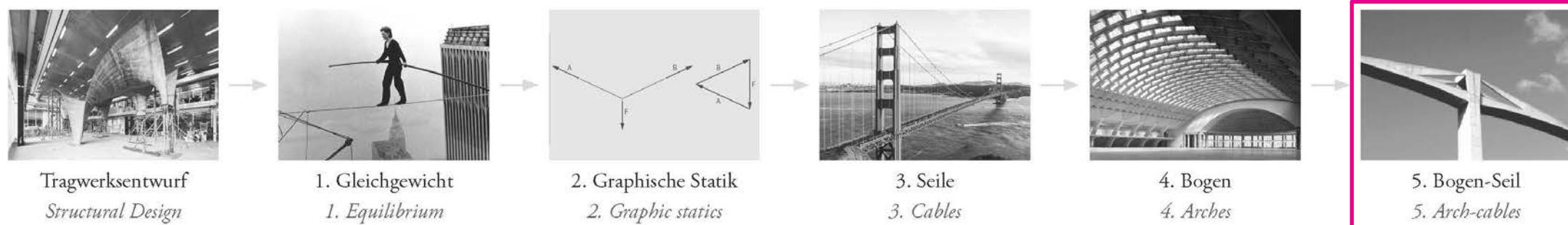


Tragwerksentwurf I

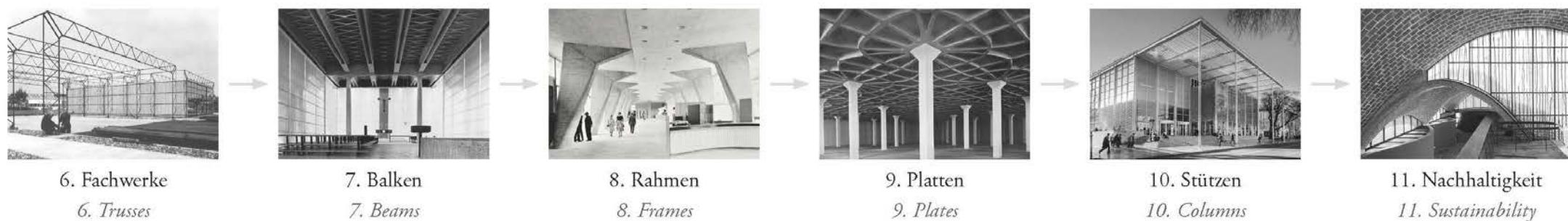
Structural Design I

Philippe Block · Joseph Schwartz



Tragwerksentwurf I *Structural Design I*

Tragwerksentwurf II *Structural Design II*



Bogen-Seil-Tragwerke

Arch-cable structures

>> Tragwirkung einfacher Bogen-Seil-Tragwerke
Structural behaviour of simple arch-cable structures

Auflagerbedingungen
Support conditions

Aufteilung der äusseren Lasten
Distribution of external loads

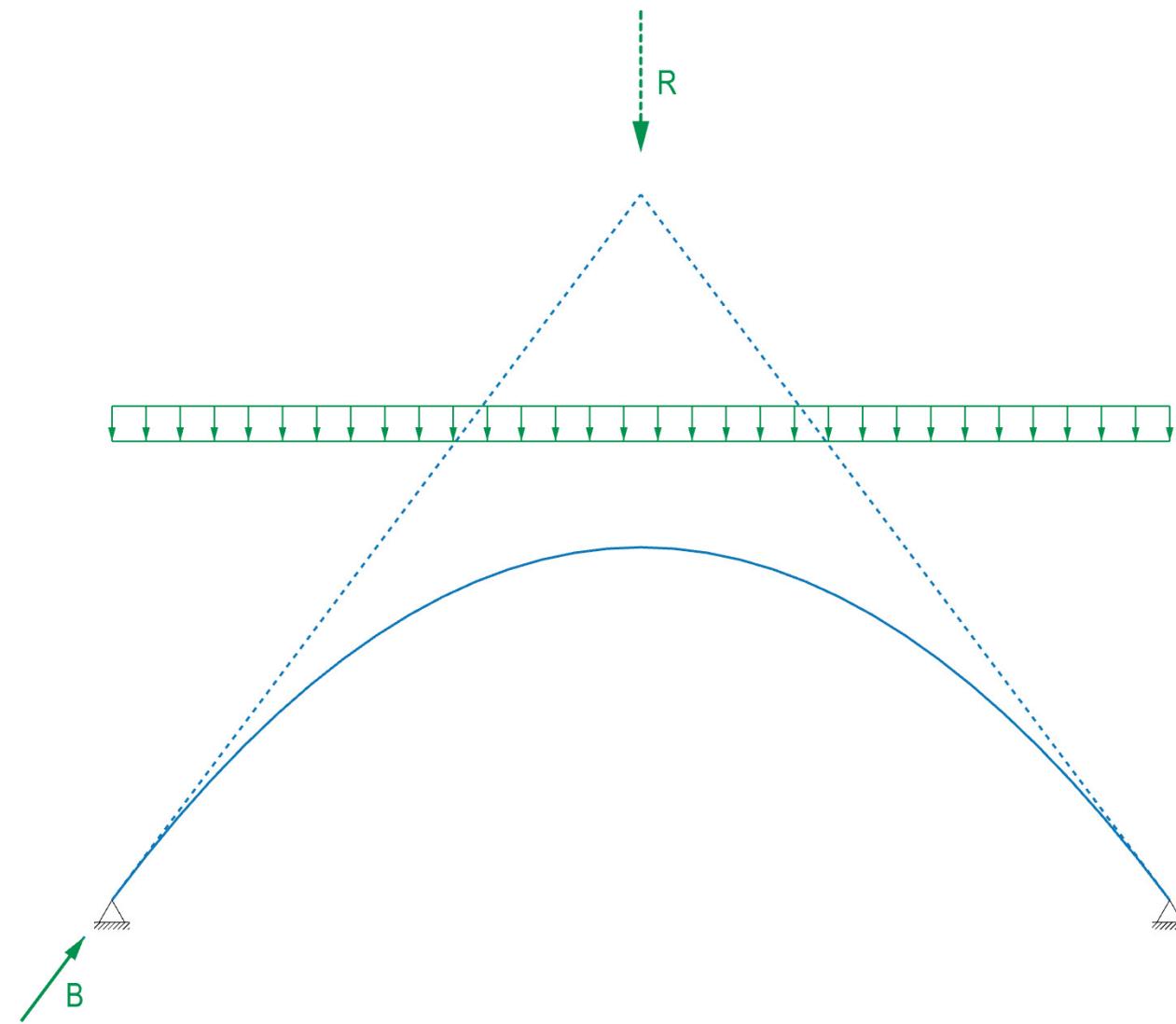
Formfindung eines überspannenden Bogen-Seils
Form-finding of a spanning arch-cable

