1936), R. Maillard.

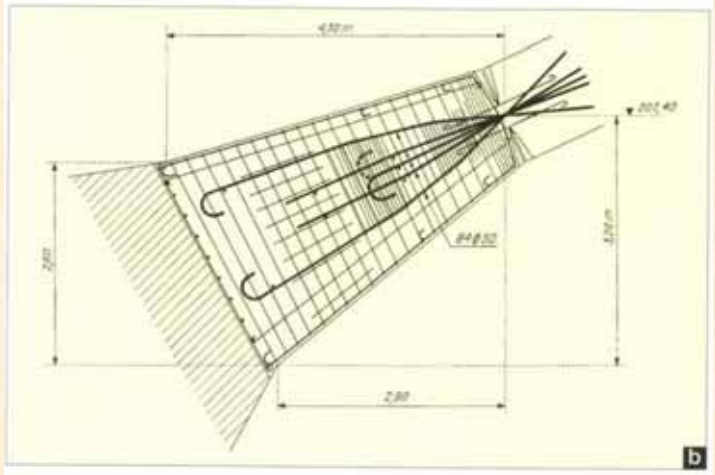
(b) Messnager hinge (three-hinged arch bridge over the river Maggia near Locarno, Switzerland, 88 metres span).

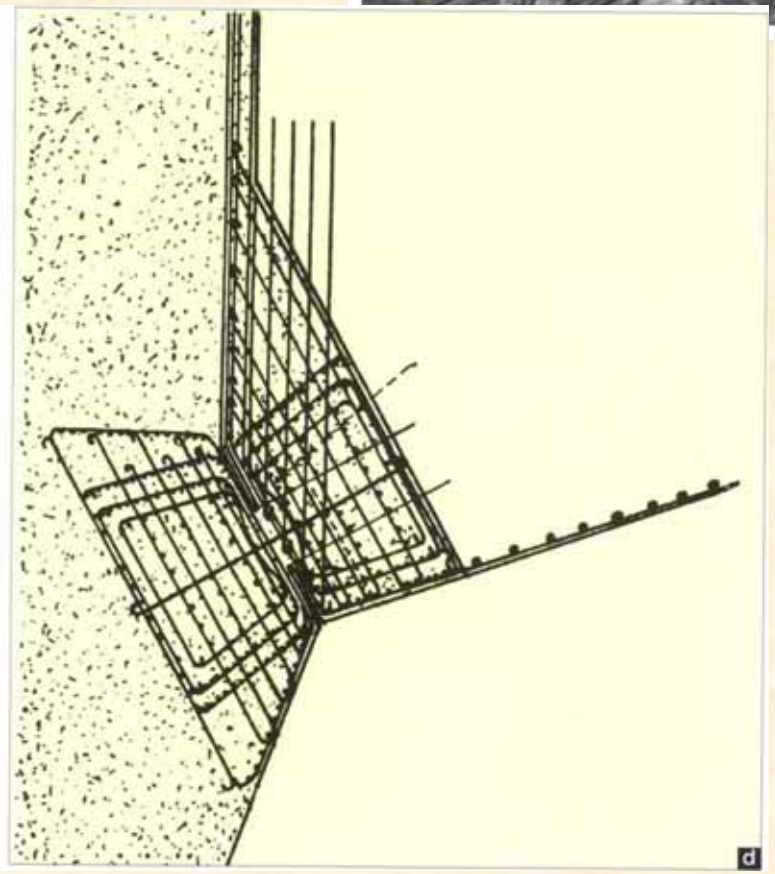
(c) Photograph of the foregoing hinge reinforcement.

(d) Freyssinet hinge (Candelier bridge, France), E. Freyssinet.







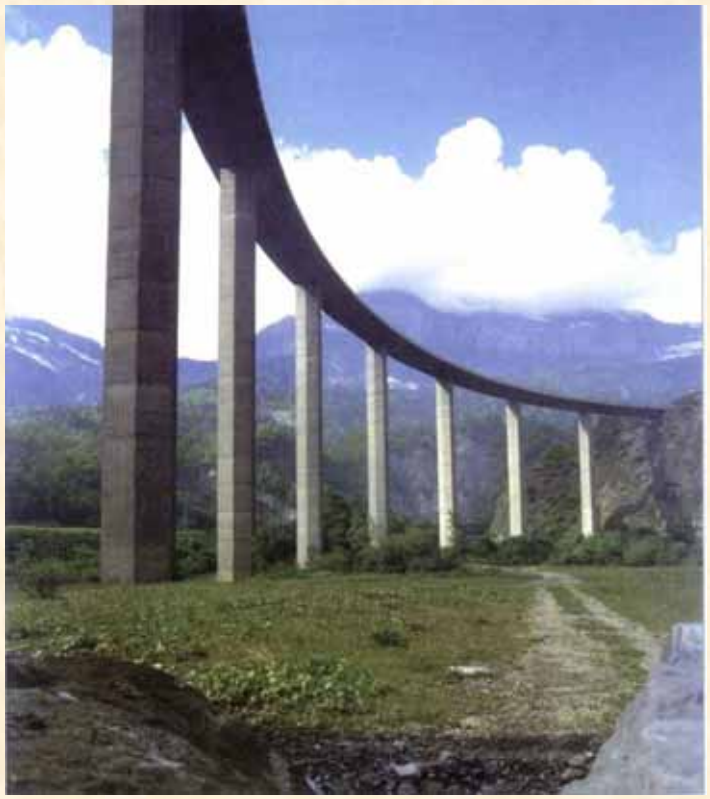


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Cuesta de silva viaduct in the island of Gran Canaria, Spain, 120 metres span, J.A. Torrojia Oficina Técnica





Egratz viaduct on the approach to Chamonix France, 50 metres span, overall length of 1469 metres (1981).

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Val-Restl viaduct, Italy, 32.metre spans (1972), B. Giovannini. Under construction and the finished viaduct.





Design of Ruck-A-Chucky bridge over the American River, california, T.Y. Lin. Not built



Kelheim footbridge over the canal connecting the Main with the Danube, 65 metres span (1987), J. Schaich

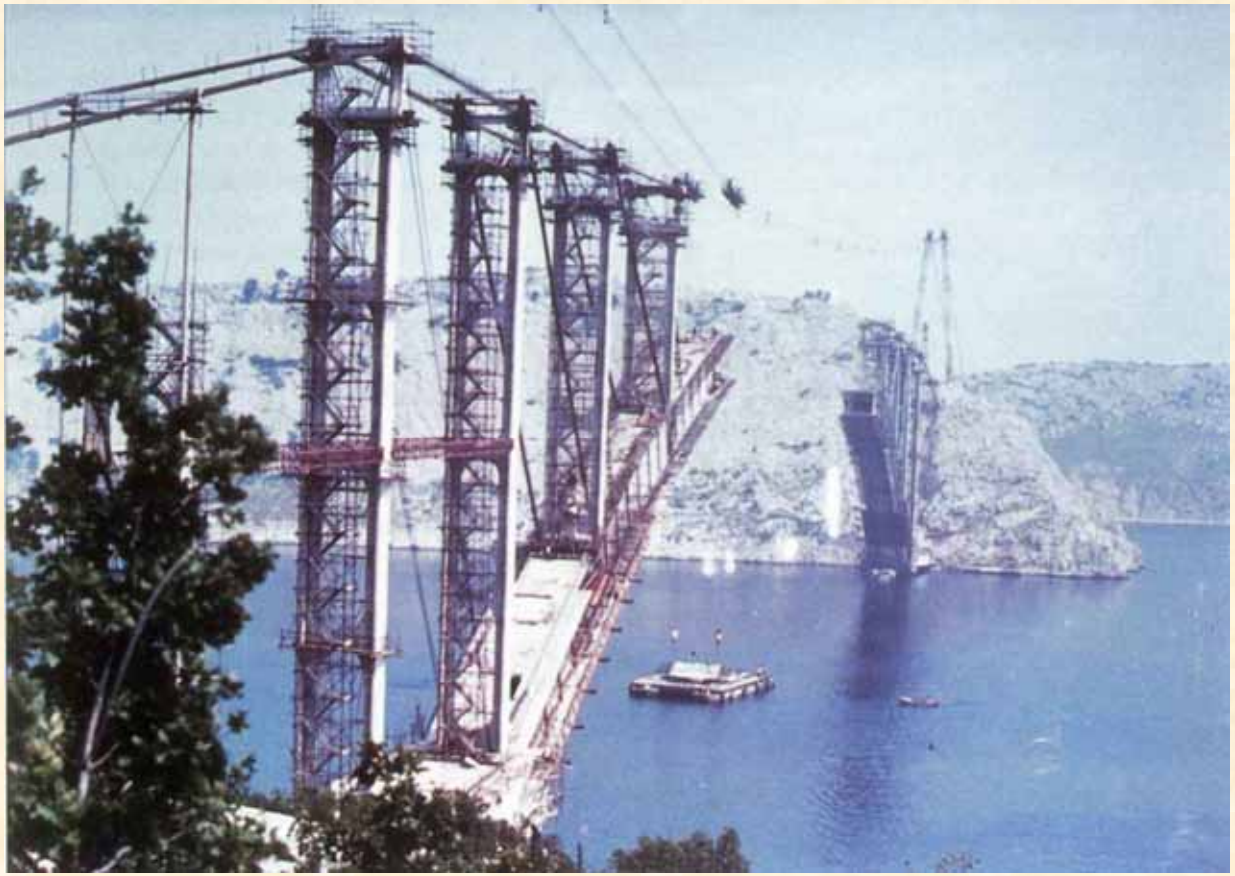


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Balanced cantilever construction of the Gateway bridge in Brisbane, Australia, 260 metres span (1985).

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Truss cantilever construction of the Krk islan arch bridge, Croatia, 390 metres span (1979).

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Isle of Olerón viaduct, France, Cantilever method by precast segments, 70 metres span, 2900 metres long (1964), Campenon Bernard

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Erection of a prefacricated bridge by complete spans using a floating crane. Kansai airport viaduct, Japan, 107 metres spans (1991).

Eichelnbleck viaduct in Germany. In situ bult using self-supporting and self-launching centring (1968), H. Wittfoht, Polenscky and Zollner.



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Erecting metal centring for the Arrábida bridge over the river Douro in Oporto, Portugal, 270 metres span (1963), E. Cardoso.

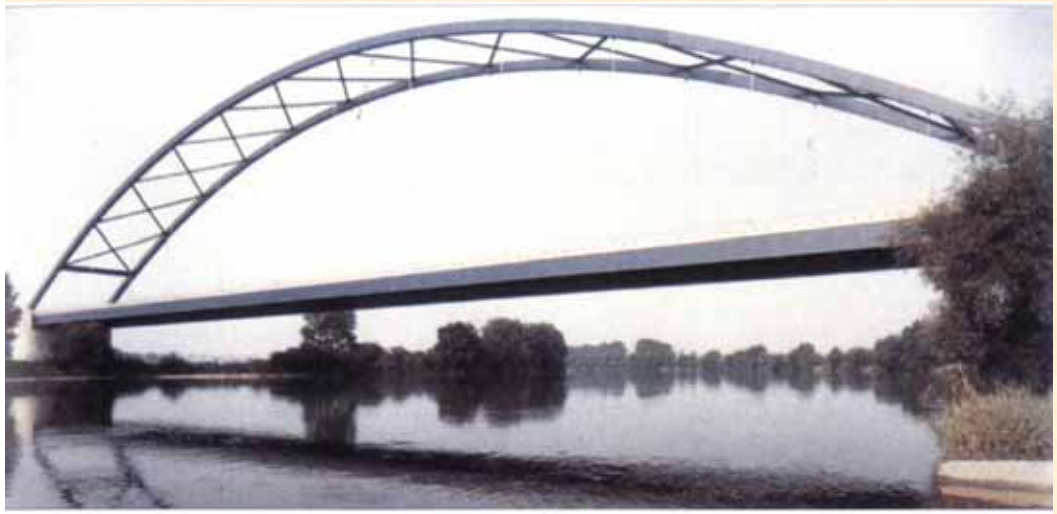
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Mythe bridge over the river Severn, Great Britain, 52 metres span (1826), T. Telford.

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Through arch or bowstring bridges



Bridge over the Danube in Straubing, Germany, 200 metres span

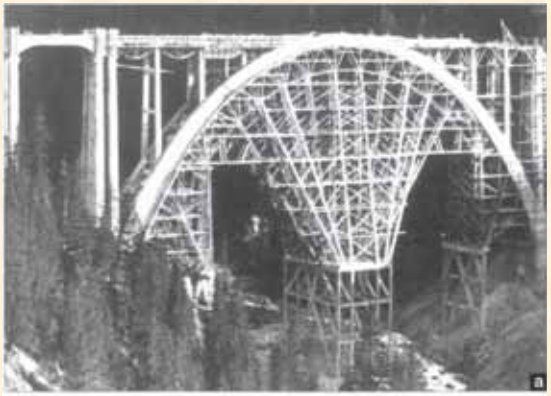


Bridge between Duisburg and Rheinhausen, Germany, 255 metres span

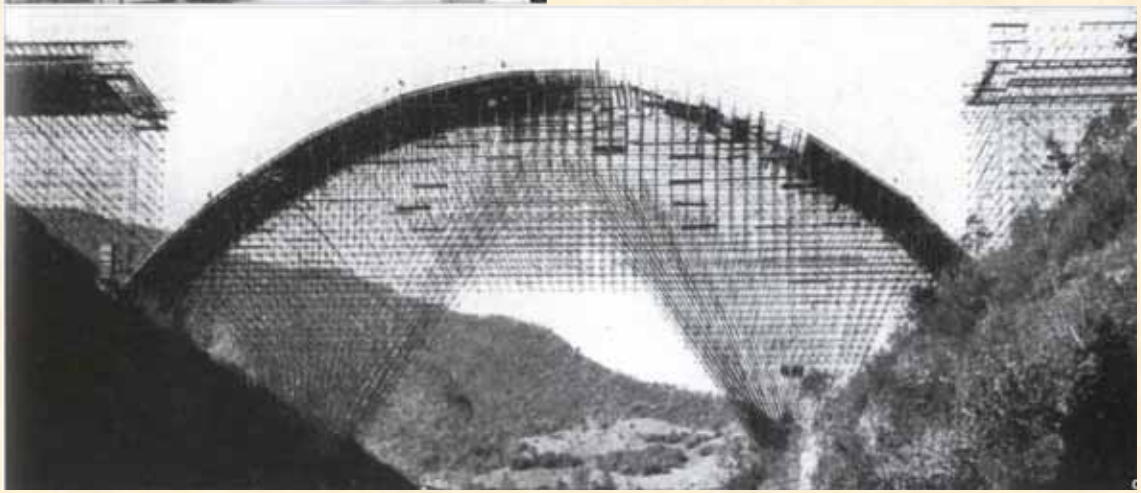


Gorinchem bridge over the river Merwede in Holland, two spans of 170 metres

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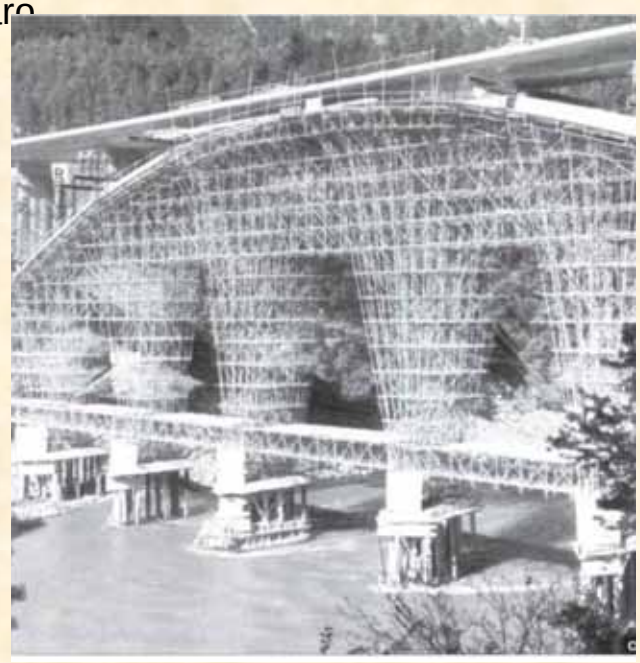
Arch centring Timber centring:

(a) Langwies viaduct, Switzerland, 100 metres span arch (1914), E. Zublin.

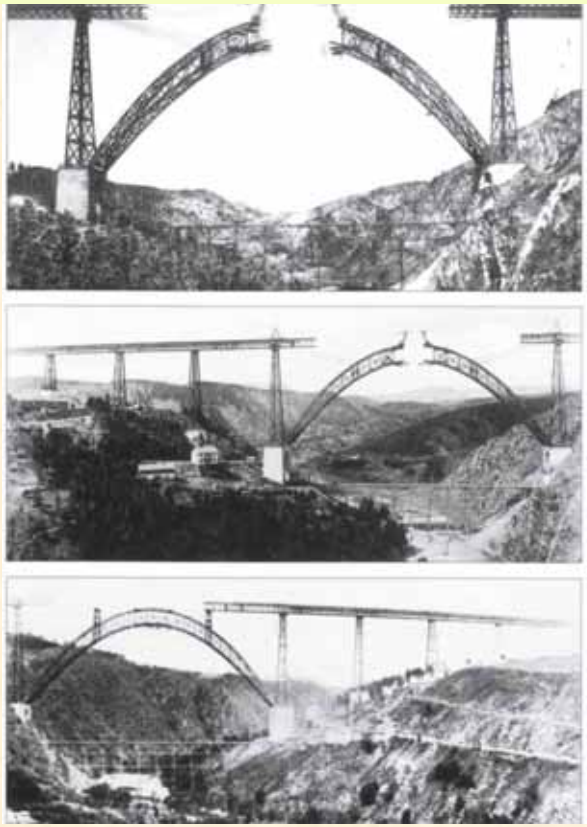
(b) Fürsteland bridge near St. Gallen, Switzerland. Tube centring.

(c) Reichenau bridge over the Rhine, Switzerland, 100 metres span, C. Menn.

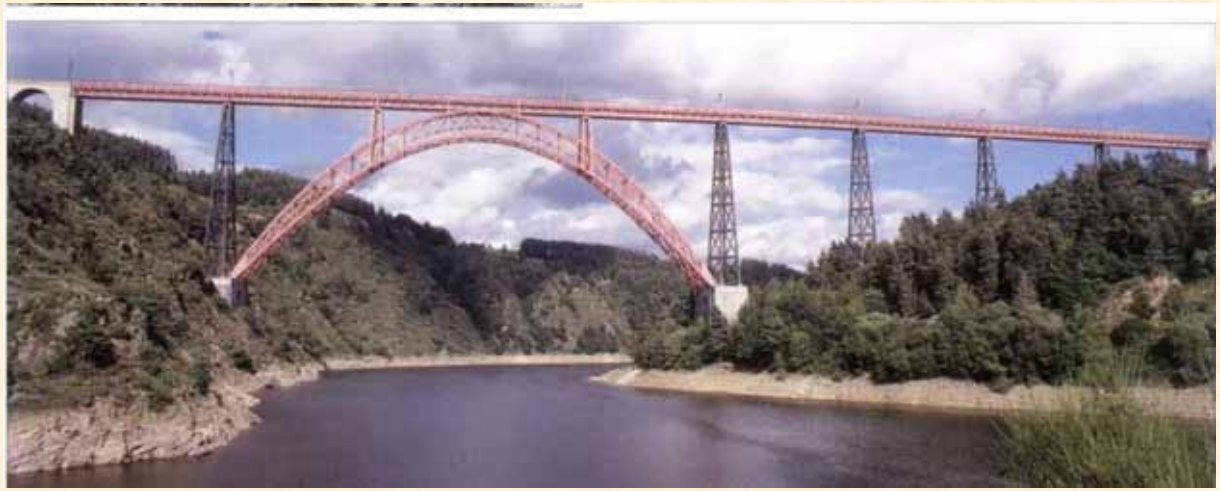
(d) Bridge over the river Costa, Italy, 100 metres span (1961). A. Passaro



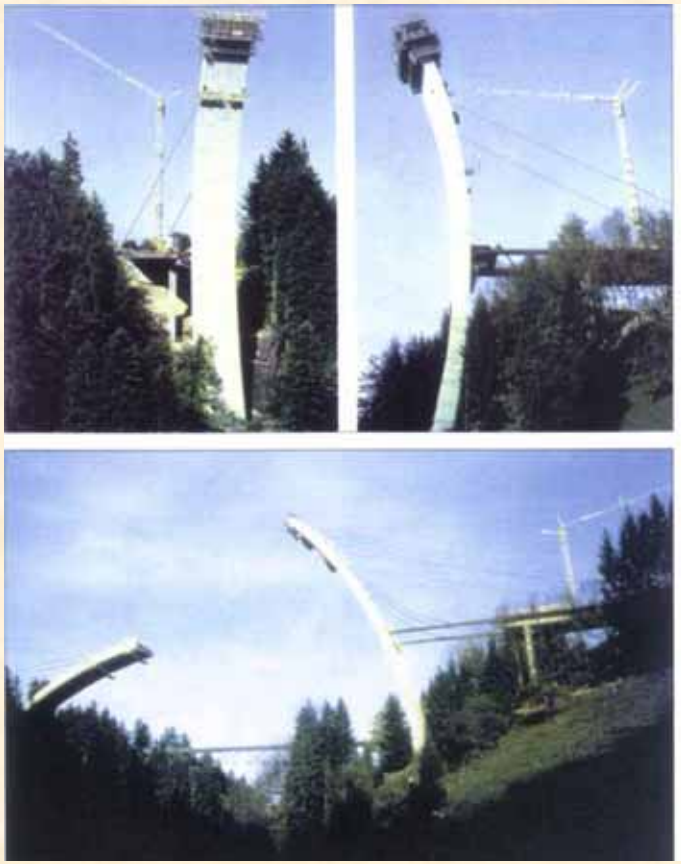
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Building Garabit bridge over the Thruyère, France, 166 metres span (1884), G. Eiffel, L. Boyer and M. Koechlin,
(a) and (b) Building the arch by th stayed cantiliver method, (c) Launching the deck till closing at the crown, (d) the finished bridge.