Konsolenartige Bogen-Seil-Tragwerke
Cantilevering arch-cable structures

Geometrische Variation
Geometric variation

Zusammengesetzte Bogen-Seil-Tragwerke
Combined arch-cables

Fallbeispiele
Case studies

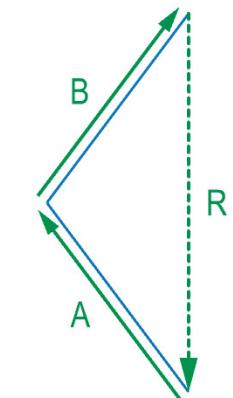


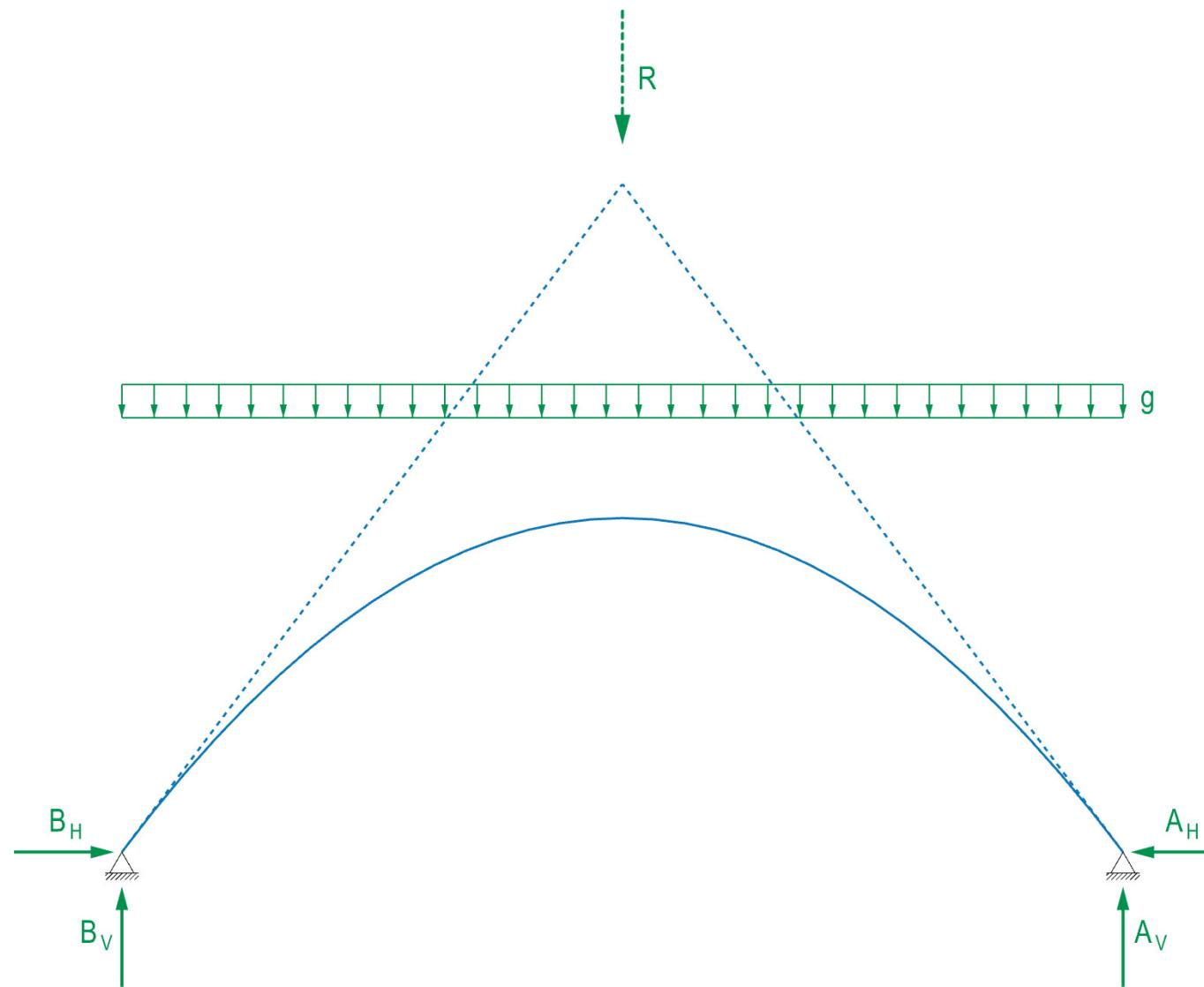
Lageplan 1:100

Form diagram 1:100

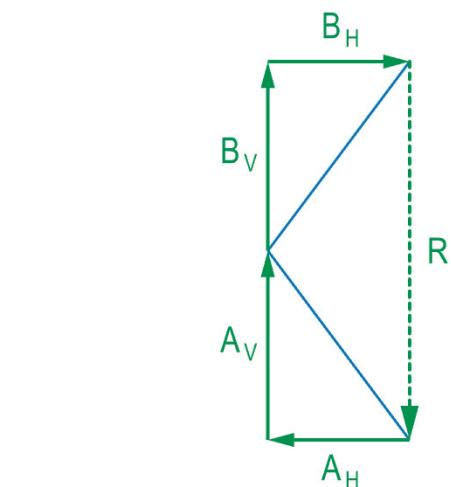
Kräfteplan 1 cm \triangleq 1 kN

Force diagram 1 cm \triangleq 1 kN

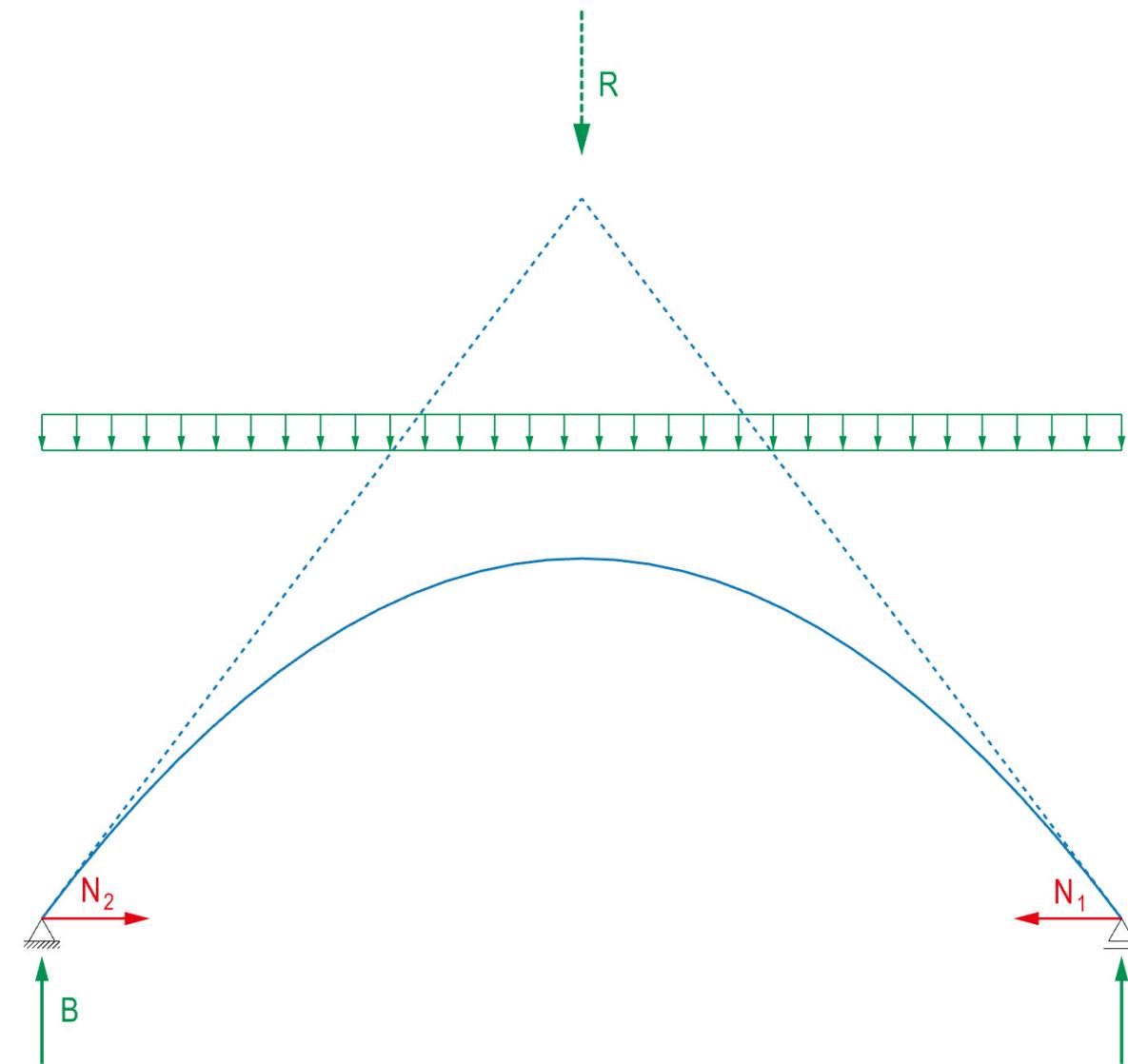




Lageplan 1:100
Form diagram 1:100

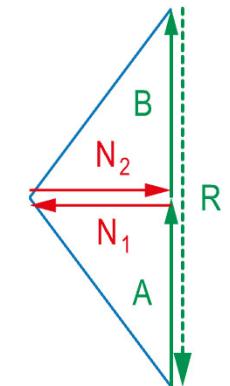


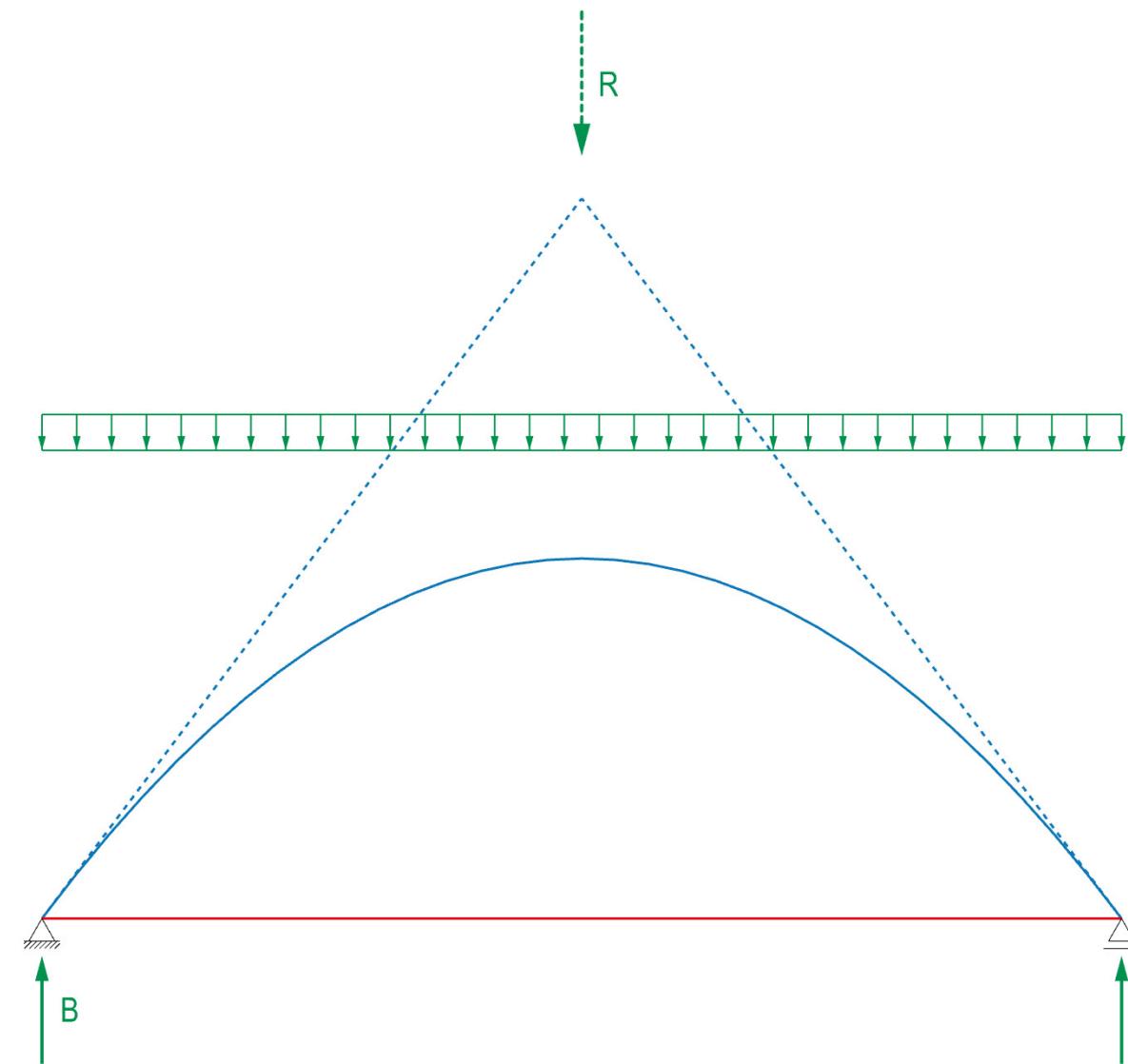
Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN