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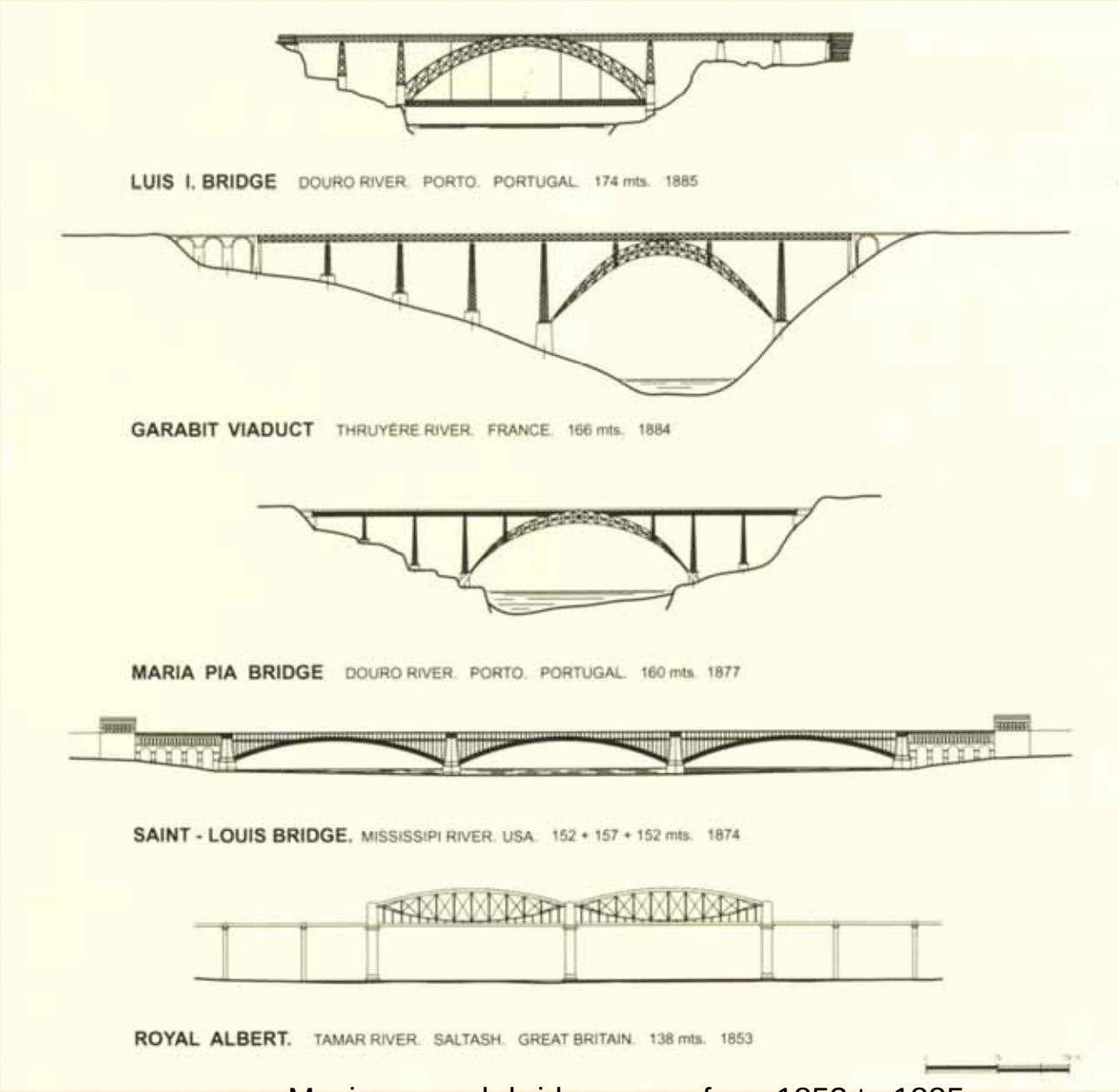
Argentobel bridge, Germany, 150 metres span (1986), E. Bung.

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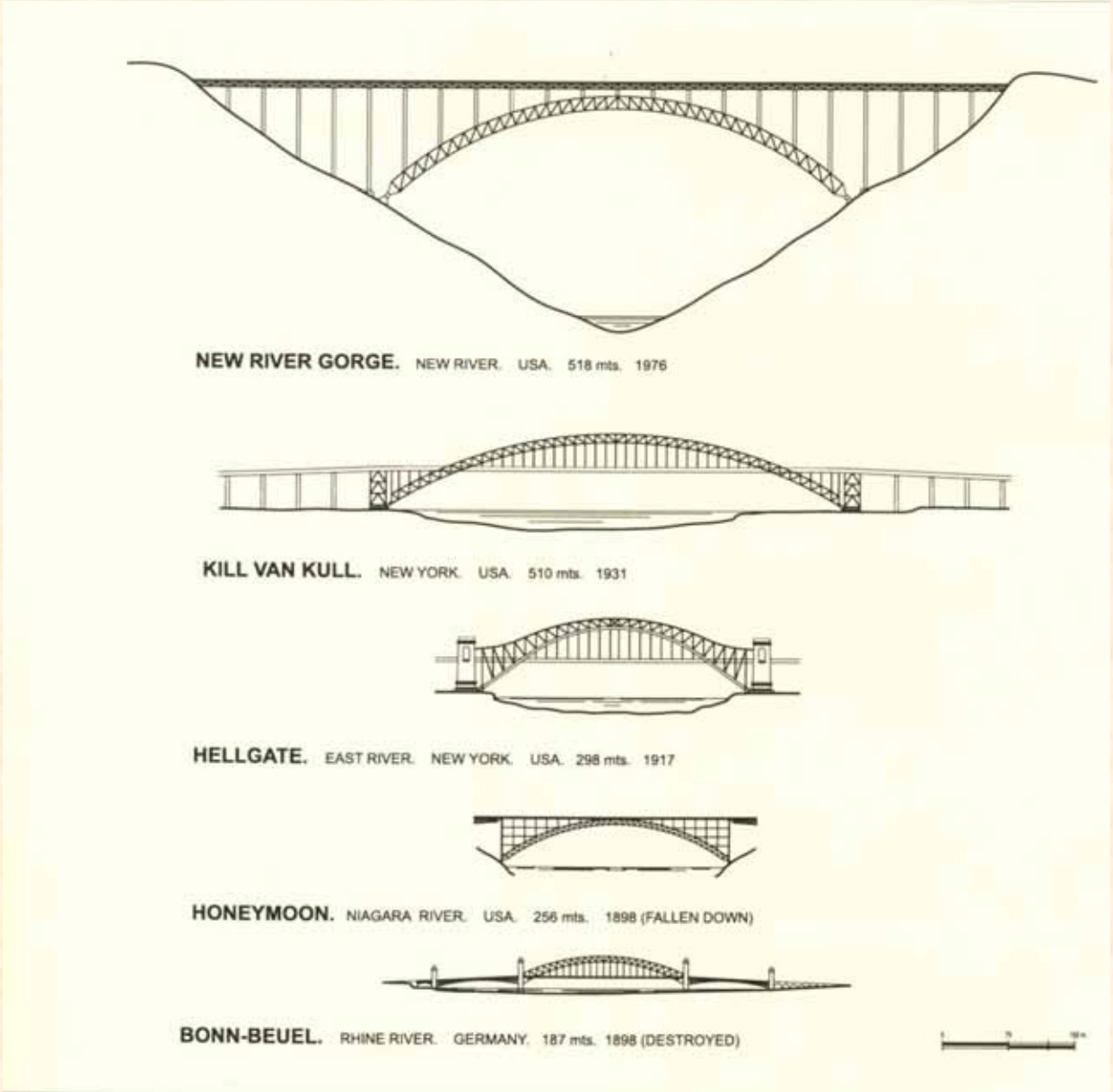
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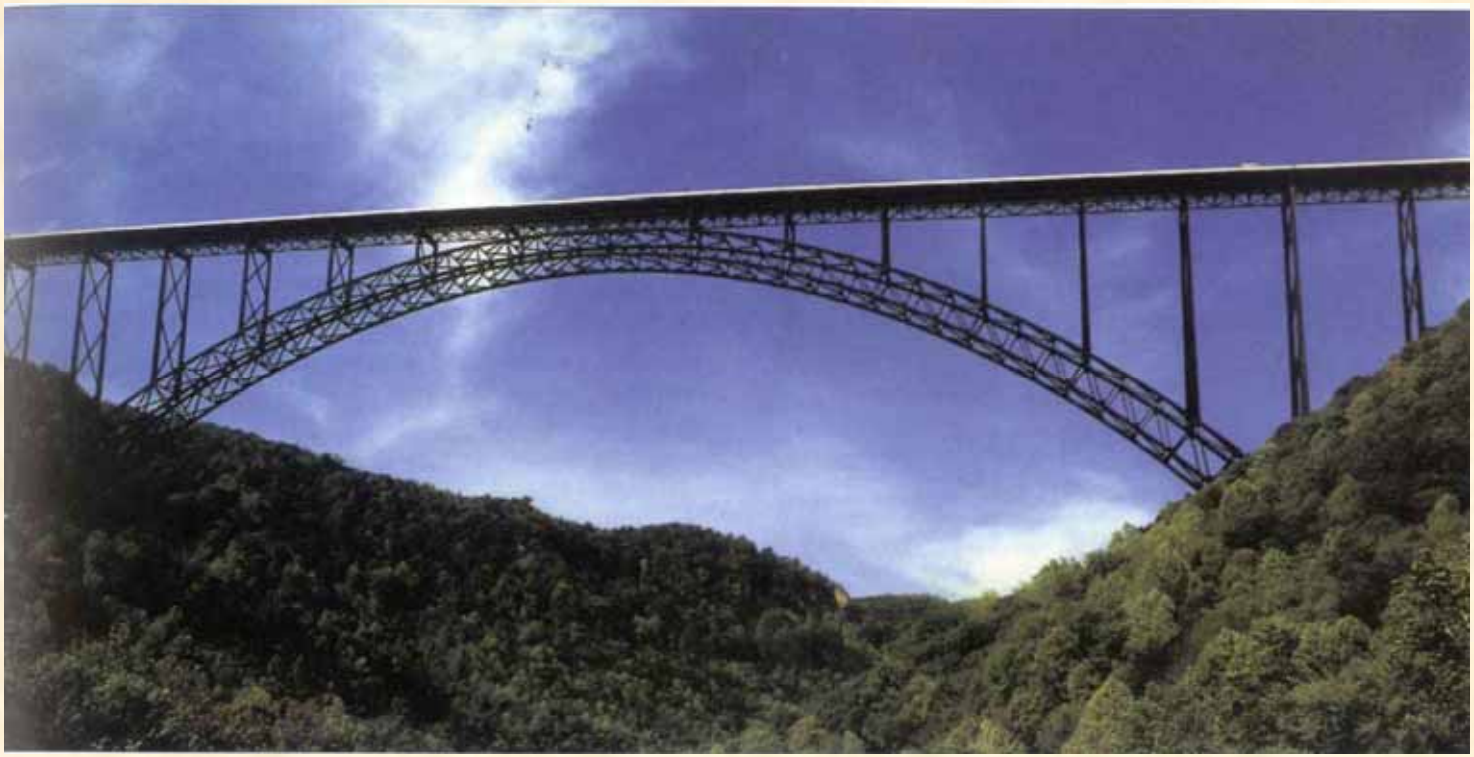
Maximum arch bridge spans from 1853 to 1885

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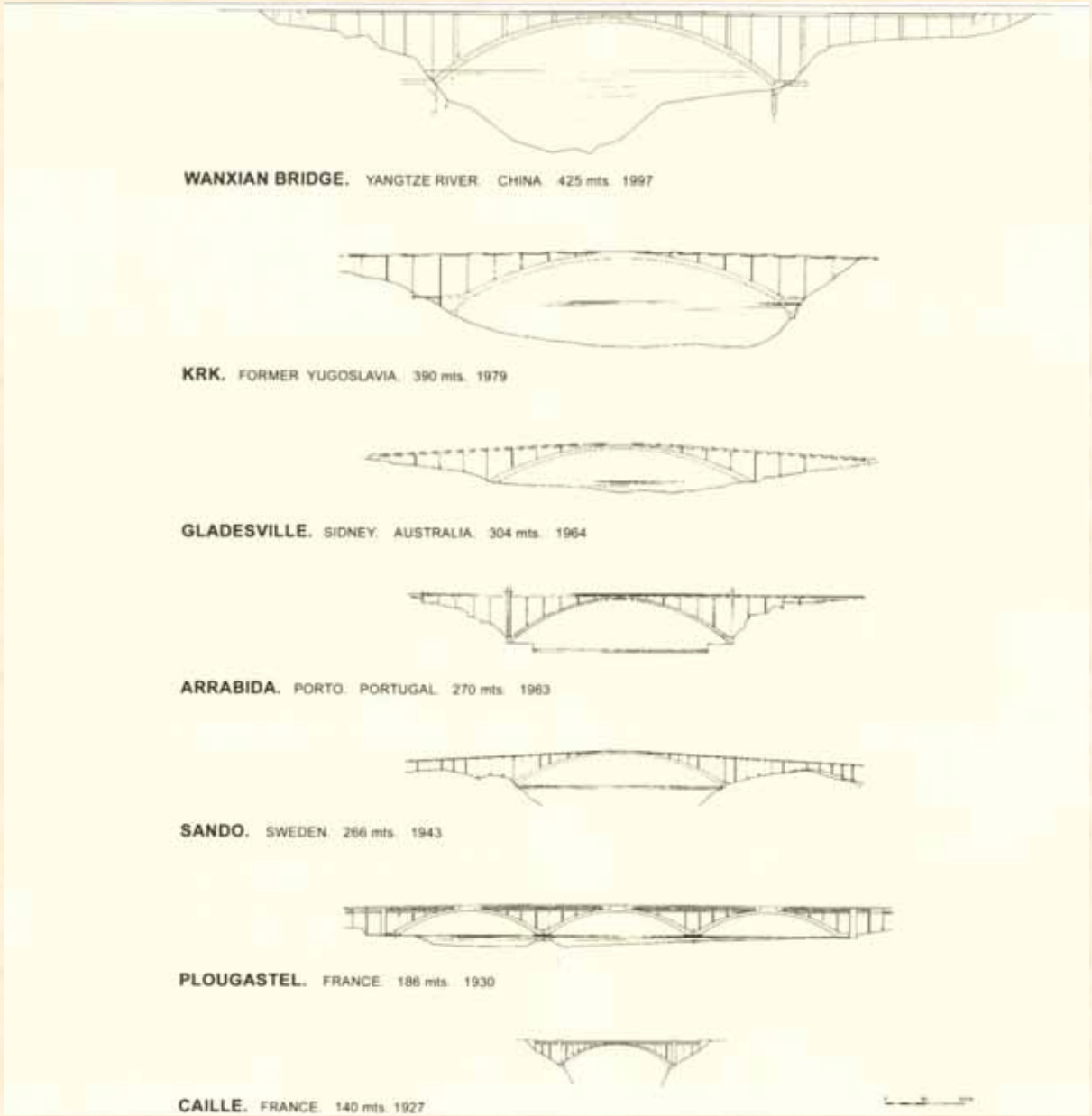
Maximum arch bridge spans since 1898 up to today

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New River George bridge in the United Stted of America, 518 metres span (1976). The largest arch in the world

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The maximum spans of concrete arch bridges

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Resorgimernto bridge over the river Tiber in Rome, 100 metres span (1911), G. Porcheddu, Hennebique licence



Gmünder Tobel bridge over the river Sitter near St. Gallen, Switzerland, 79 metres span (1908), E. Hörsch



Langwies viaduct, Switzerland, 100 metres span (1914), E. Zublin

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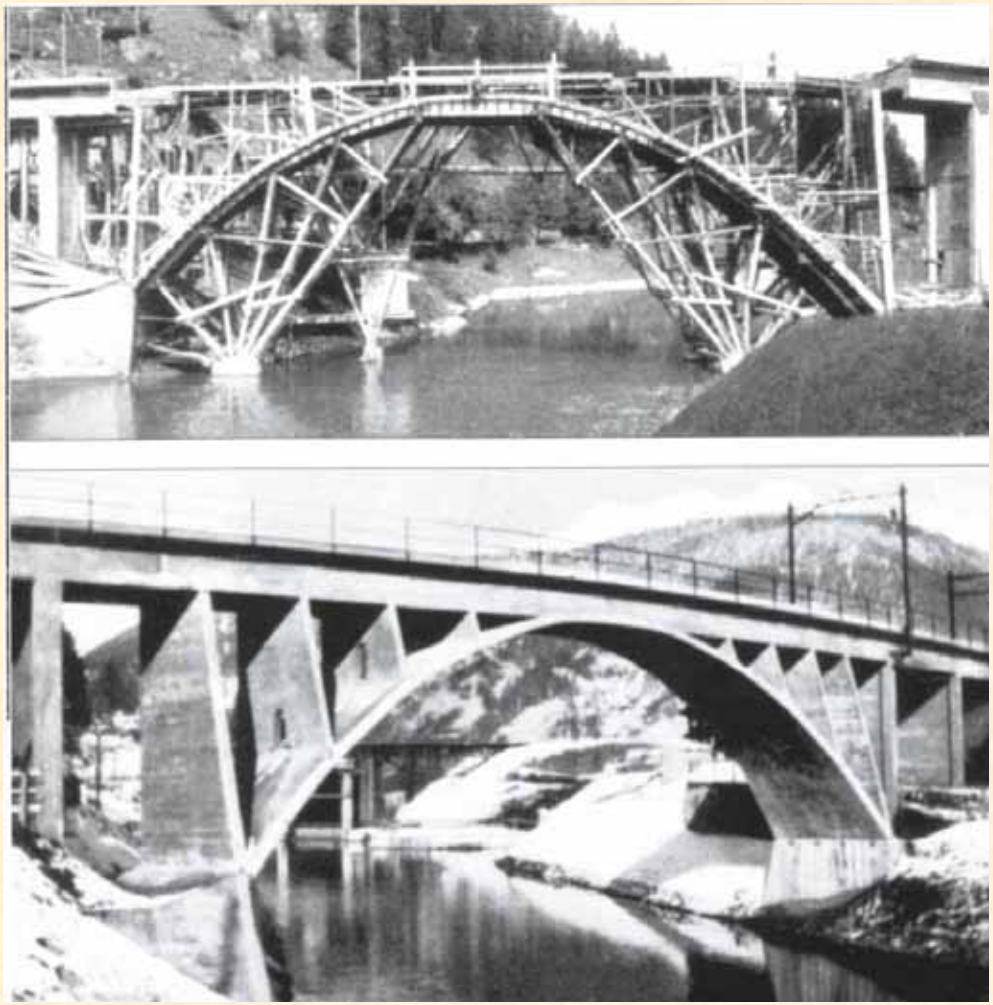
Bridge over the river Aare in Vessy, near Geneva, Switzerland, 56 metres span (1936), R. Maillart.





Gastatt bridge over the river Simme, Switzerland, 32 metres span (1940), R. Maillard.
(a) The recently finished bridge. (b) Present status

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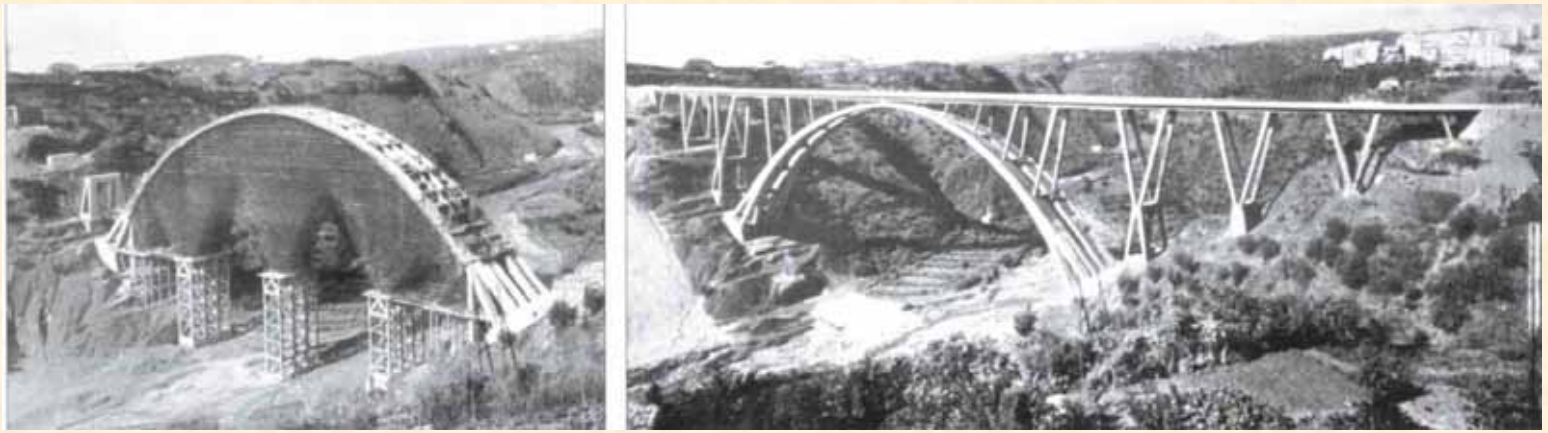
Klosters railway bridge over the river Landquart, Switzerland, 30 metres span (1930), R, Maillard, Recently disappeared

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Arrábida bridge over the river Bouro in Oporto, Portugal,
270 metres span (1963), E. Cardoso

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River Fiumarella viaduct near Catanzaro, Italy, 231 metres span (1962), R. Morandi:
(a) The centring.
(b) The finished bridge.