Lageplan 1:100
Form diagram 1:100

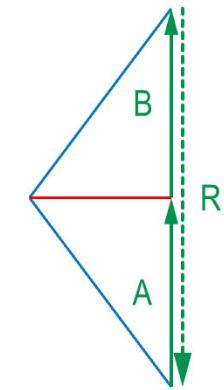
Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN

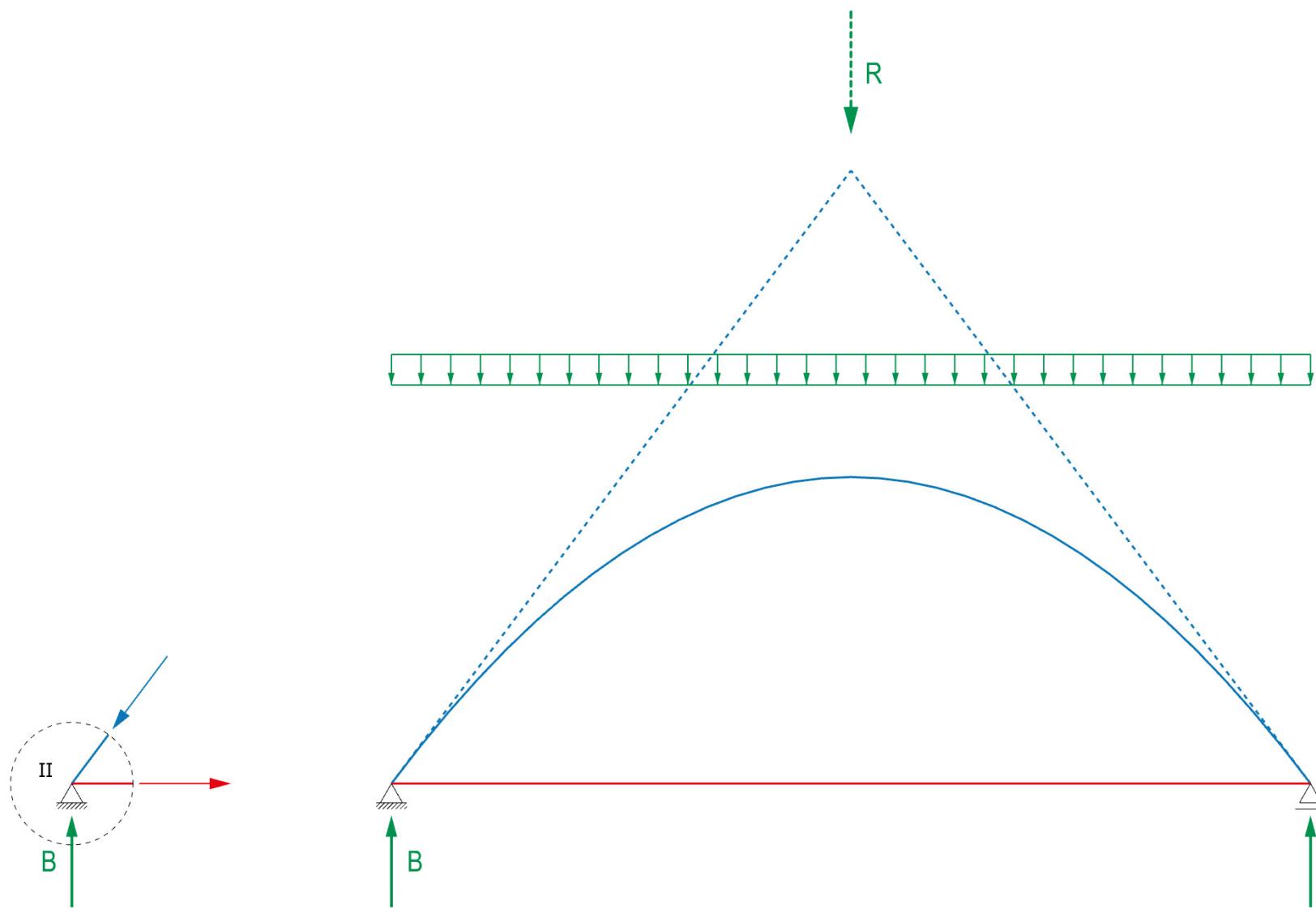