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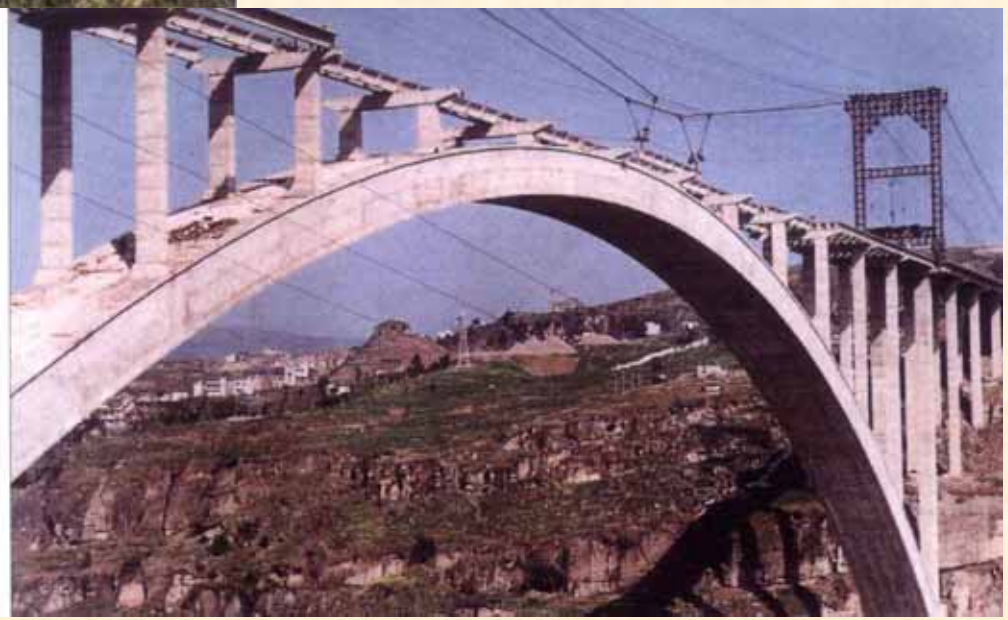
Blokrans bridge in South Africa, 272 metres span (1984), Liebenberg and Stander





Wanxian bridge over the river Yangtze, China, 420 metres span (1997): (a) Rigid reinforcement. (b) The finished arc





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Aversrrhein bridge near Letziwald, Switzerland, C. Menn

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Curved solid slab in Hohenysburg. Germany. Spans of 17+18+17 metres (1956), H. Wittfoth



Slab with circular relievings. Torrelodones overpass on the N-VI motorway. Spain, 48 metres span (1964), Carlos Fernández Casado, S.L.





Precast beam and pier bridge. Huerna viaduct on the Campomanes-León motorway, Spain, spans of 38 metres (1983), Carlos Fernández Casado, S.L.

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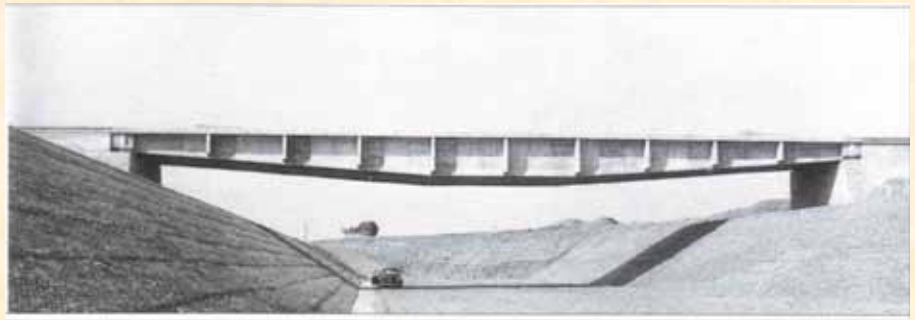
Double box brider bridge over the Ponevedra estuary, two spans of 120 metres (1991), Carlos Fernández Casado, S.L.





Voussoir (segment) yard of the box girders of Pont Aval on the paris perifery Boulevard, main span of 92 metres (1968), Campenon Bernard

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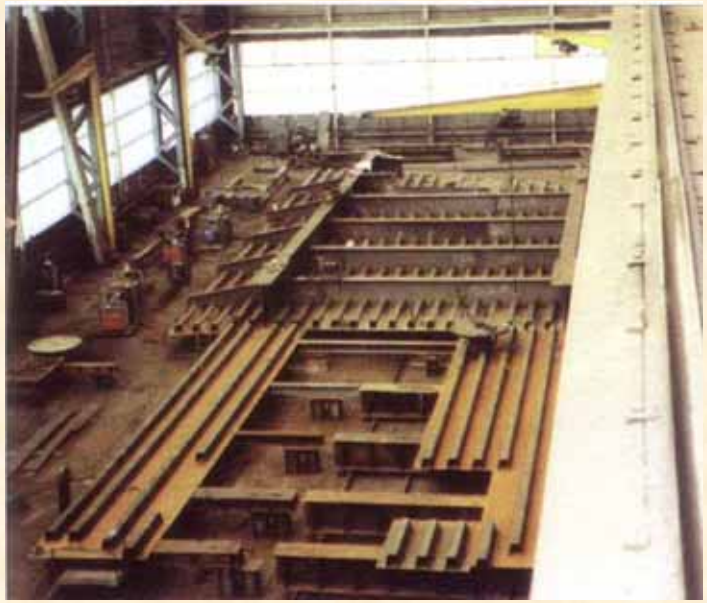






Simply supported beam decks. Beck with cross braces. Bridge over the Canal del Bajo Guadalquivir, Seville, 47 metres span (1961), A, Santonja. Torrebaró viaduct in Barcelona, on the Barcelona-La Junquera motorway, maximum span f 51 metres (1969), Carlos Fernández Casado, S.L.

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Shop manufacturing of a closed section orthotropic slab. Moving bridge of Southampton link in l'Havre harbour

Balanced cantilevers of the Grand Belt West Bridge. Length of the part 110 metres, weight 5700 t, 51 spans of 110 metres. Made on land floated out into position. Cowiconsult



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Transversal suddivisión of the precast segment deck. Segment yard of the Oleron island bridge, France, 70 metres span (1962), Campenon Bernard.



Self-supporting centring of the Dölbachtal viaduct, Germany,spans of 46 metres and one of 70. Construction of the 70-metre span with a temporary support (H. Wittfoht), Polensky and Zöllner.

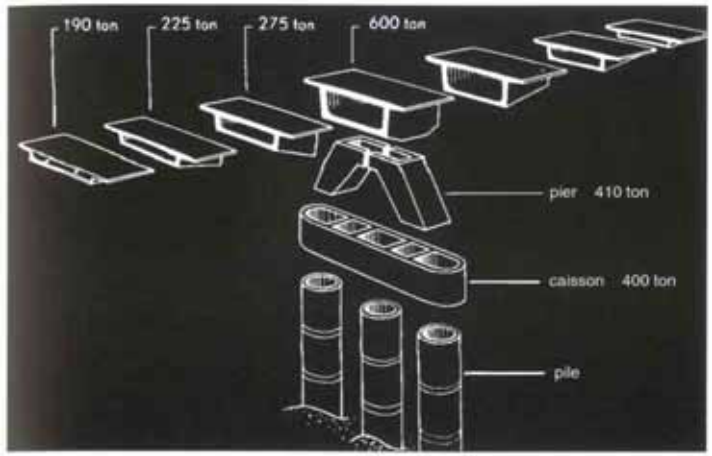
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Construction of the Elztal viaduct with self-supporting centring, spans of 37.5 metres, U. Finsterwalder, Dyckerhoff und Widmann

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Oosterchelde bridge, Holland, spans of 95 metrs. Length, 5 kilometres, 600 tonne segments, concreted joints (1965), Van Hattum. Axonometric projection. Erection of the segments with an overhead beam. The finished bridge.

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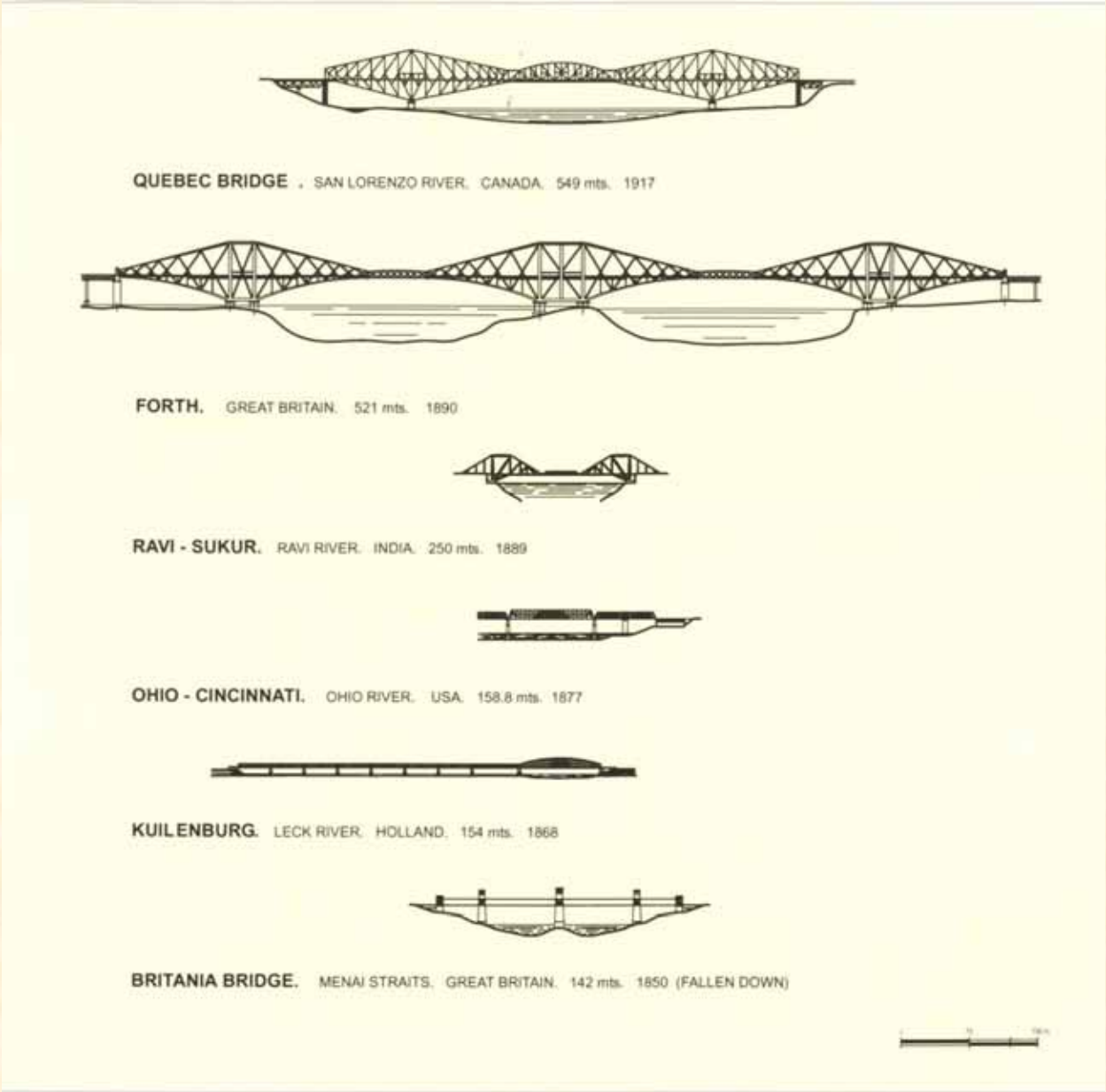




Siegtal viaduct, Germany, spans of 105 metres, piers 90 metres high (1969), Polensky and Zöllner. Start of the travellers from a pier. The travellers in cantilever suspended from the metal girder. The viaduct during the construction of the second box girder.



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The largest metal girder bridges since 1850 to the presen day.

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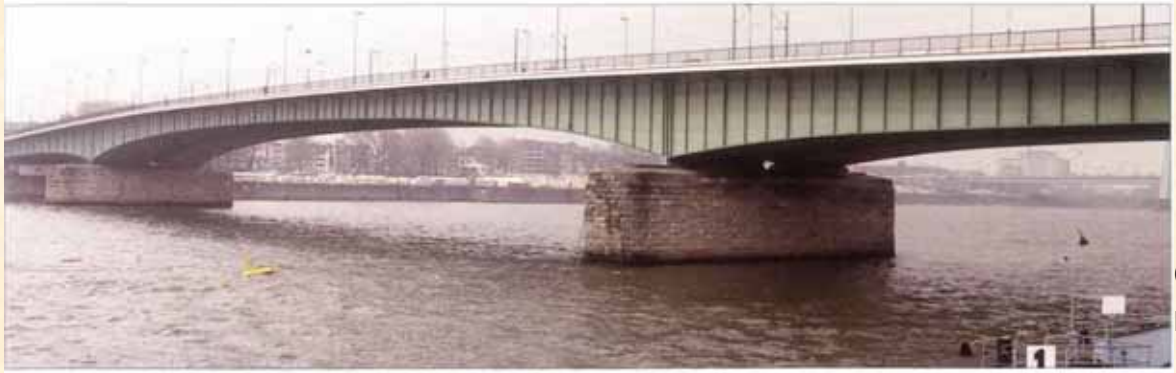






Busseau-sur-Creuse viaduct, spans of 50 metres (1864), W. Nördling and F. Moreaux. Above left, launching the deck with a provisional stay arrangement. Bottom, the viaduct at present

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German web girder bridges over the Rhine

Cologne-Deutz, centre span of 185 metres (1948). Leonhard und Andrä



Bonn-Beuel, centre span of 196 metres (1949), A. Kramer.



Düsseldorf.Neuss, centre span of 206 metres (1951).

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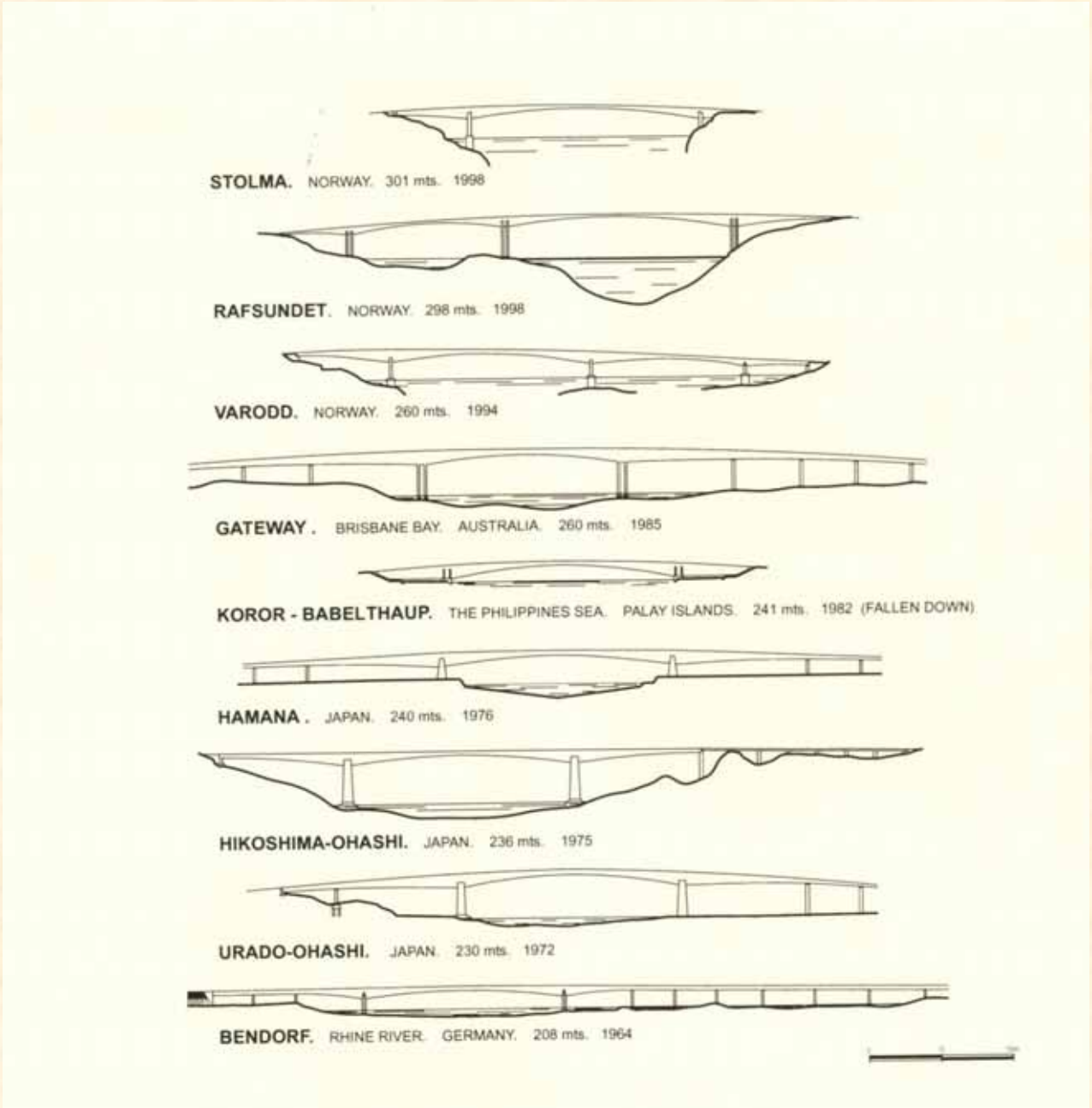
Europa bridge near Innsbruck, Austria, main span, 198 metres, pier height 180 metres (1963), Waagher-Biro.





Winningen viaduct over the river Moselle near Klobenz, Germany, main span, 218 metres, pier height; 150 metres (1972), Leonhardt und Andrä

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The largest prestressed concrete beam bridges since 1964.

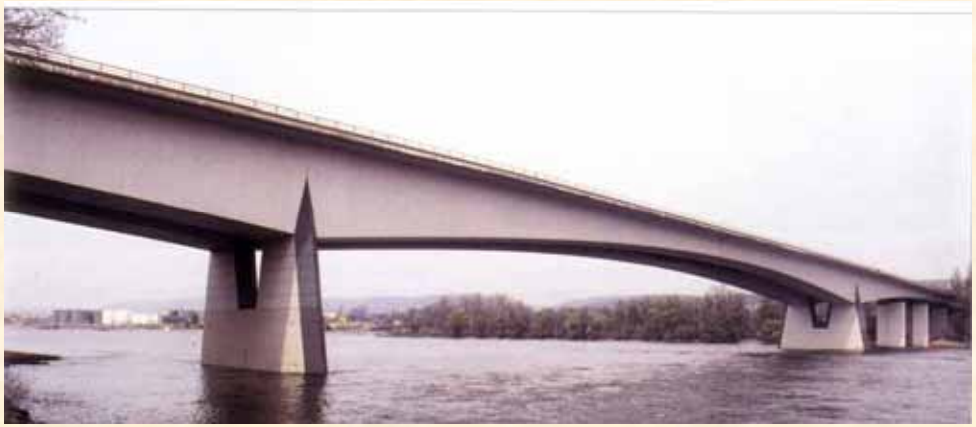
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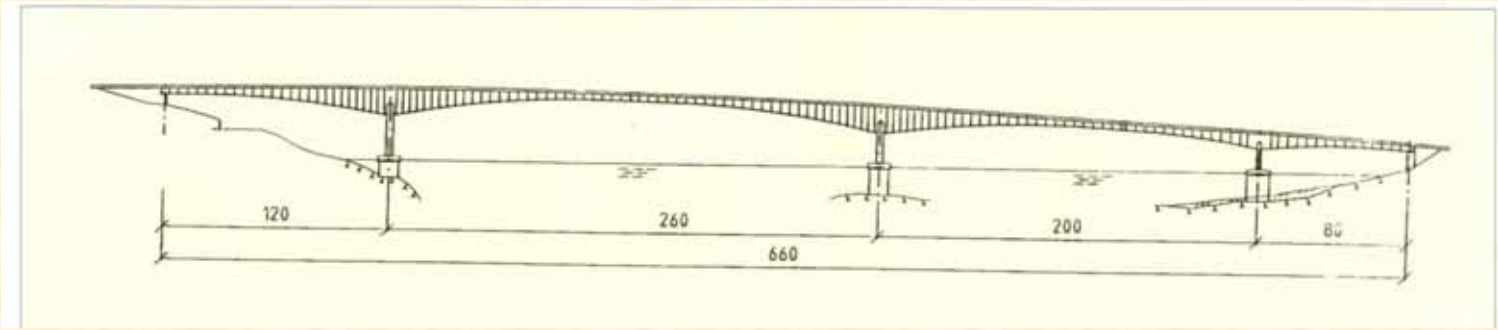
Benford bridge over the Rhine, 208 metres span (1964), U. Finsterwalder, G. Lohmer, Dyckerhoff und Widmann. Double left bank cantilever, right bank cantilever. The bridge today



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Varodd bridge near Kristiansand in Norway, 260 metres span (1994), General elevation. The bridge under construction





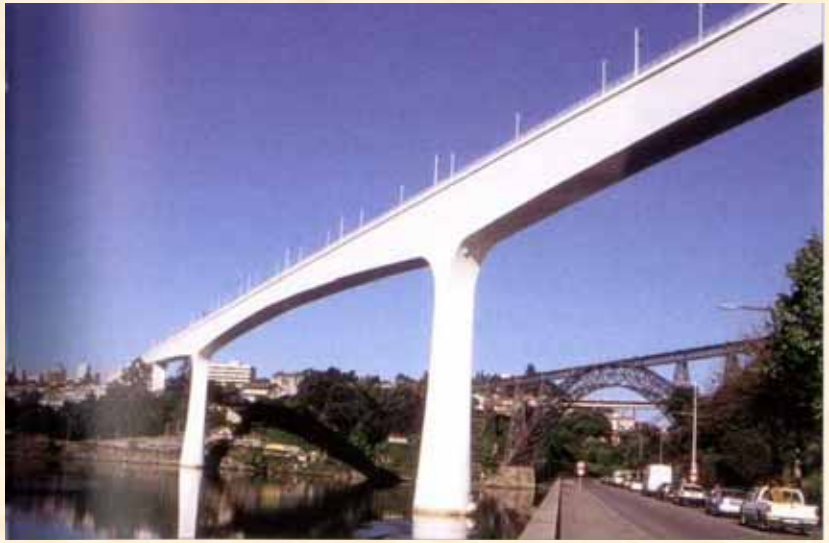
Rafsundet bridge between two of the Lofoton islands, Norway, 298 metres (1998).



Stolma bridge between Stolmen and Selbjorn islands, Norway, 301 metres span (1998)

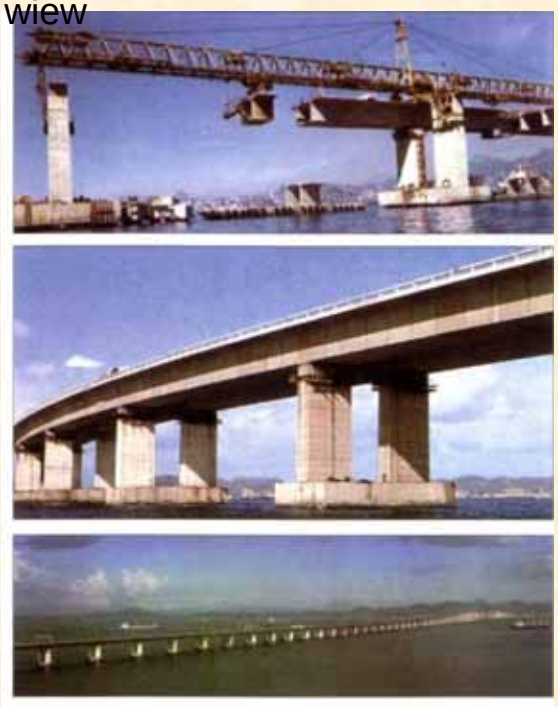
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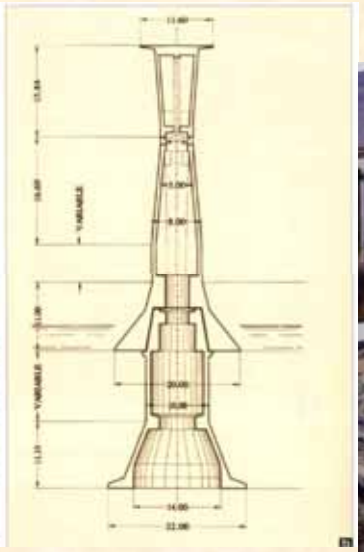
Railway bridge in Oporto over the river Douro, Portugal. Also called San Joao, 250 metres psna (1990). E. Cardoso. The bridge under construction. The finished bridge. Aerial wiew of the threee Oporto bridge.





Viaduct accessing Niteroi brigde in Guanabara Bay, Rio de Janeiro. Normal span, 80 metres; Length 9 kilometres (including the metal bridge), (1974). From topo to bottom, erecting a segment, partial view of the access viaduct and the viaduct complete.

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Confederation bridge, connecting Prince Edward Island in the mainland in Cnada, spans of 250 metres (1997). Jean Muller International. Buckland and Taylor:

(a) Precasting yard on Prince Edward Island.
(b) Cross-section of the three precast parts superimposed: foundations, pier and deck;
(c) Piers in the precasting uard.
(d) 250 metres long parts in the precasting yard.
(e) Erecting a 5000 Tonne foundation piece with the gloating crane
(f) Erecting the 93 metres side spans using precast segments
(g) Erecting a double cantilever 192.5 metres long with the floating crane
(h) A stretch of the finished bridge.



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Launched bridges Atenquique I viaduct over the river Tuxpan, Mexico, spans of 60 metres (1991). New Pilar bridge in Zaragoza, spans of 47 metres (1991). Marquesa bridge near Mexico city, spans of 60 metres (1988), Carlos Fernández Casado, S.L. Mexpresa.

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Bubyan viaduct in Kuwait, spans of 40 metres (1982), P. Richard Bougues. From topo to bottom, erection of segments, segment suspended from the centring and the finished bridge

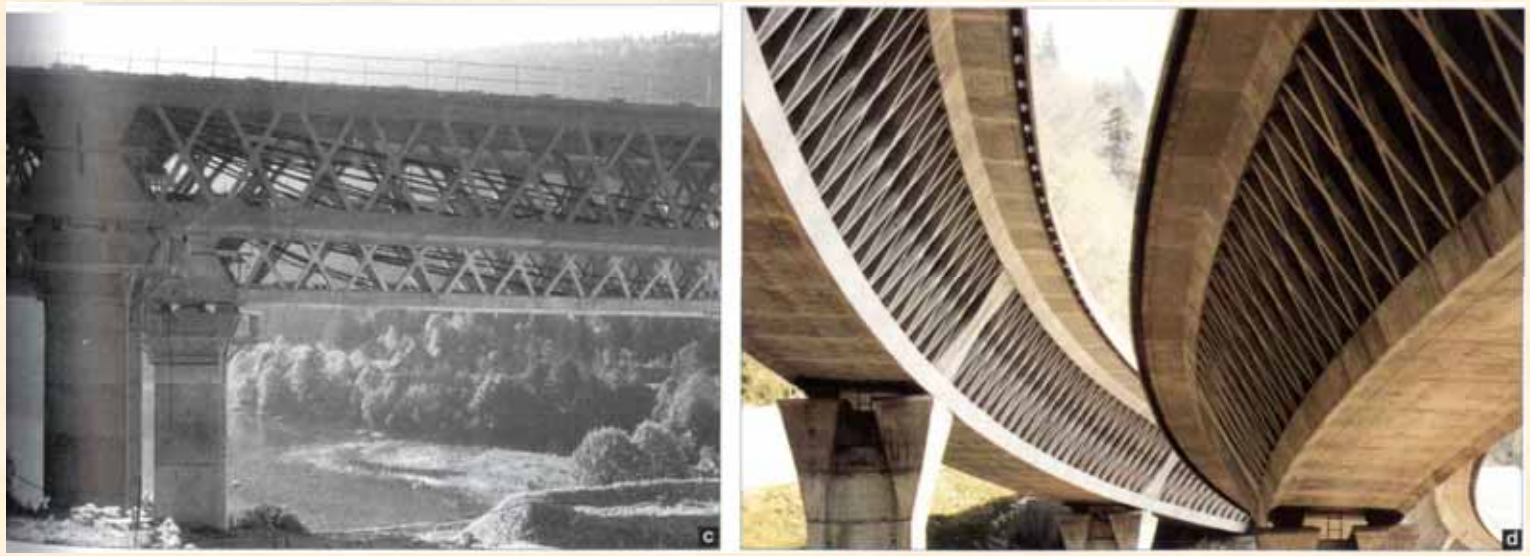
Klosters railway bridge over the river Lanquart, 76.5 metres span (1993), H. Rigendinguer



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Lake Sylans hilliside viaduct, France, spans of 60 metres.
(a) A segment
(b) Segment erecting girger
(c) Outside prestressing after triangulation
(d) The finished bridge, Bouygues.



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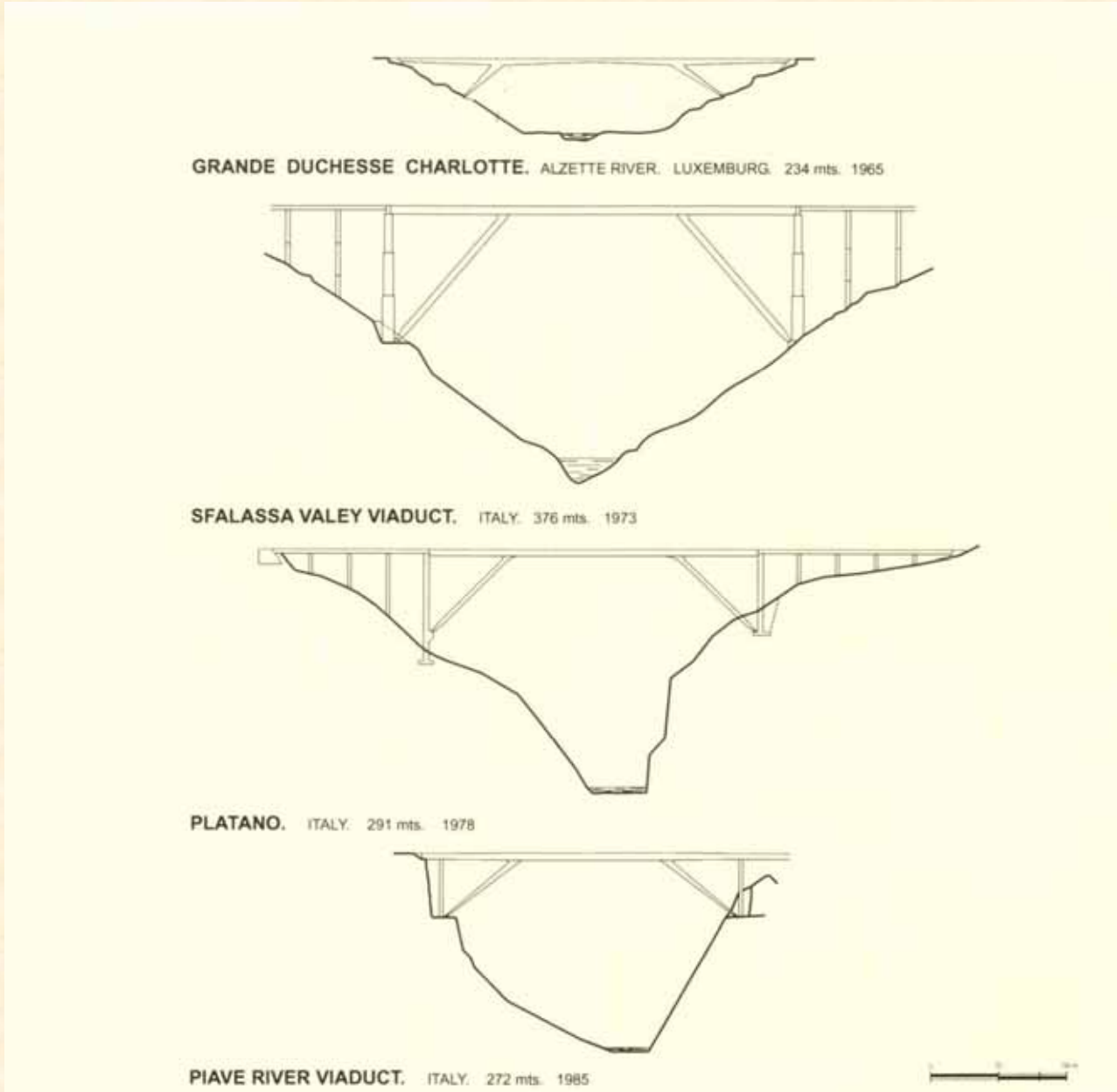
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Sfalassa ravine viaduct in Italy, 376 metres span between pier centre lines (1973), S. Zorzi, L. Lonardo and S. Procaccia. The largest frame bridge in the world.

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Large metal frames

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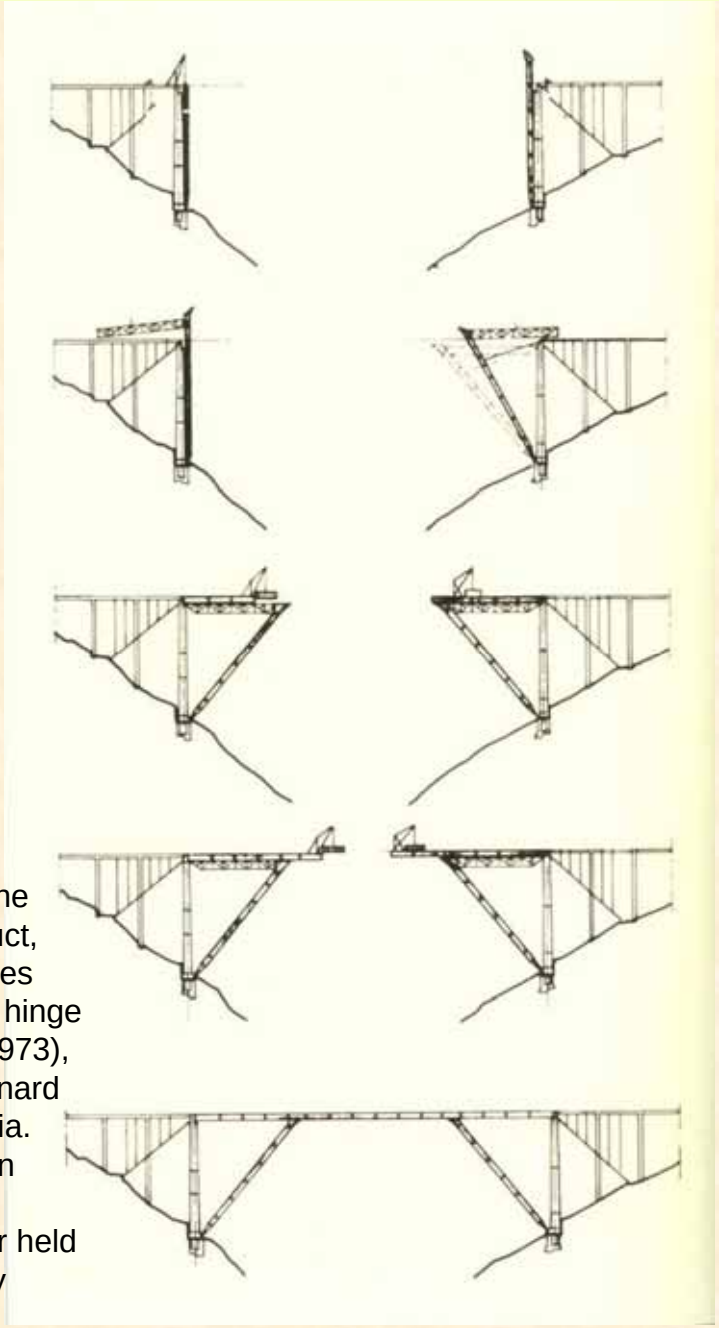




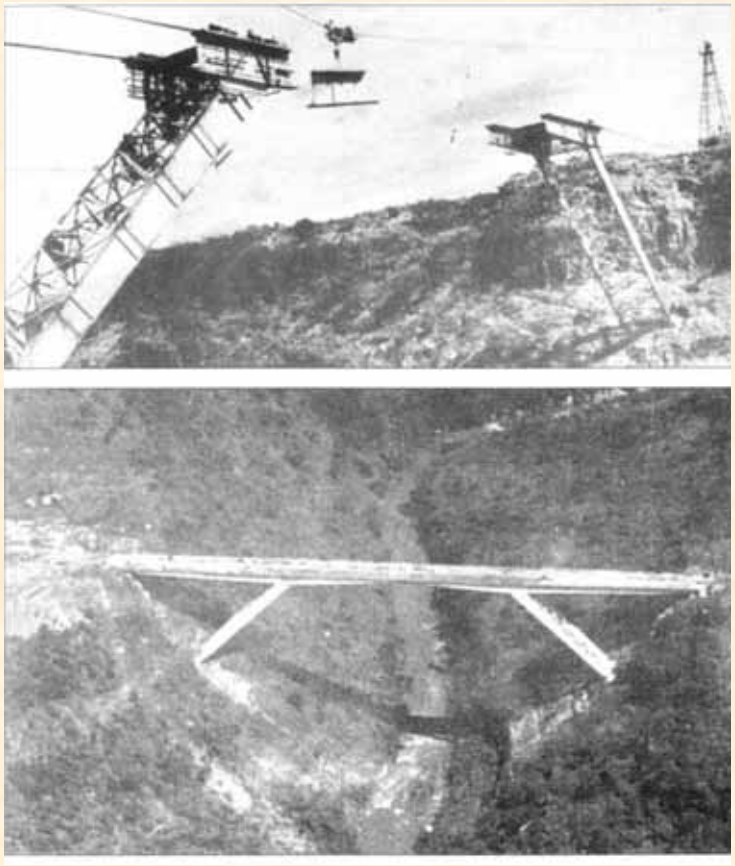
Martigues viaduct over Caronte canal near Marseille, 210 metres span (1972). Gyrating a pier once the deck has been raised. The finished viaduct.

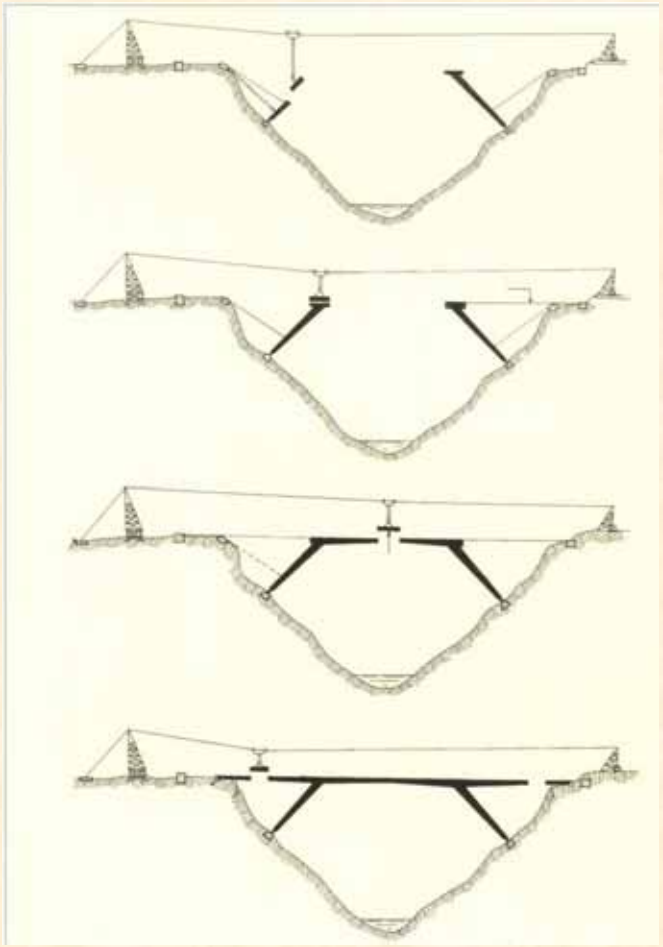


Construction the Sfalassa viaduct, Italy, 360 metres span between hinge centre lines (1973), S. Zorzi, L. Lonard and S. Procacia. (Right) erection stages. (Left) gyrating a pier held with temporary centring



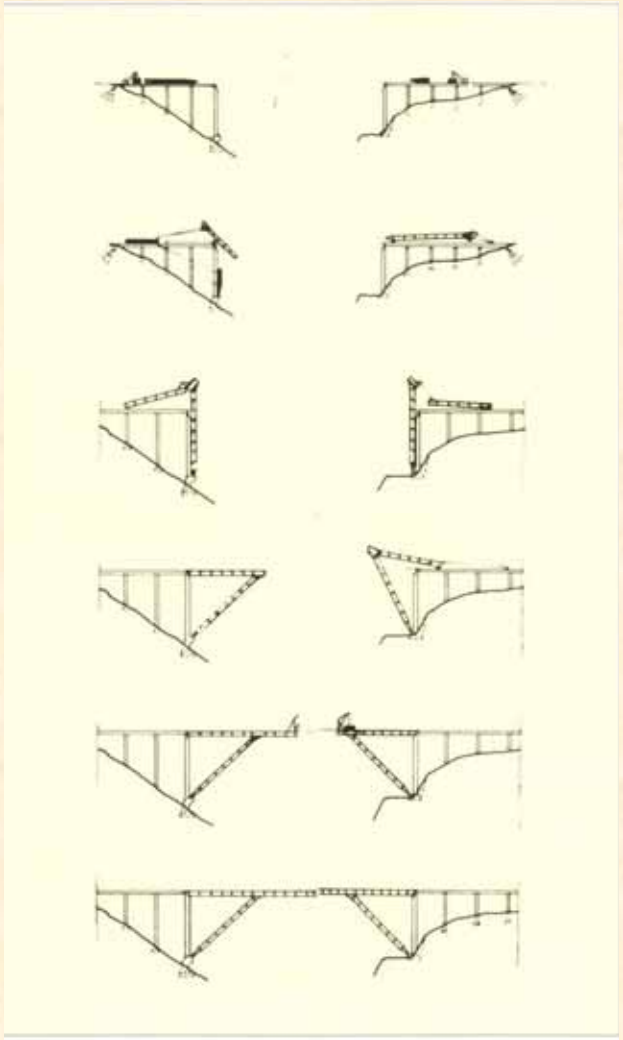
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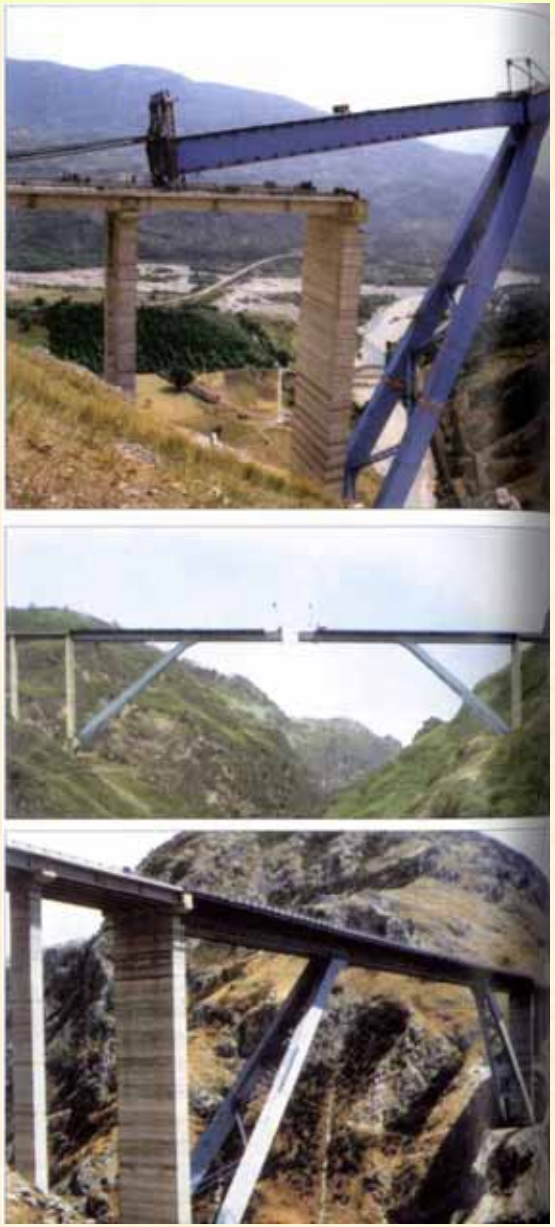




Ingeniero Fernando Espinosa bridge over the river Santiago, Mexico, 206 metres span. Comec. Erection phases (right). Fitting a segment of one of the beams (top). The finished bridge (above).