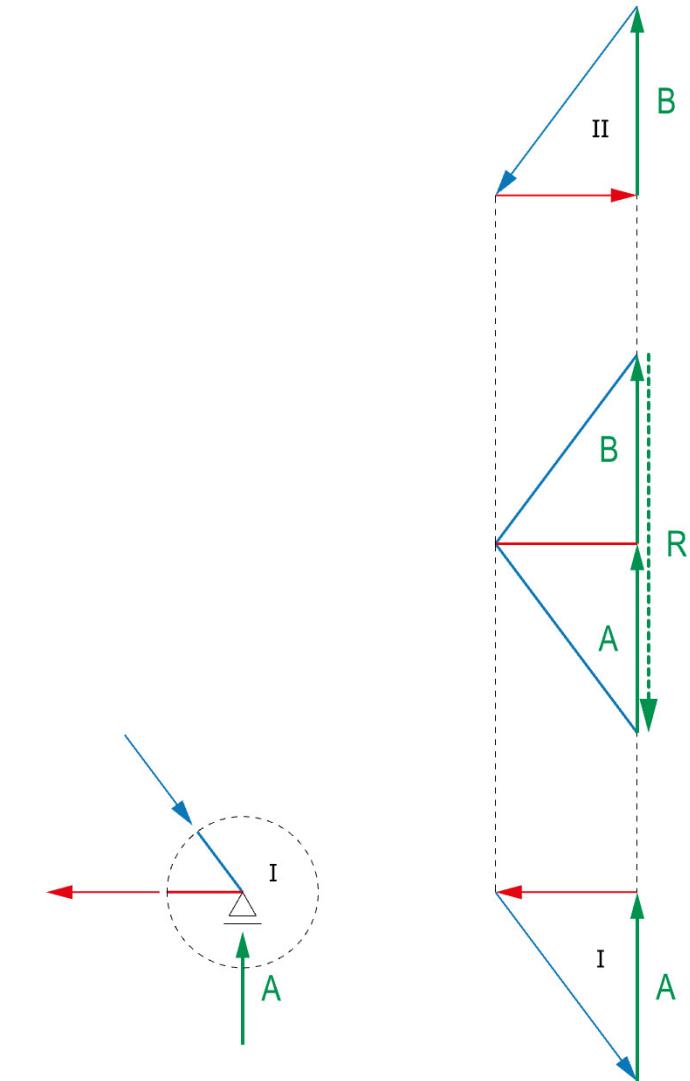
Lageplan 1:100
Form diagram 1:100

Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN

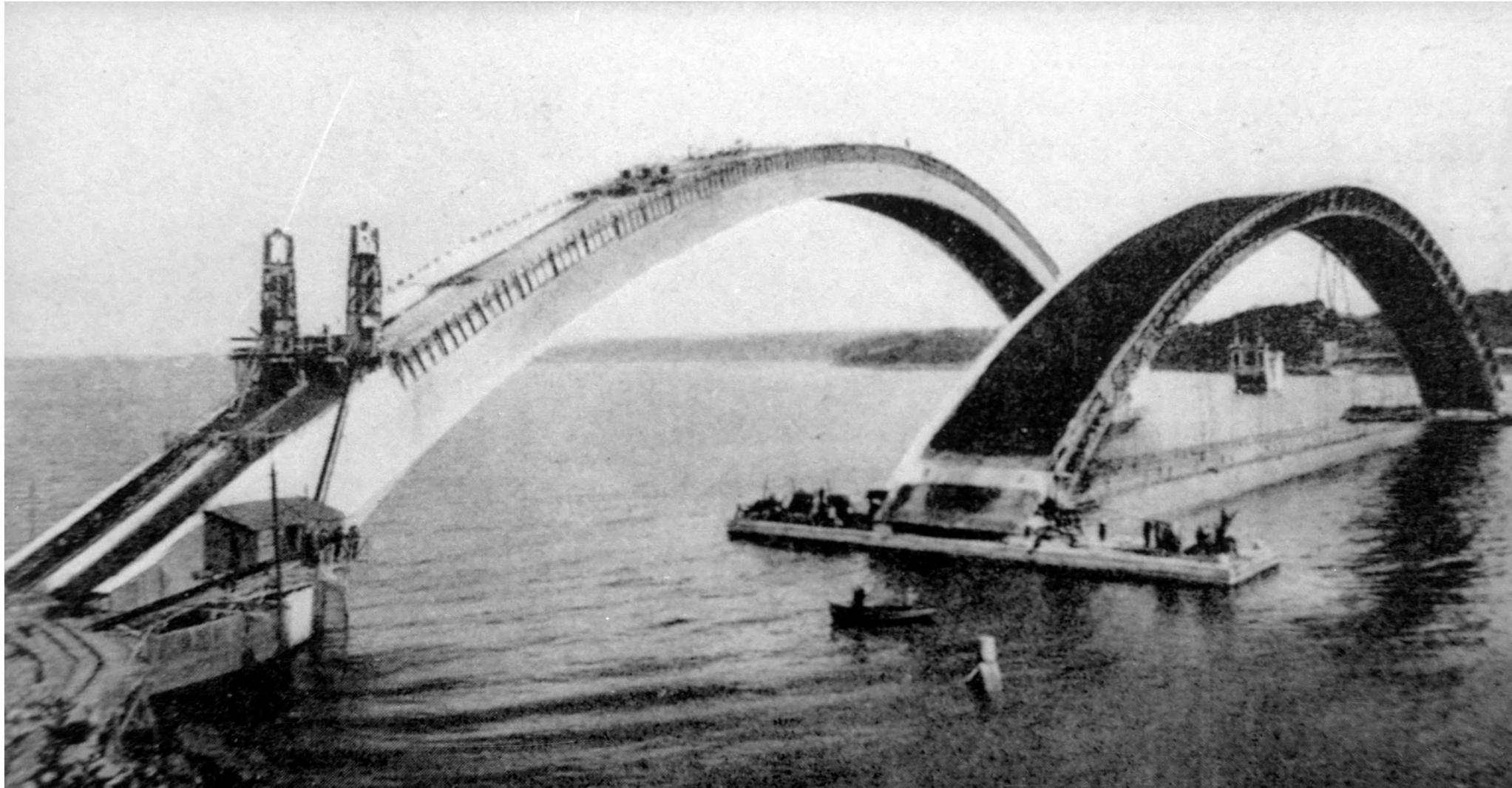




Lageplan 1:100
Form diagram 1:100



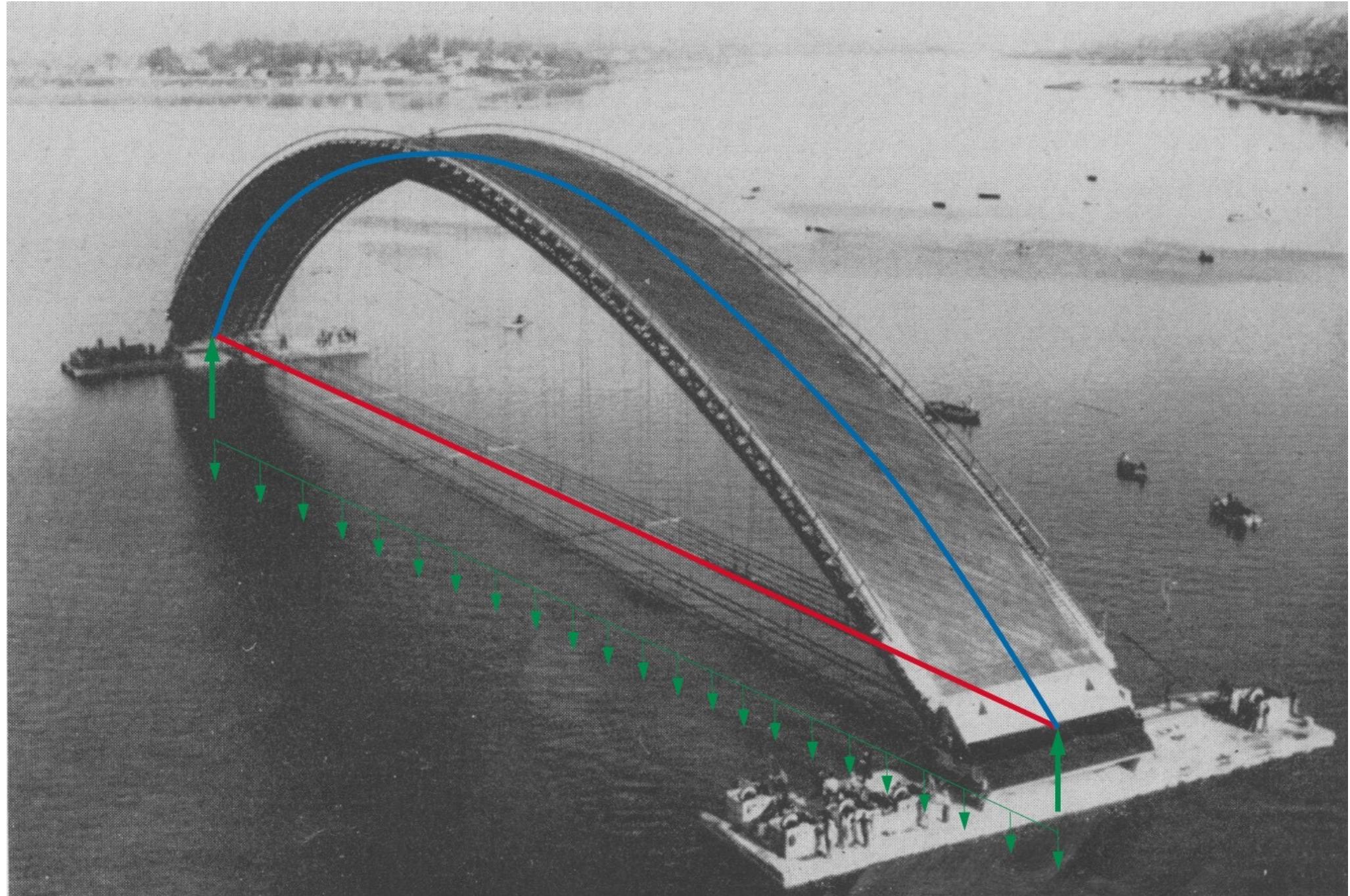
Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN



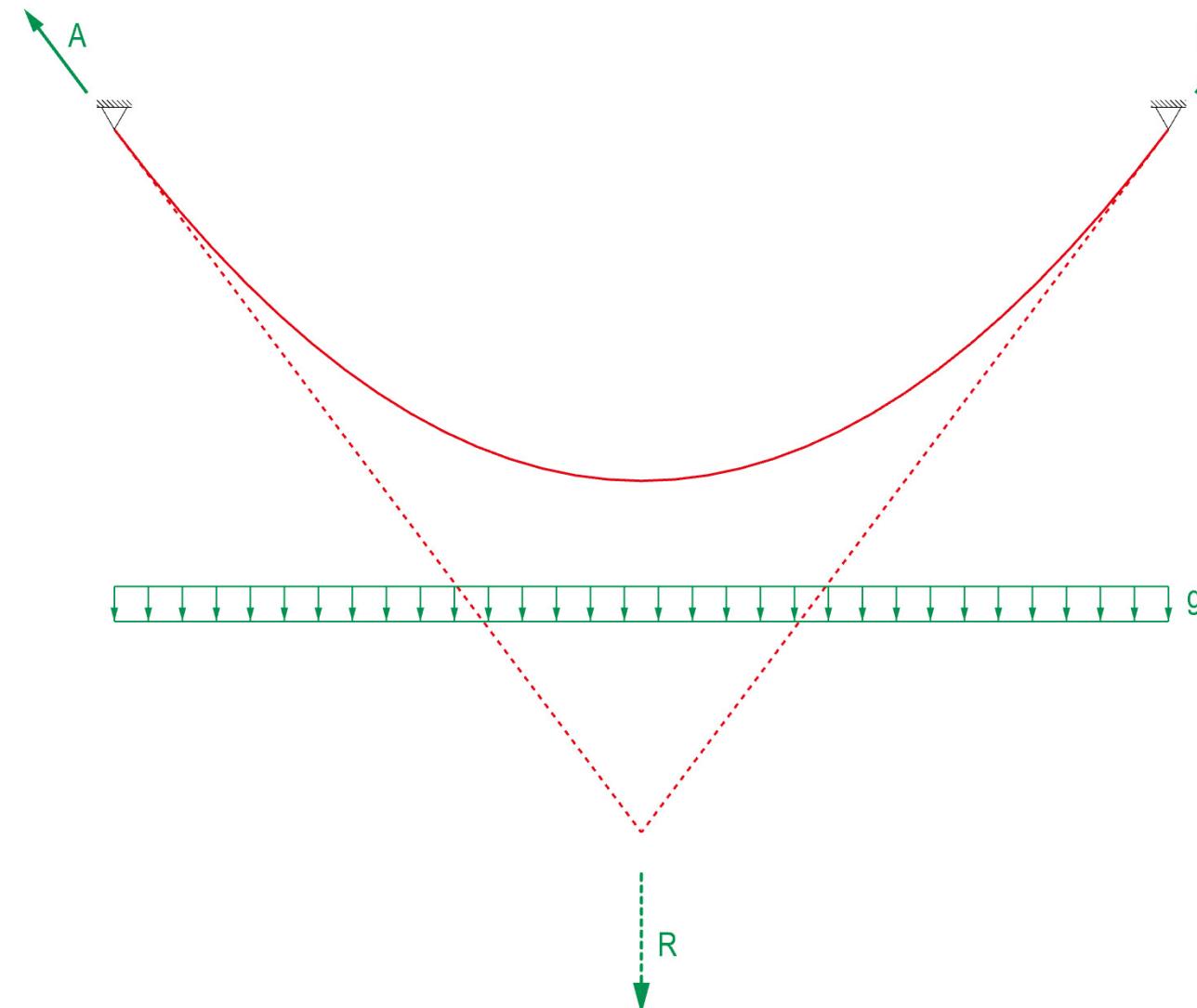
Eugène Freyssinet: Pont Albert Louppe, Bretagne, 1930