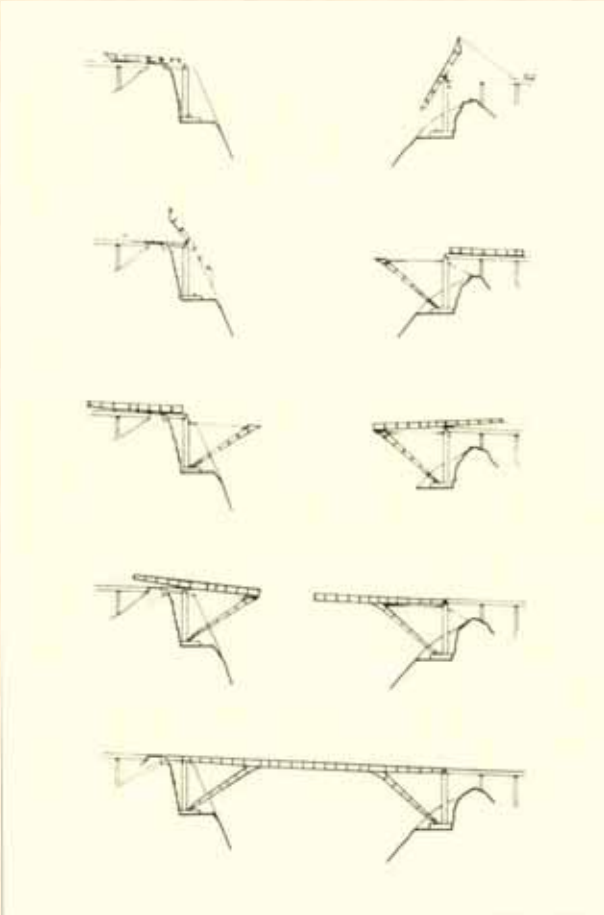
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Platano viaduct, Italy, 291 metres span (S. Procaccia), CImolai. Erection phases. Gyrationg the pier with the side span. Advancing in cantilevers until closing the crown. The finished bridge

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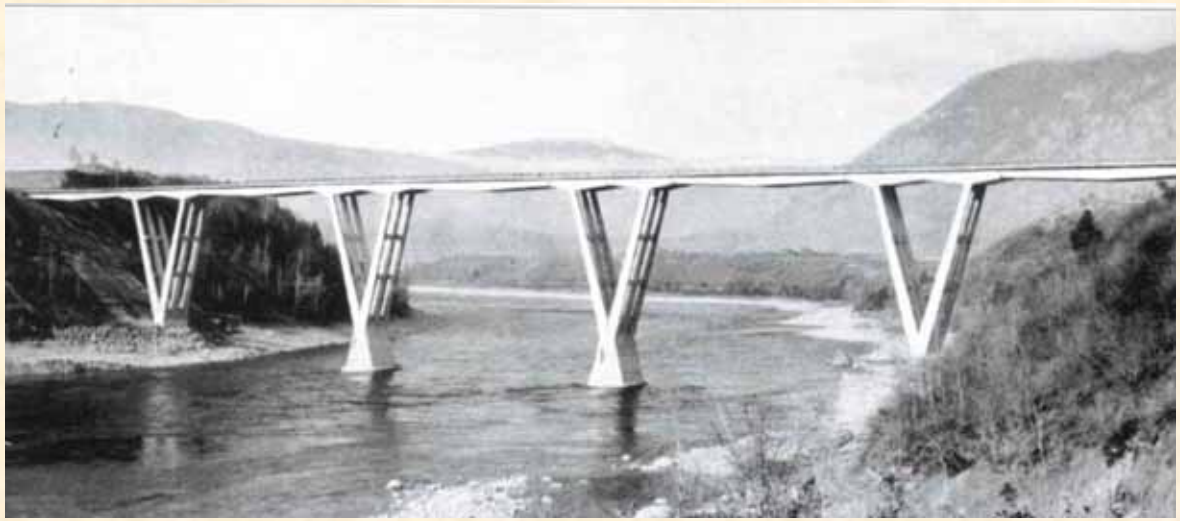




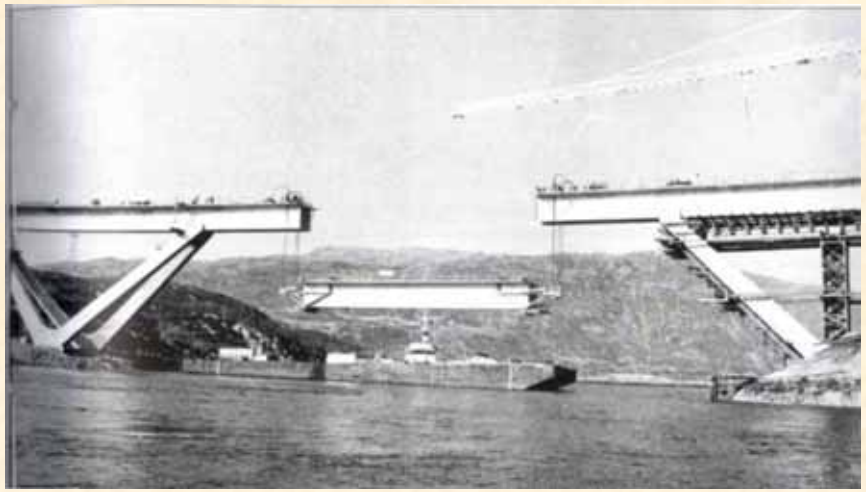
Viaduct over the river Piave near Caralte, Italy, 256 metres span, P. Matildi and G. Matildi, Cimolai. Erection phases. Launching the two half-deck. The finished bridge

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Kinnaird bridge over the river Columbia in Canada, spans of 80 metres (1960). R. Morandi.



Bridge near Kylesku in Scotland, 132 metres central span (1986). Ove Arup and Partners. Erecting the centre stretch. The finished bridge

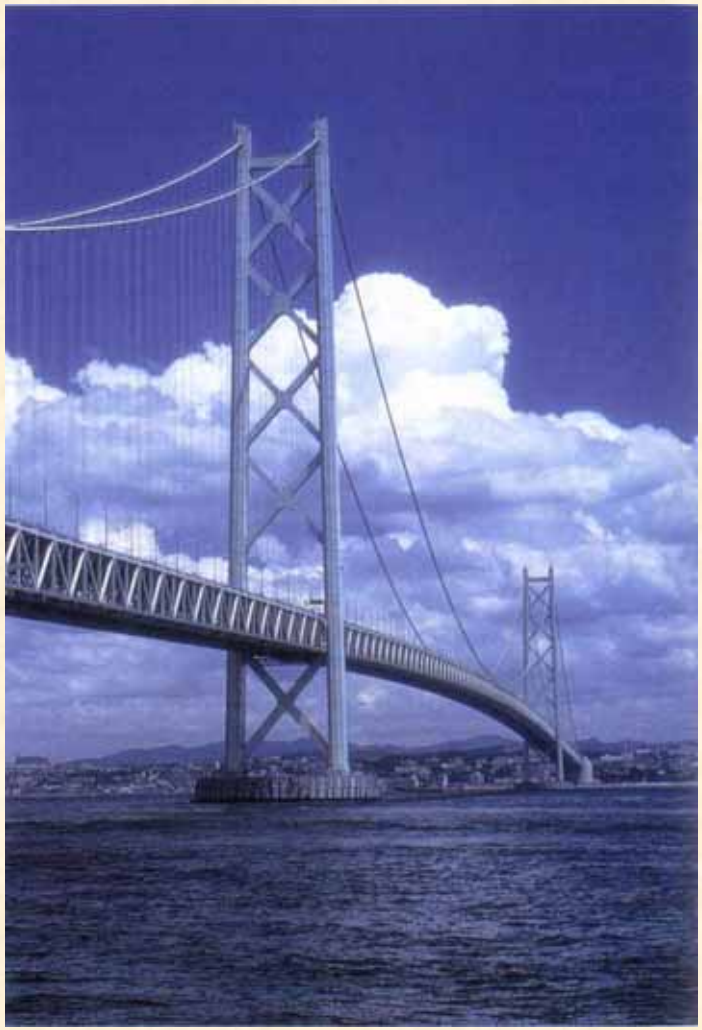


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Ponti strallati e sospesi

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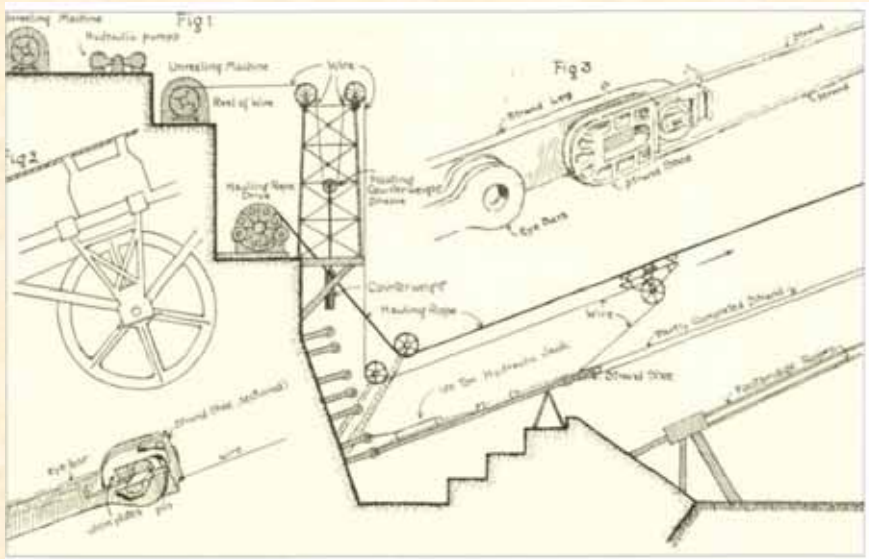
Akashi-Kaikyo bridge on the Kobe-Naruto route between Honsbu and Shikoku islands, Japan 1990 metres span (1998). The largest bridge in the world.

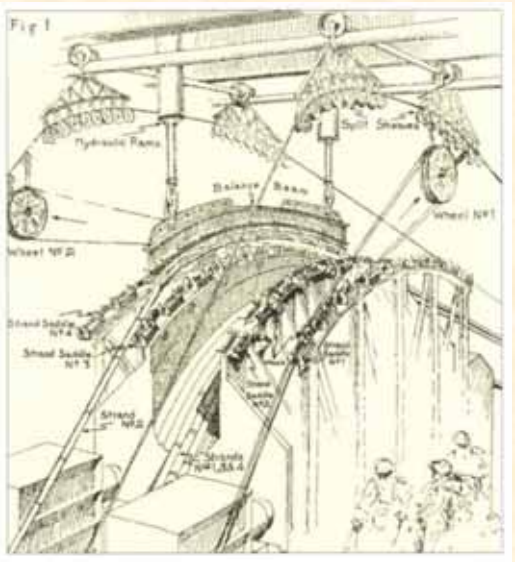
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Tatara bridge over the Seto Island sea on the Onomichi-Imabiri route, between Honshu and Shikoku islands, Japan, 890 metres span (1999). The largest cable-stayed bridge in the world.

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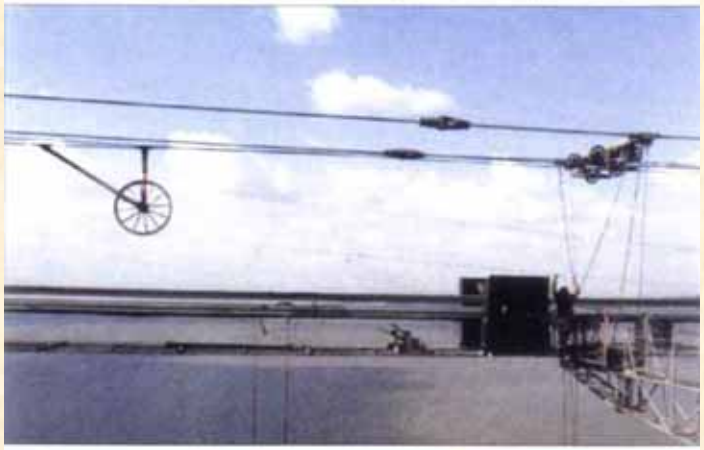
Fitting thhe straight wire cables of the Golden bridge by wire to wire winding (Roebling method). Installation in the counterweight. Moving pulleys pass over the tower saddles





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Moving pullys for winding the wires of large main cables (Roebling method). Multiple pulleys (Golden Gate). Single pulleys with two wires (Humber). Bicycle (Bisan-.Seto I).

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Main cable anchorage in counterweights. George Washington bridge. Verrazzano-Narrows bridge. Crossed anchorages of the Bisan-Seto bridge.





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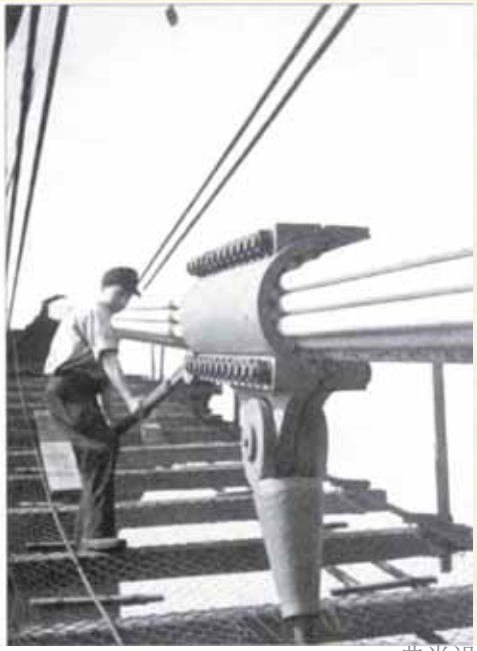


Annular cable wire compacting jack. Golden Gate. Bisan-Seto

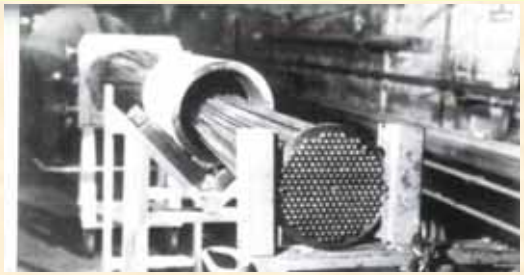
Main cable clamps for securing suspenders. Golden Gate bridge, 1280 metres span. Bisan-Seto bridge, 1100 metres span. Duisburg-Homberg bridge over the Rhine, 285.5 metres span (1954), main cable formed by lock-coiled cables and suspenders finishing in eyebar sockets-







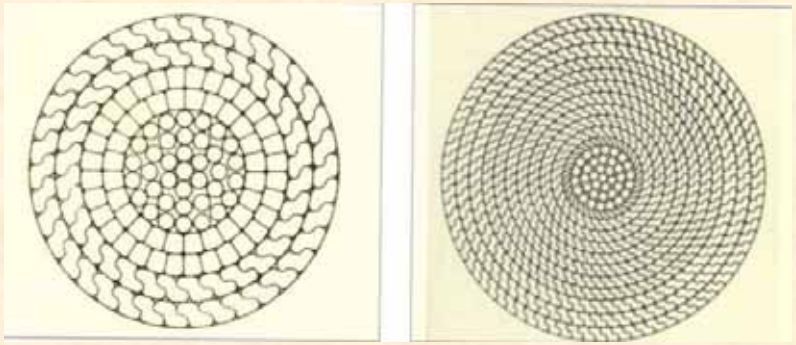
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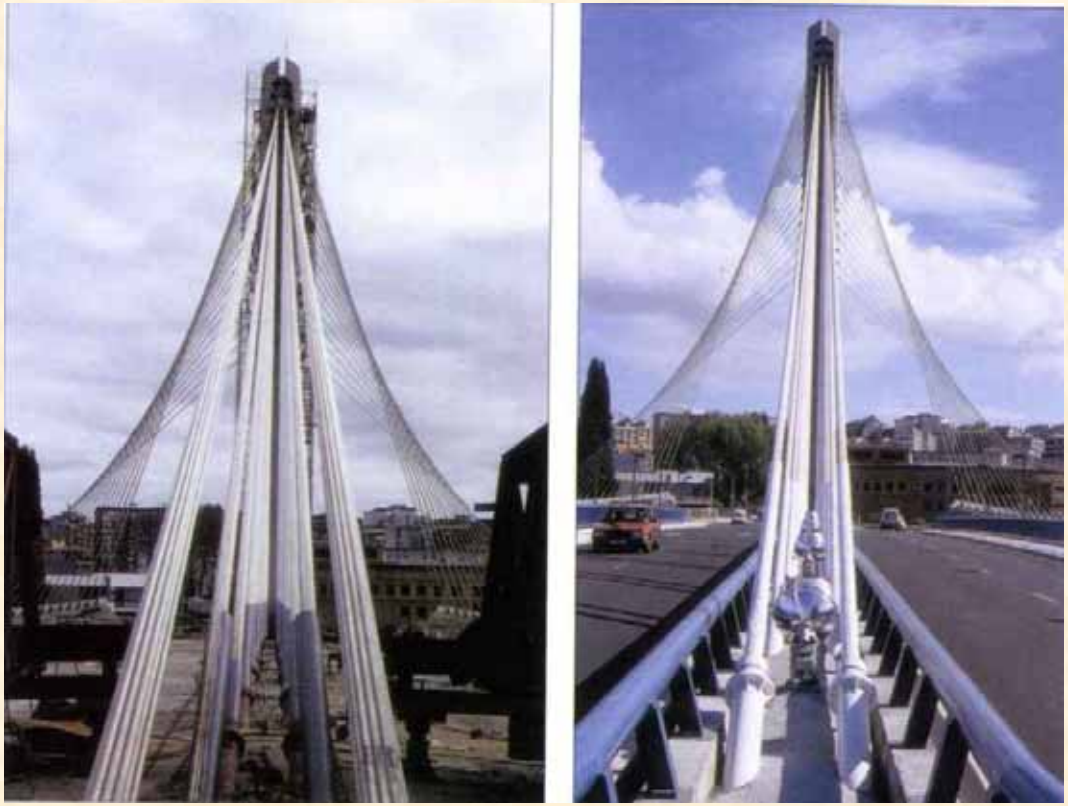
Hi-Am stays for cable stayed bridges. Rivetted wire heads. Straight wire cable with the expoxy filled anchorage socket. Cablea transportation reel with its factory made anchorages. Fitting a stay (Mannheim-Ludwigshafen).





Lock-coiled cable cross-sections. (a) OVVZZ diameter 72 millimetres cable (b) OZ x 11 cables. With diameters from 121 millimetres to 167 millimetres for Bangkok bridge.

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Stays formed by 0.6” diameter indivudally protected cables. Bridge over the river Lérez in Pontevedra. 125 metres span. (1995). The stays during construction. The stays secured to shock absorbers at the ends and bottom protection pipes.

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Ganter bridge on the Simplon road,
Switzerland, main span of 174 metres (1982).
C. Menn.

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Sunninberg bridge in Kloster, Switzerland, 140 metres maximum span (1998), Christian Menn







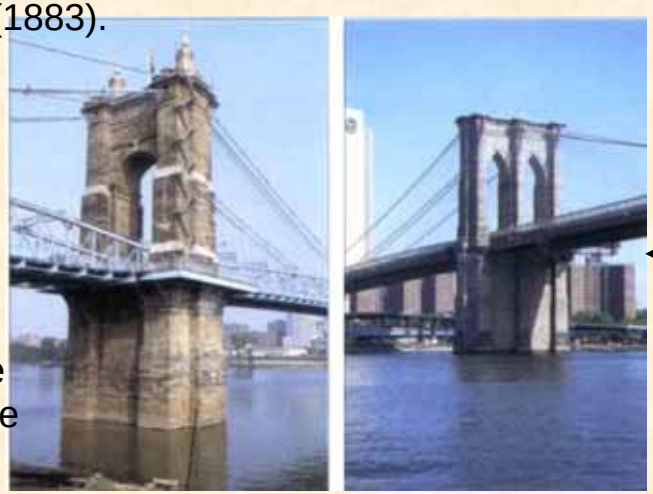
Osormort viaduct, 40-.metre spans (1995), Carlos Fernández Casado, S.L.