Eugène Freyssinet: Pont Albert Louppe, Bretagne, 1930



Eugène Freyssinet: Pont Albert Louppe, Bretagne, 1930

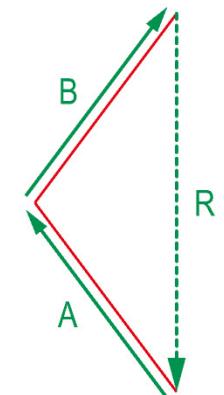


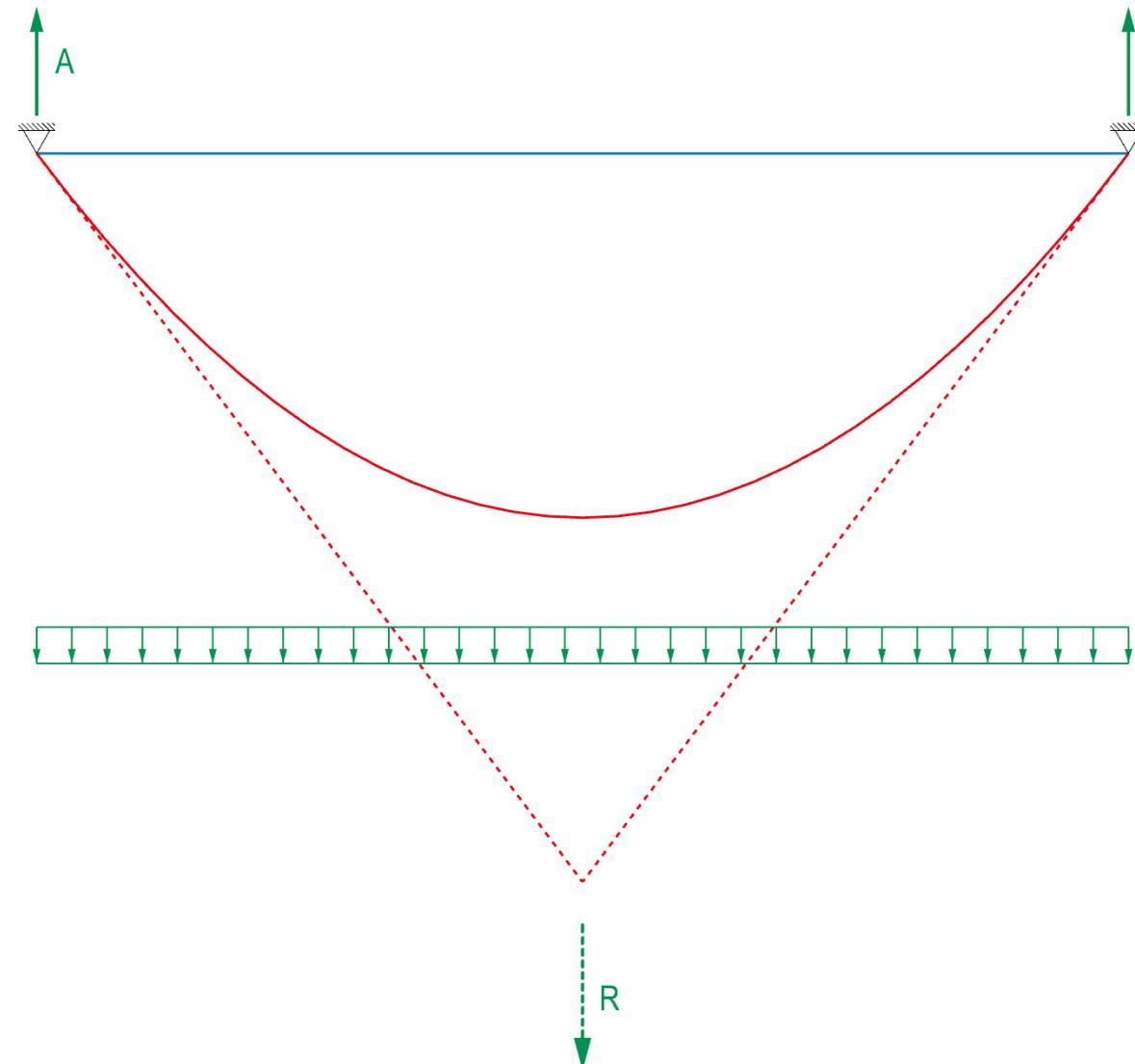
Lageplan 1:100

Form diagram 1:100