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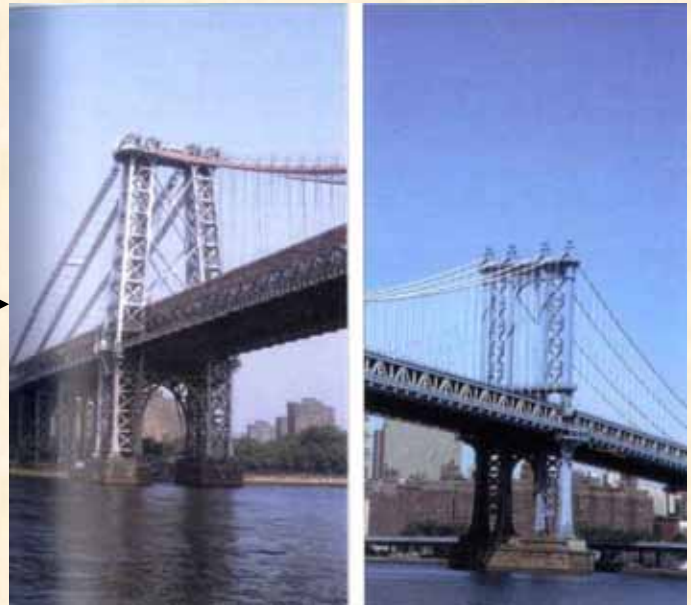


Metal stut towers. St.-Gerges footbridge over the river Saône in Lyon, 87 metres span (1882. Footbrigde over the river Aare in Berna.

Stone towers by J.A. Roebling. Covington-Cincinnati bridge over the river Ohio, 322 metres span (1867). Booklyn bridge over Ner York East River, 486 metres span (1883).



East iver suspension bridge towers in New York. Williamsburg bridge, 487.5 metres span (1903), Manhattan bridge, 448 metres span (1909).



Tower of the Golden Gate bridge in San Francisco bay, 1280 metres span (1937).



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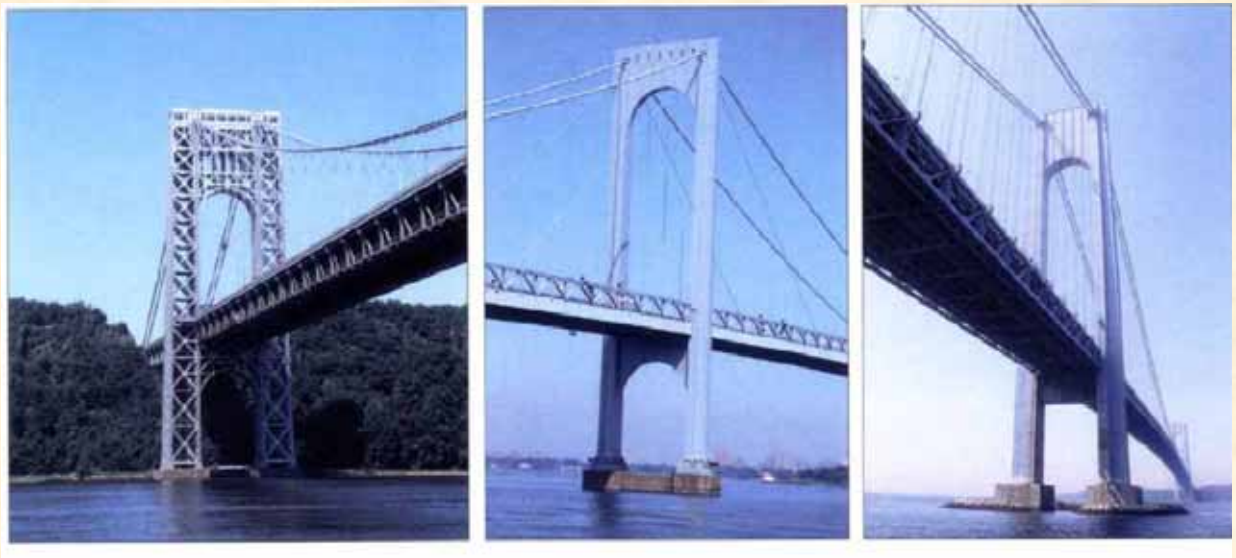


Towers with St. Andrew cross braces. Ambassador bridge over the river Detroit, 564 metres span (1929). Bay Bridge in San Francisco, 704 metres span (1936). Forth Road bridge over the Firth of Forth, Scotland, 1006 metres span (1964). Bridge over the Tagus estuary in Lisbon, 1013 metres span (1966). Akashi-Kaykyo bridge in Japan, 1990 metres span. Under construction.



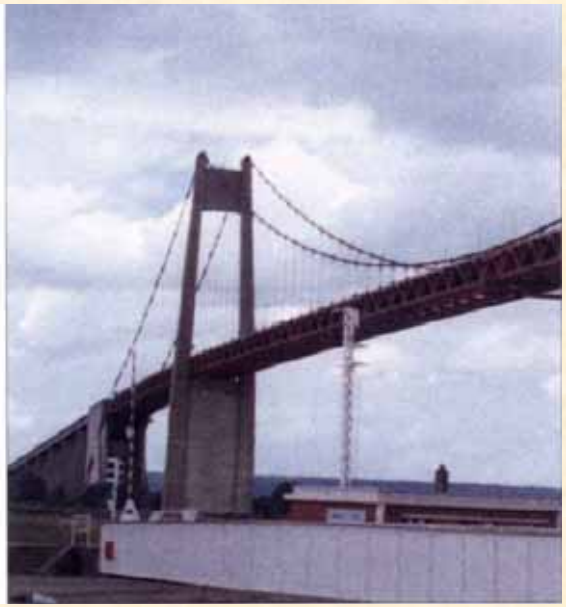
Simple frame towers. Delaware Memorial bridge over the river Delaware in Wilmington, UDA, 655 metres span. Bridge I (1951). Bridge II (1968), Howard, Neadles, Tammen and Bergendoff. Walt Whitman bridge over the river Delaware between Philadelphia and Camdem, 609 metres span (1957), Modijeski, Ammann and Whitney.

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Towers of O.H. Ammann bridges. (a) George Washington over the river Hudson in New York, 1067 metres span (1931). (b) Bronx-Whitestone bridge over the East River in New York, 701 metres spoan (1939), © Verrazzano-Narrows bridge at the entrance to New York harbour, 1298 metres span (1964).

Tower of Tancarville bridge over the Seine, 608 metres span (1959), Tower desig: N. Esquillan



Towers of the Humber bridge, 1410 metres span (1981). Freemann Fox and partne. Construction with slip formwork



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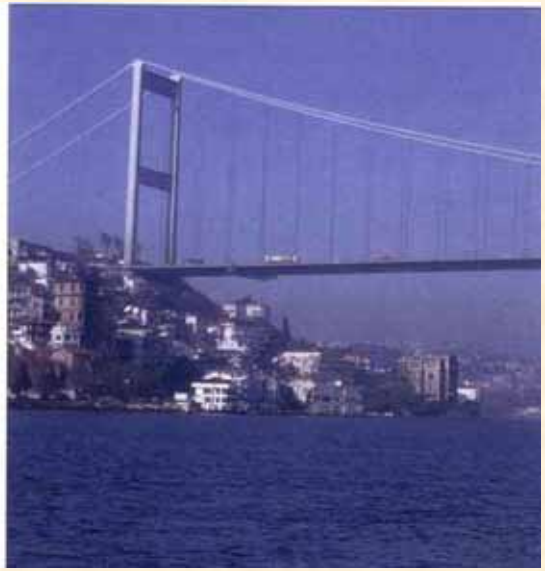
Towers of the Storebealt, Denmark, 1624 metres span. During cable erection. The storm ropes can be seen. The finished deck. Cowiconsult.











Metal towers of Freeman Fox and Partner bridge. Bridge over the Severn estuary, 987.5 metres span (1966). Bridge over the Bosporus I in Instabul, 1074 metres span (1973). Bosporus Ii bridge, 1090 metres span (1988).

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Second Tacoma strait bridge near Seattle, 853 metres span (1948). Slenderness ratio 1/85. Bridge over Mackinac strait, 1158 metres span (1957). Slenderness ratio 1/100



Akashi-Kaikyo bridge under construction, 1990 metres span. Truss girder deck with torsion rigidity (1998). Slenderness ratio 1/142.

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Closed box girder decks with aerodynamic shape. Severn, 987.5 metres span (1966). Lillebaelt, 600 metres span (1970), Humber, 1410 metres span (1981). Slenderness ratio 1/352

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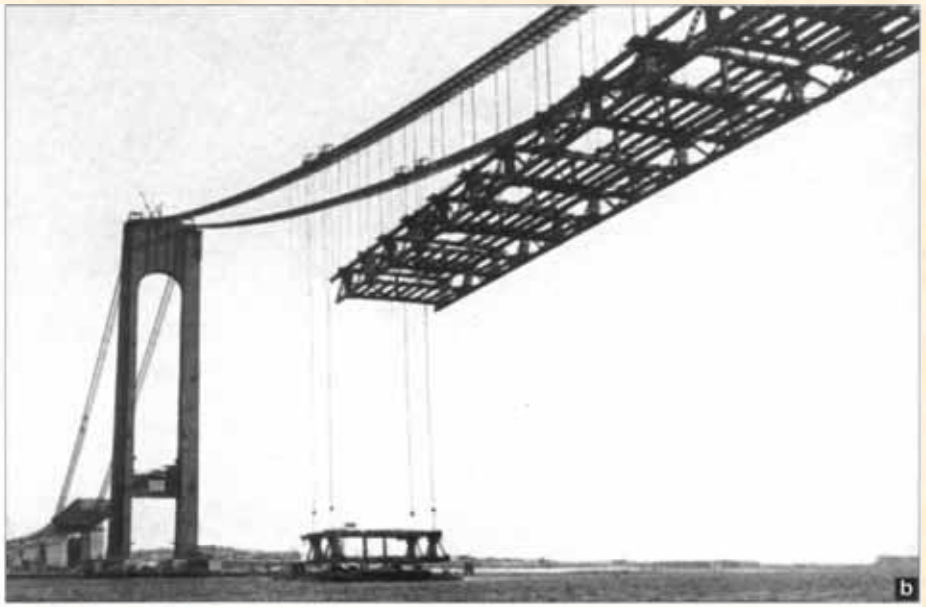




Consturction of the deck by the cantilever method from one suspender to the next. Ambassador, 564 metres span (1929). Golden Gate. 1280 metres span (1937). Forth Road, 1006 metres span (1964), Akashi-Kaikyo, 1990 metres span.

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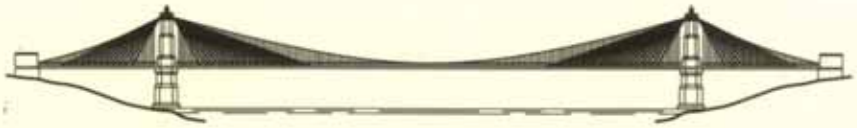






Construction of the deck with segments raised from the main cables
(a) Bay Bridge, 704 metres span (1936.
(b) Verrazano-Narrows, 1298 metres span (1964).
(c) Lillebealt, 600 metre span (1970).
(d) Humber, 1410 metres span (1981).

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COVINGTON-CINCINNATI. OHIO RIVER. USA. 322 mts. 1867



WHEELING. OHIO RIVER. USA. 308 mts. 1854



FRIBURGO. SARINE RIVER. SWITZERLAND. 256 mts. 1834



MENAI. MENAI STRAITS. GREAT BRITAIN. 177 mts. 1826

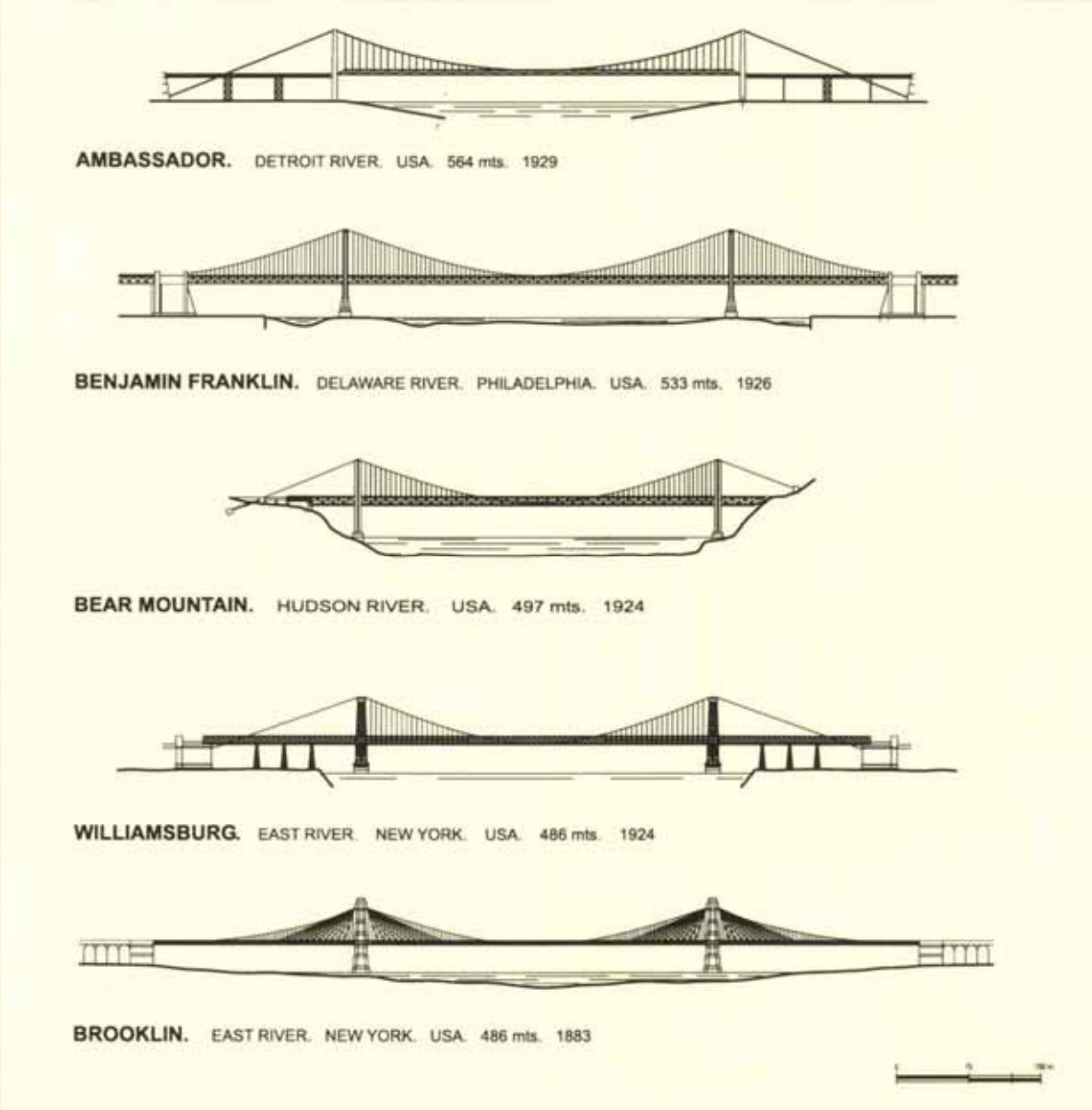


UNION BRIDGE. TWEED RIVER. GREAT BRITAIN. 137 mts. 1820



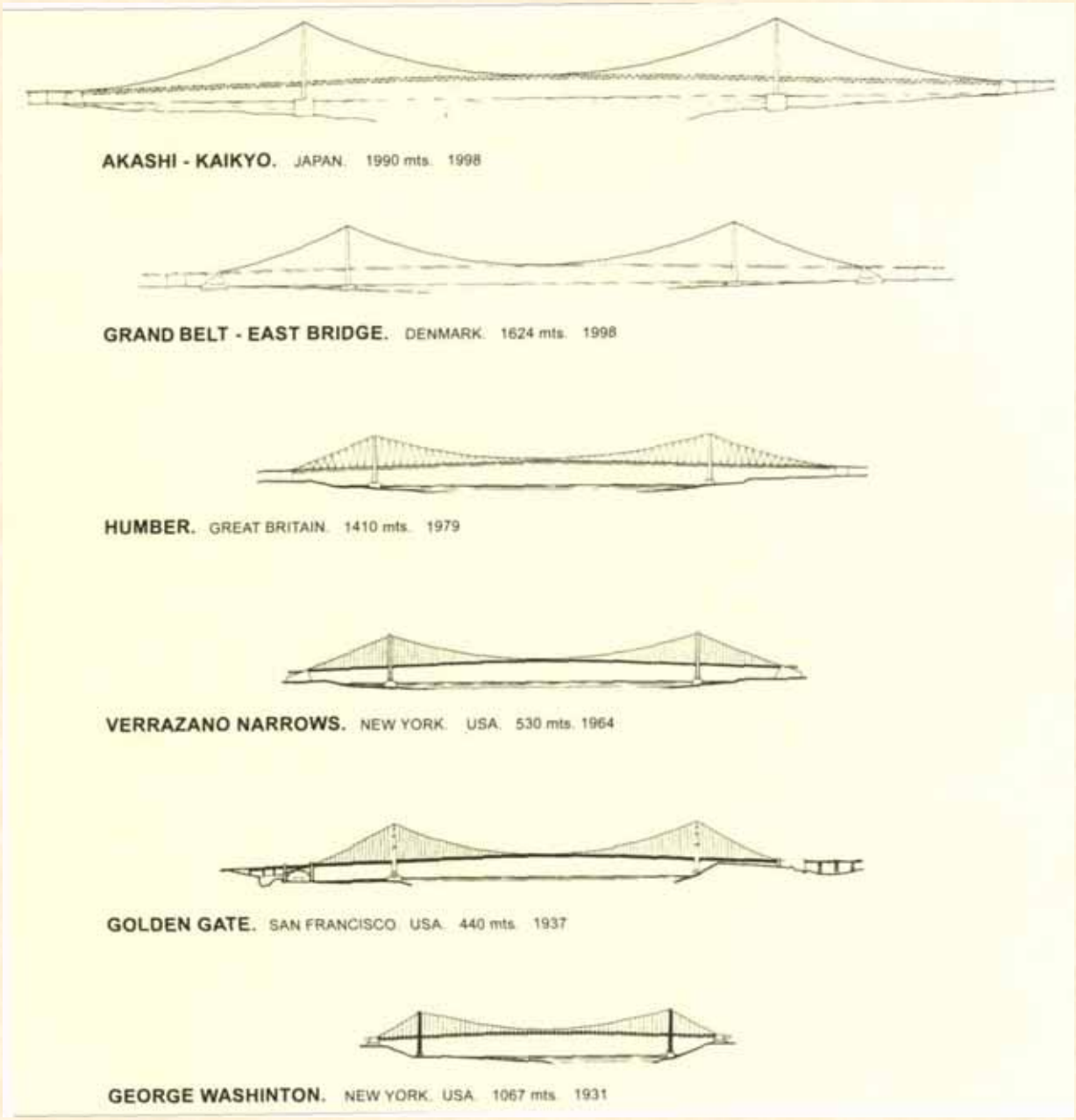
Maximum suspension bridge spans from 1820 to 1867

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Maximum suspension bridge spans from 1883 to 1929

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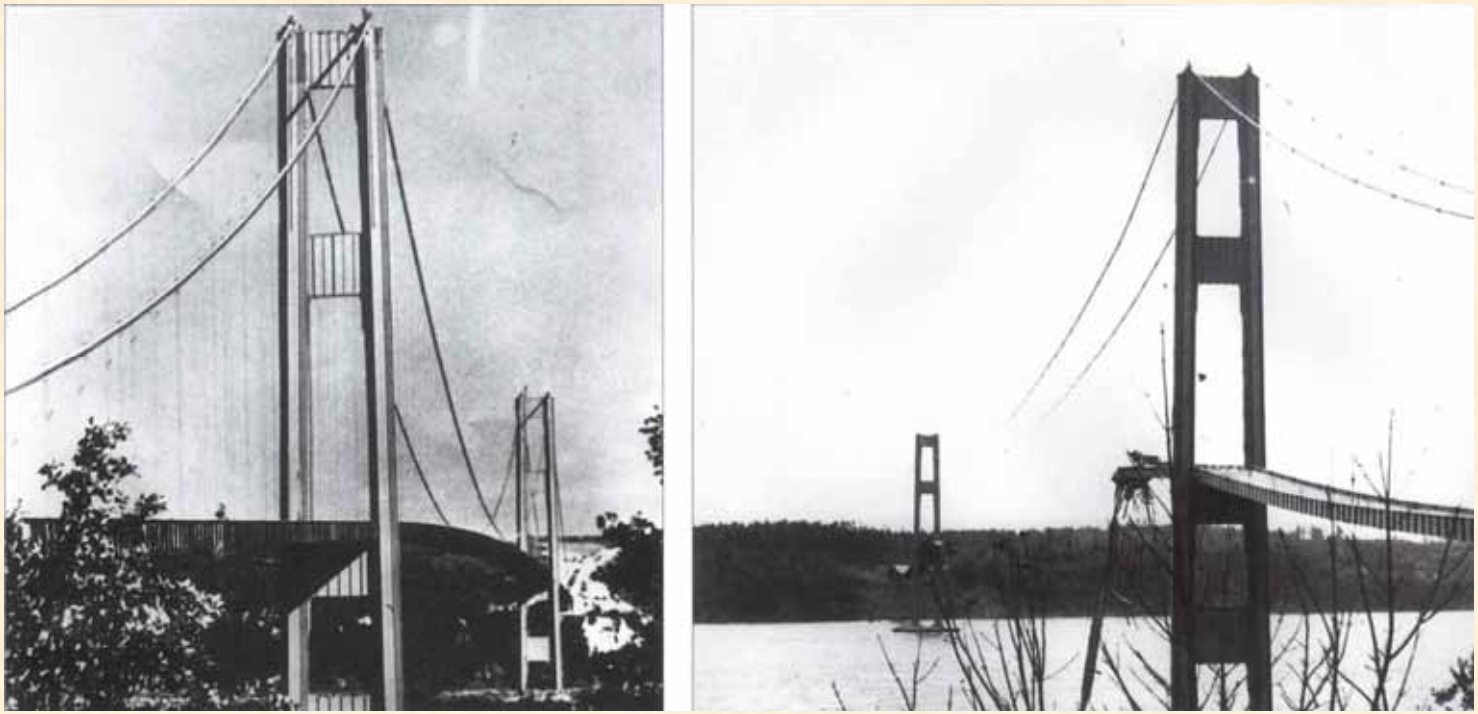
Maximum suspension bridge spans from 1831 to the present day

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Bridge over the Menai strait, Wales, 177 metres span (1826), T. Tèlford.

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Tacoma-Narrows bridge over Puget Soung neard Seattle, United States of America, 853 metres span (1940). Photograph after collapse on 7 November 1940.

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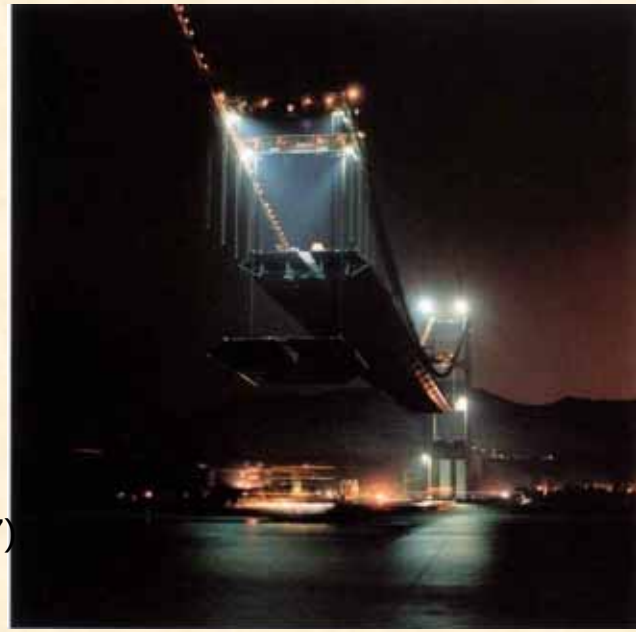
Storebealt bridge with the deck now finished (1998.

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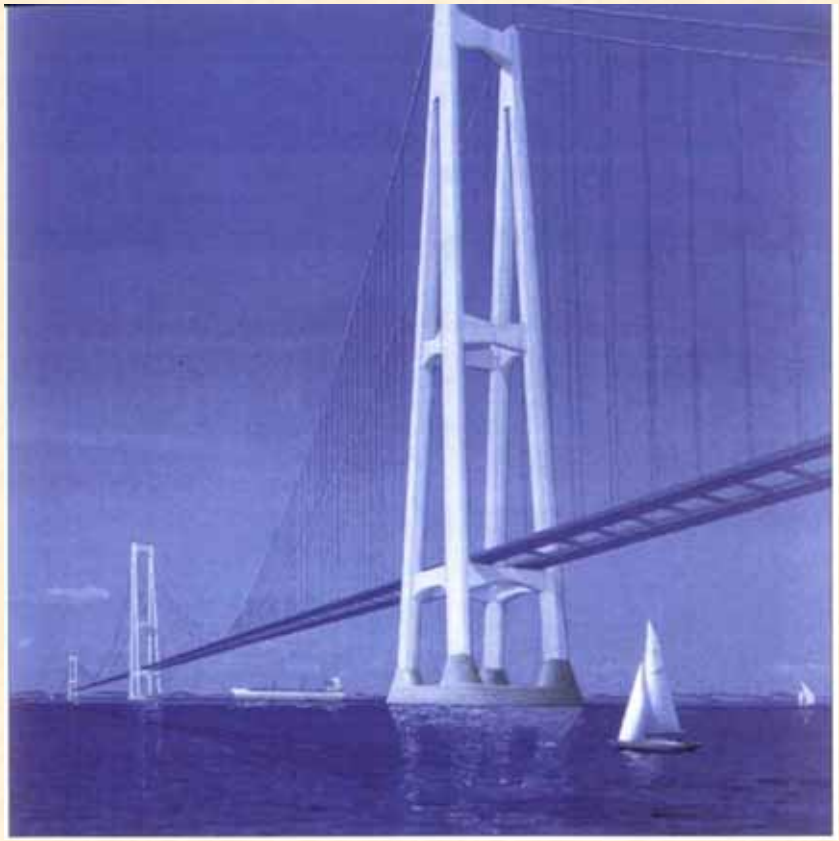
Akashi-Kaikyo bridge near the city of Kobe, on the Kobe-Naruto route bnetween Honsu and Shikoku islands, Japan, 1990 metres span (1998).

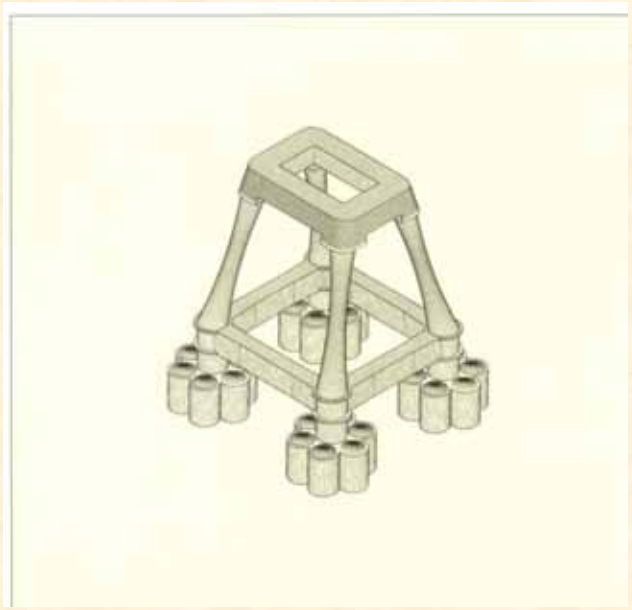


Tsing-Ma bridge in Hong-Kong, 1377 metres span (1997) Mott, Hay and Anderson.

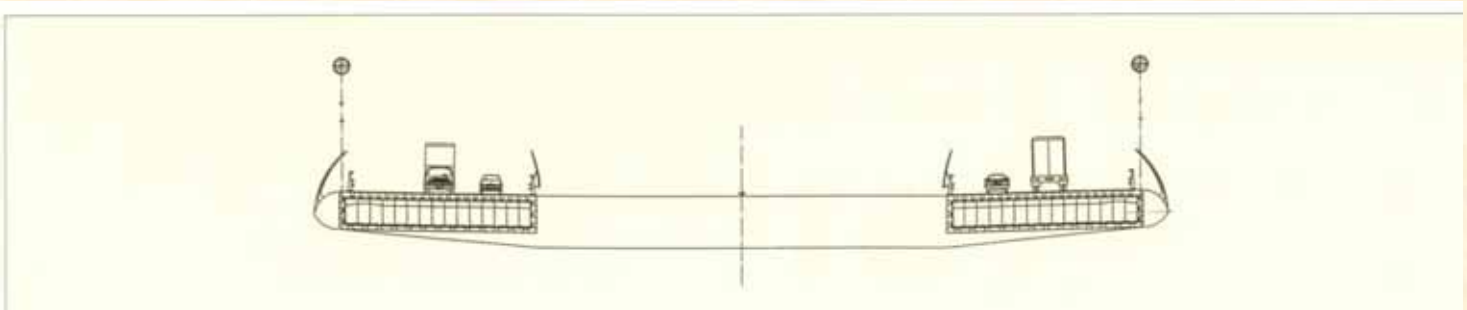


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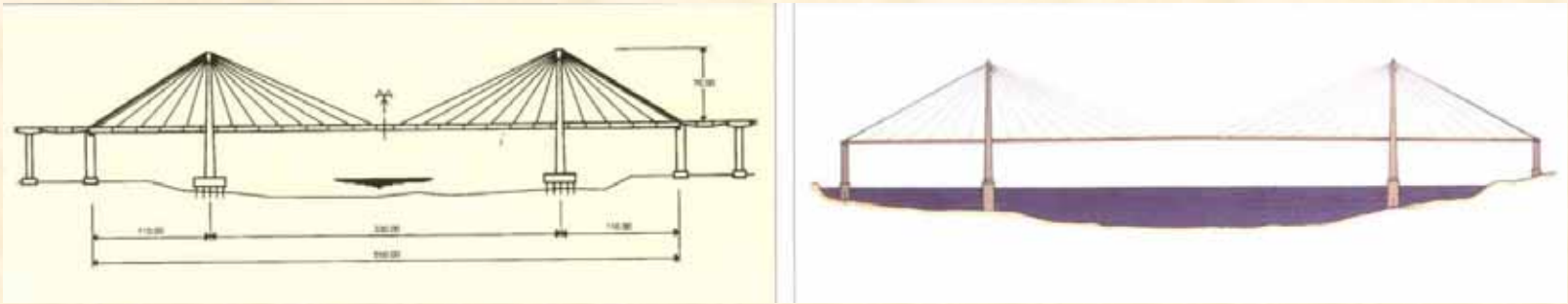




Preliminary design of the bridge over the Straits of Gibraltar between Spain and Marocco, spans of 3500 metres. General perspective. Tower infrastructure. Cross-section. Cowiconsult. Carlos Fernández Casado. S.L.



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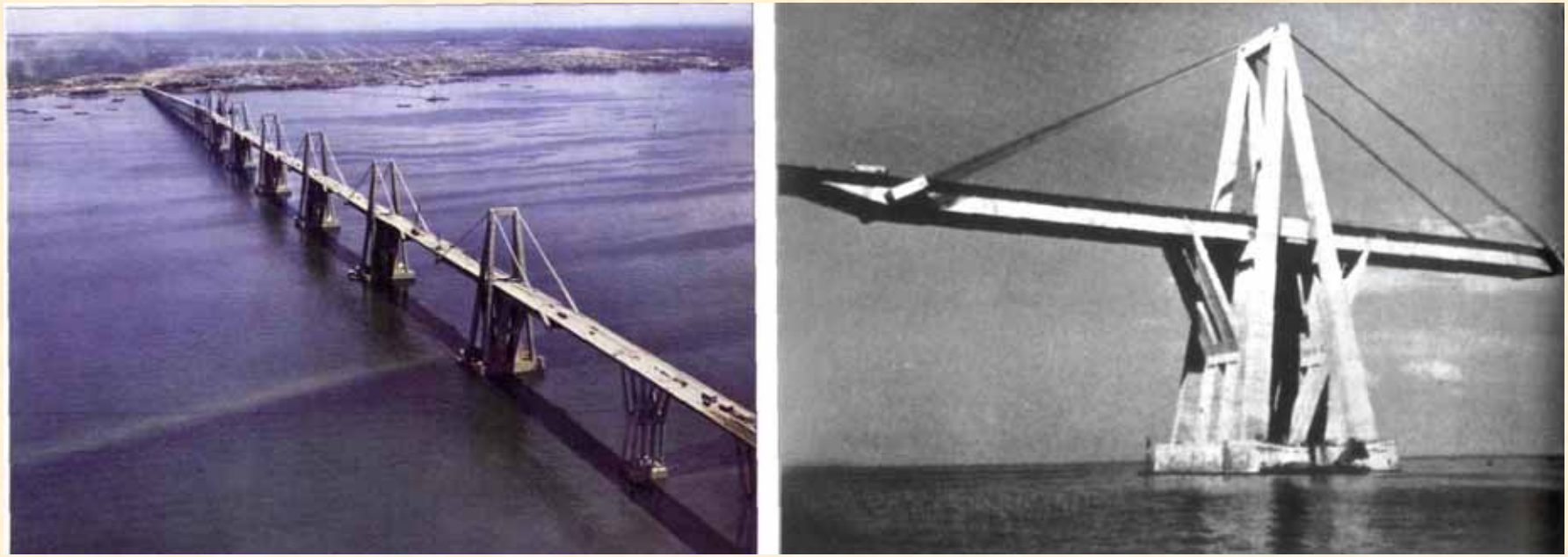
Bridges with an asynnetruic stay arrangement. Part of the rear stays are concentrated on the end piers. Zárate-Brazo Lrgo bridge over the river Paraná in Argentina, 330 metres span (1978), F.- de Miranda. Leonhardt and Andrä. Rande strait bridge in the Vigo estuary on the Atlantic Motorway, 400 metres span (1978), F. de Miranda, F. del Pozo.

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Brotonne bridge over the river Seine, France, 320 metres span (1977), Campenon Bernard.

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Bridge over lake Maracaibo in Venezuela, five main spans of 235 metres (1961), R. Morandi

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Polcevera viaduct in the city of Genoa, Italy, two main spans of 210 metres (1964), R. Morandi

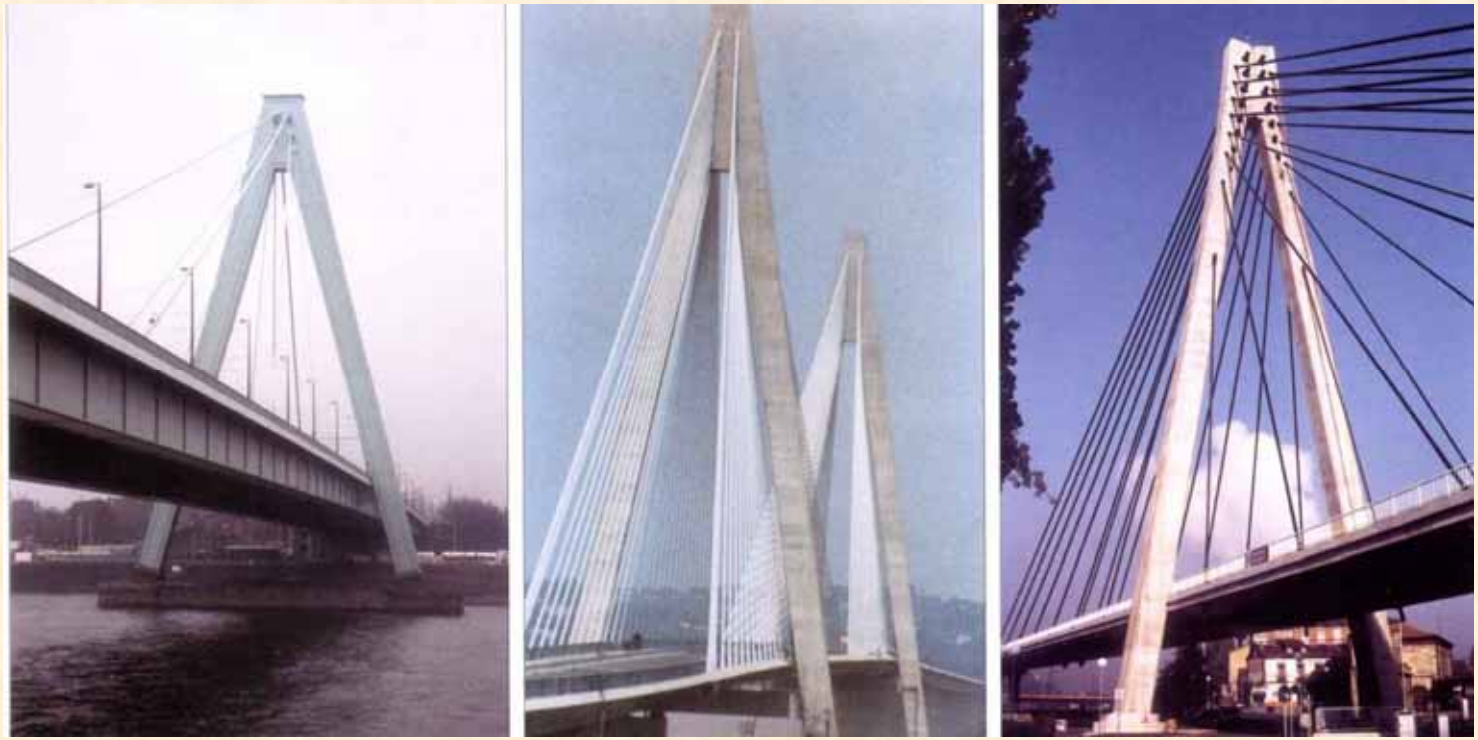




Kwan-Fu bridge in Taiwan, two spans of 134 metres (1977), T.Y. Lin



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A-shaped towers. Severin bridge in Cologne over the Rhine, Germany, 301 metres span (1960), Gutehoffnungshütte Sterkrade, G. Lohmer. Psadas-Encarnaciçn bridge over the river Paranà, between Argentina and paraguay, 30 metres spans C. Heckausen, H. Cabjolsky. Leonhardt and Andrä. Sma de Langreo bridge over the river Naçn, 130 metres span (1989), Carlos Fernàndez Casado, S.L.

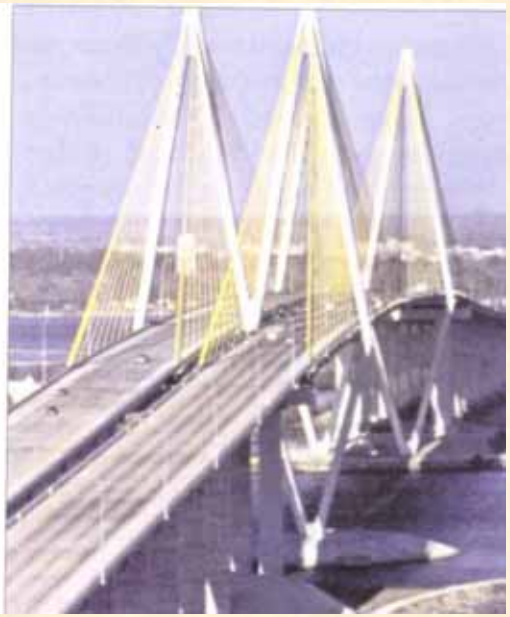
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Maogang bridge over the river Mao in Shangai. China, 200 metres span (1982).

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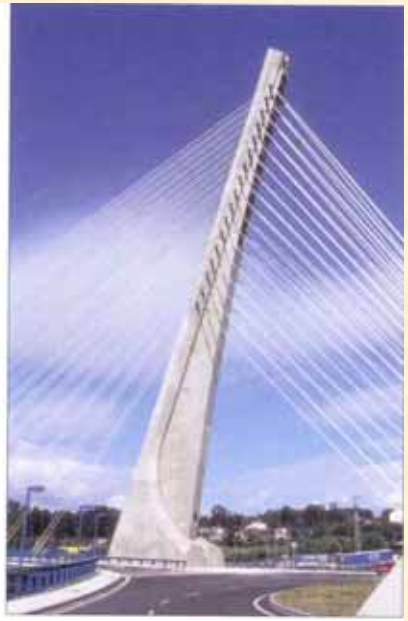




Diamond shaped towers. Faro bridge in Denmark, 290 metres (1985). Cowiconsult.
Double diamond bridge. Bridge over the Houston shipping canal near Baytown, Texas, 381 metres span (1996), Leonhardt and Andrä

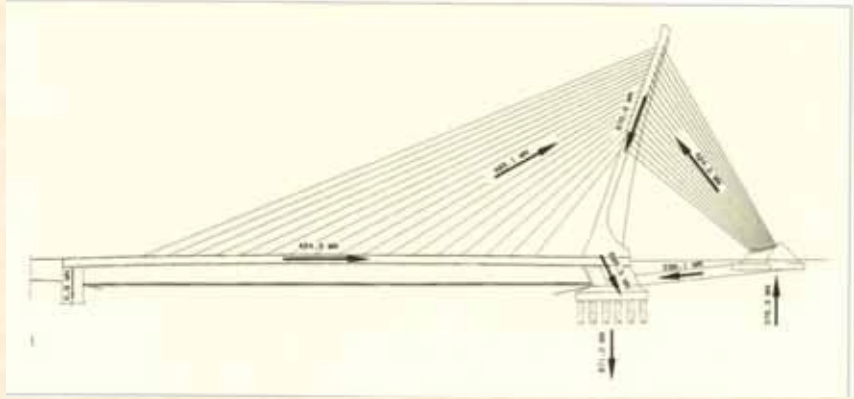
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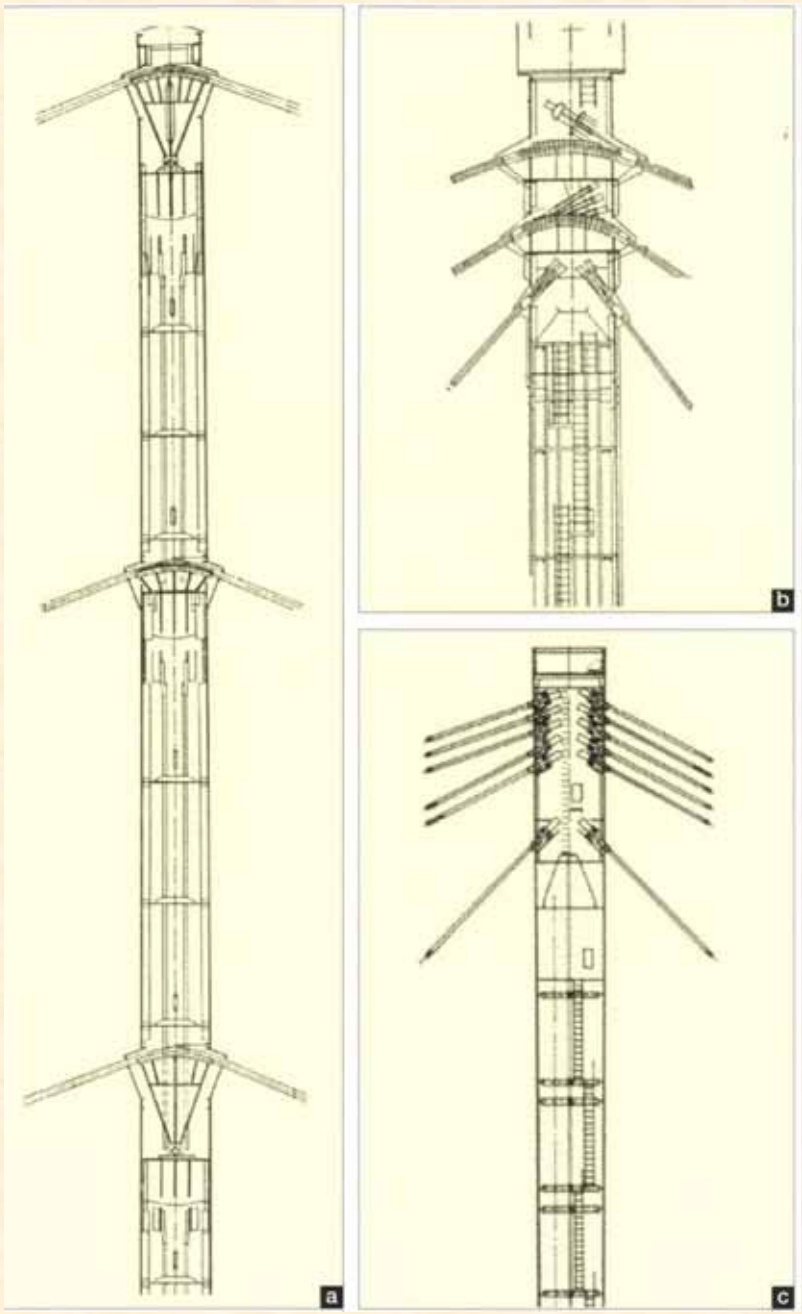


Bridge over the river Arno in Florence, 206 metres span (1977), F. de Miranda



Inlined concrede towers. Bridge over the river Ebro in Navarra, also called Sancho el Mayor, 140 metres span (1978). Bridge over the river Lérez in Potevedra, 125 metres span (1995). Carlos Fernàndez Casado, S.L.. Force polygon for the bridge over the river Lérez.

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Stay anchorage in the metal towers of the early German bridges

a) (a) Nordrücke in Düsseldorf with hinged and fixed saddles.
b) Severin in Cologne with cables anchored in the tower and saddles,
c) Mannheim-Ludwighafen with the cables anchored in the tower.

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Construction of concrete decks by cantilevers using form travellers. Ingeniero Carlo Fernàndez Casado bridge over the barrios de Luna reservoir, 440 metres span (1983), Carlos Fernàndez Casado, S.L., Huarte y Cia S.A.

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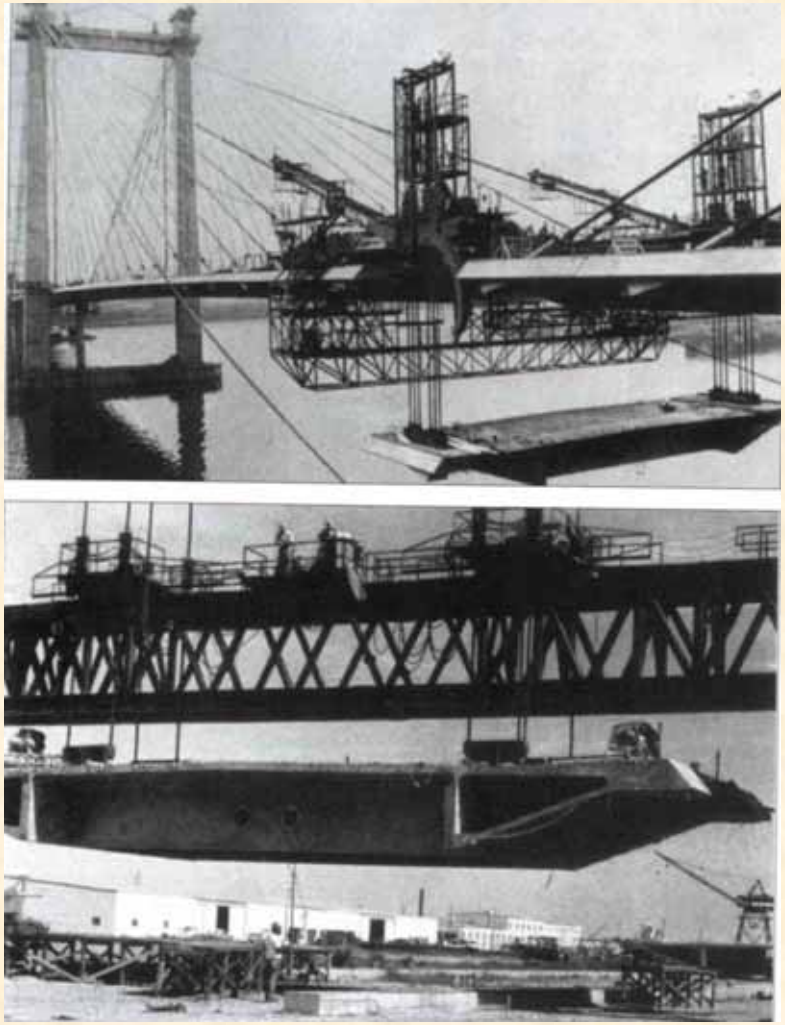


Construction of the Normandie bridge over the mouth of the Seine, 856 metre span (1995). Construction of the concrete stretch by balanced cantilevers. Lifting the first metal segment. Advancing the main span with sigle cantilevers. Fitting the segment into tre crown.





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Paso-Kennewick bridge over the river Columbia. 299-metres span (1978). Successive cantilevers with full cross-section precast segments.



Sancho el Mayor bridge over the river Ebro in Navarre, 146-metre span (1978). Cantilevers with half cross-section precast segmets.



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Faro bridge in Denmark, 290 metres span (1985). Successive cantilevers by means of metal segments.

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DUISBURG-NEUENKAMP. GERMANY. 350 mts. 1970



KNIEBRUCKE DUSSELDORF. GERMANY. 319 mts. 1969



SEVERIN COLOGNE. GERMANY. 301 mts. 1919



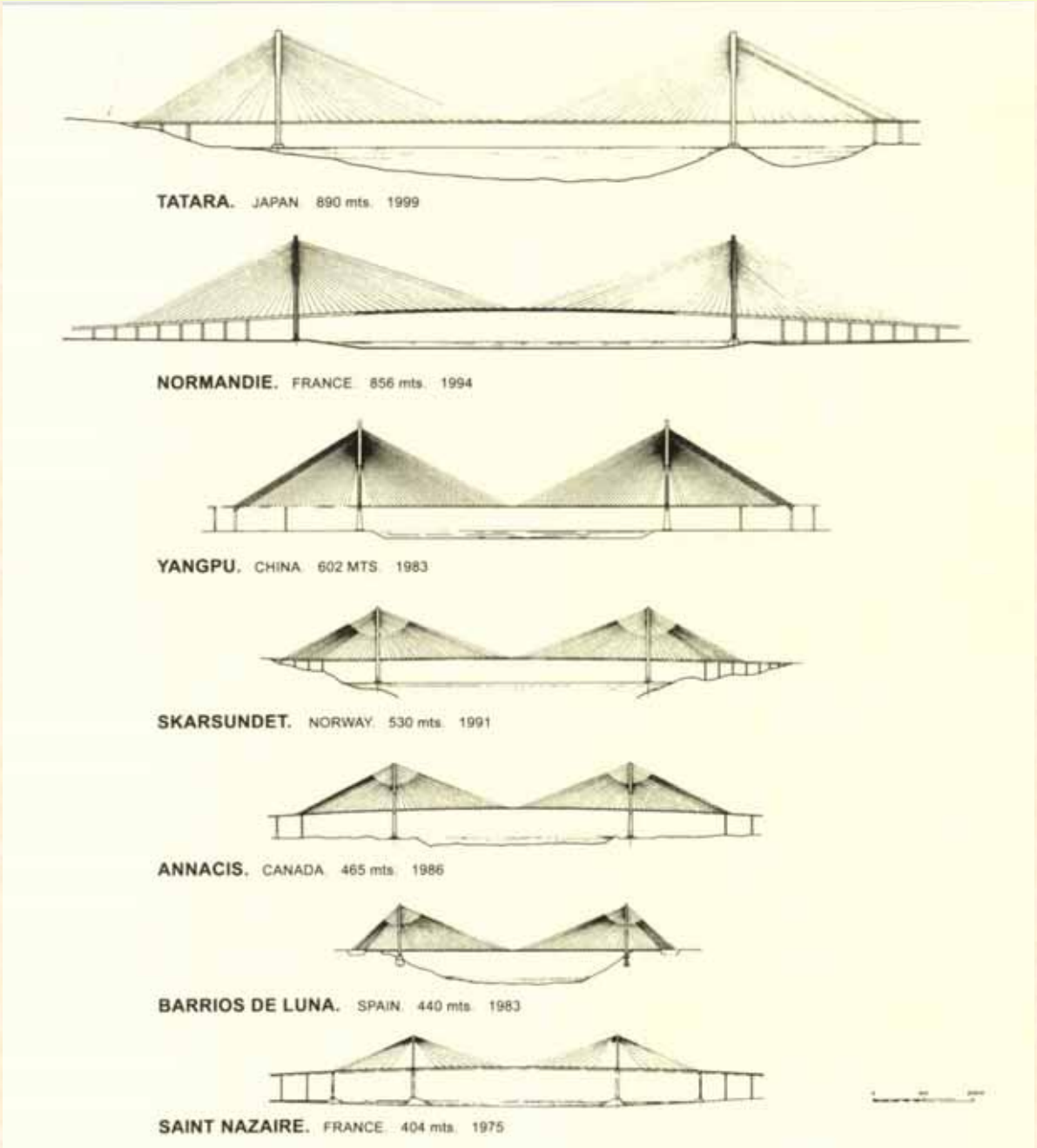
NORDBRUCKE DUSSELDORF. GERMANY. 260 mts. 1958



STROMSUND. SWEDEN 183 mts. 1955

Maximum spans of the first generation of cable-stayed bridges.

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Maximum cable-stayed bridge spans from (1975) to the end of the century.

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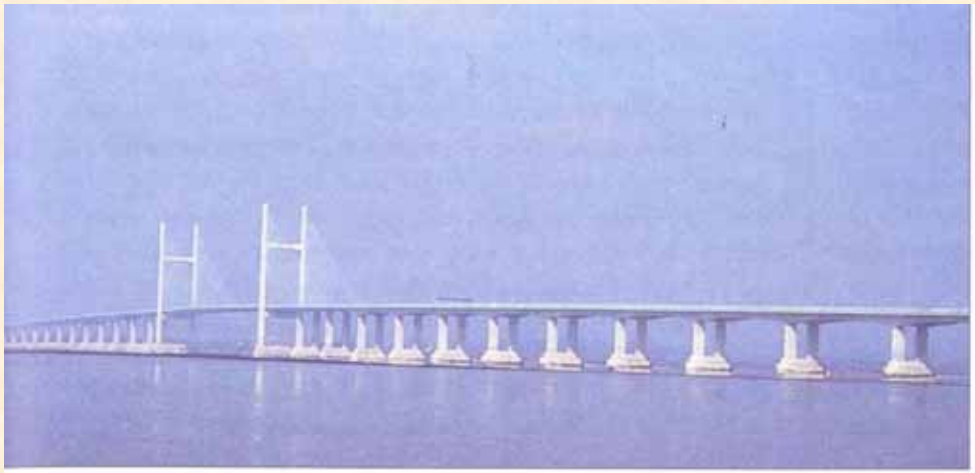
Normandie bridge at the mouth of the Seine, France, 856 metres span (1995), M. Virlogeux

General view of the cable.stayed bridge and approaches under construction



Bridge after final connection of the deck.

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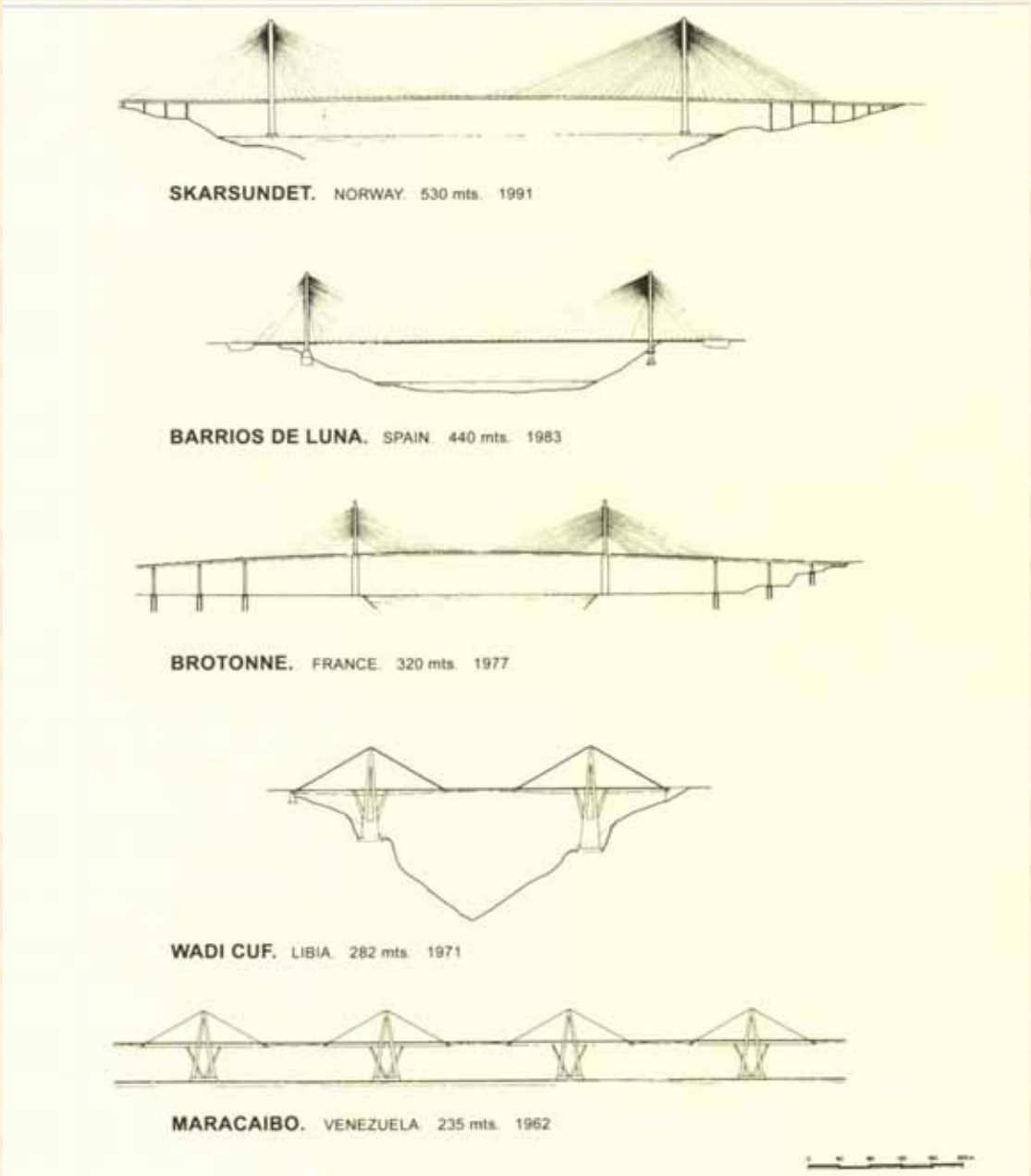






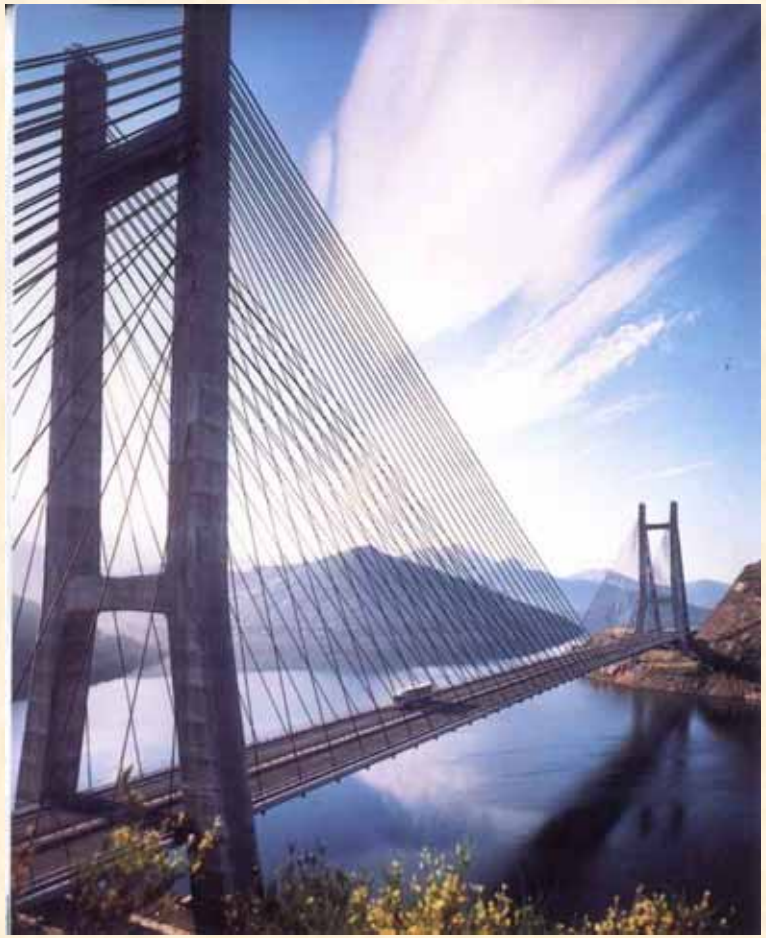
Two large viaducts with a cable-stayed shipping span. Bridge in the river Severn estuary downstream from the suspension bridge, Great Britain. Maximum span 456 metres (1996). Metal deck. Bridge over the Tagus estuary in Lisbon upstream of the suspension bridge, maximum span 420 metres. Under construction. Concrete deck with metal cross girders.

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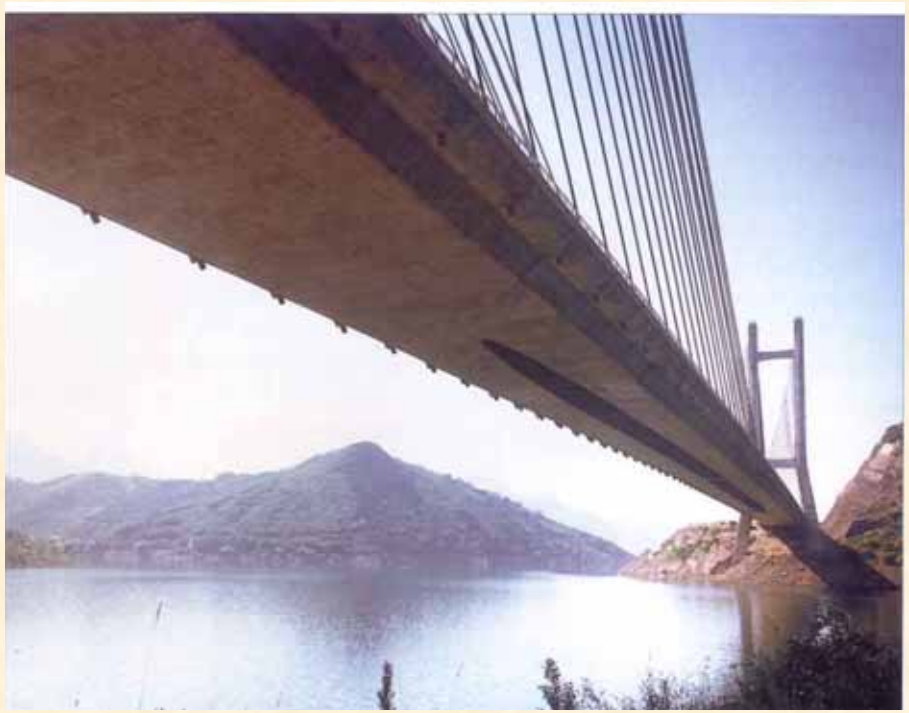


Maximum spans of concrete cable-stayed bridge

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Ingeniero Carlos Fernàndez Casado bridge over the Barrios de Luna reservoir, León, 440 metres span (1983), Carlos Fernàndez Casado, S.L.



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Tipologie – Criteri progettuali - Realizzazioni

1. Ponti e viadotti con campate appoggiate

2. Ponti e viadotti con campate di lunghezza “media”

3. Ponti di “grande” luce

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