Kräfteplan 1 cm $\hat{=}$ 1 kN

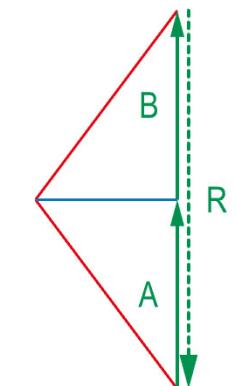
Force diagram 1 cm $\hat{=}$ 1 kN

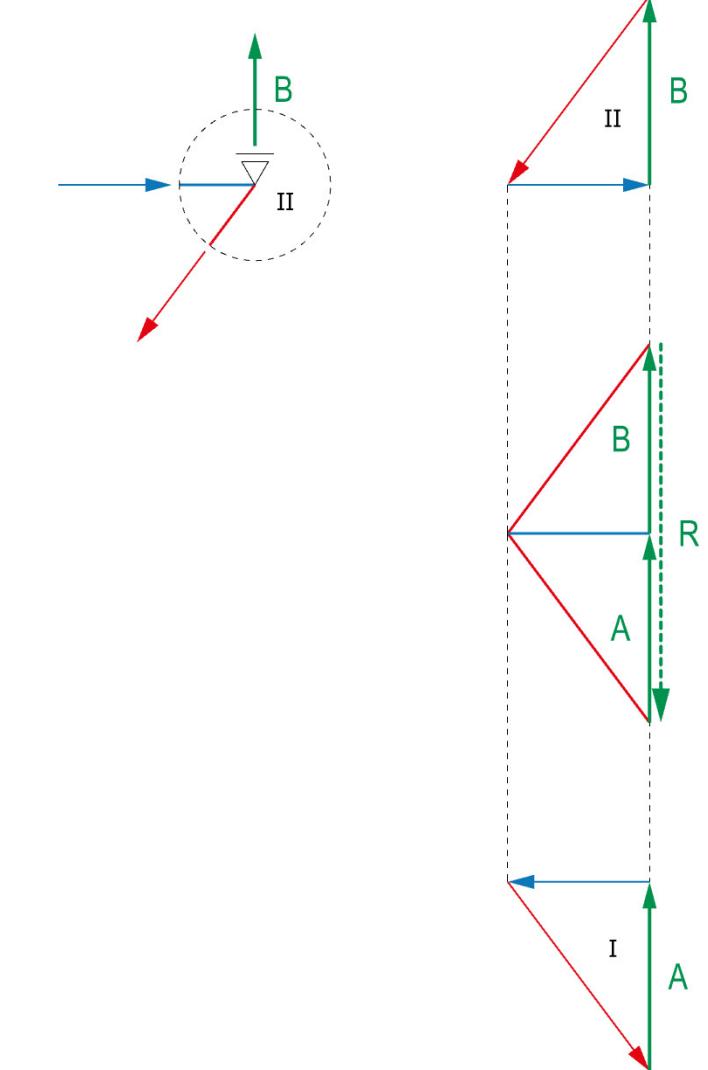
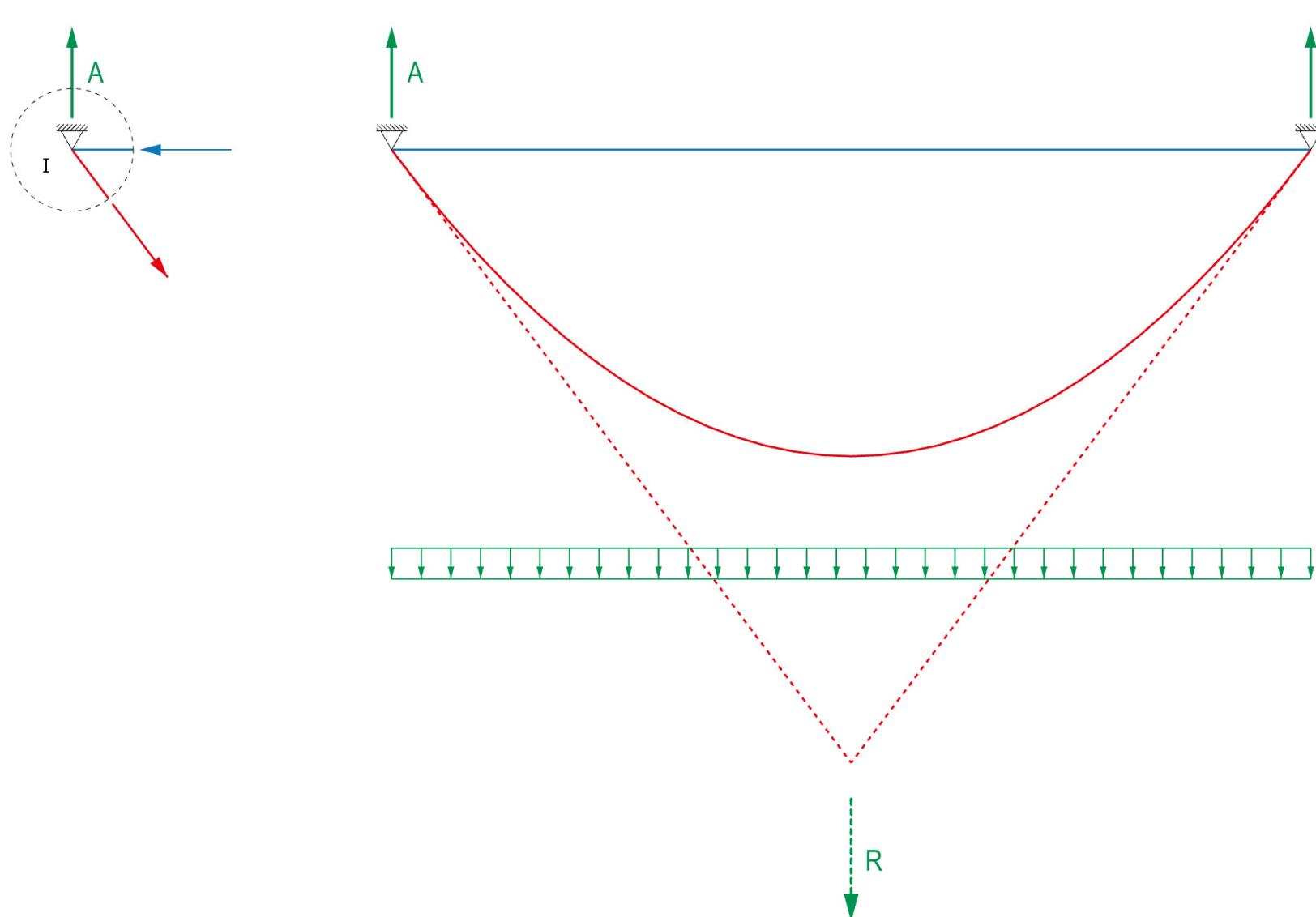




Lageplan 1:100

Form diagram 1:100

Kräfteplan 1 cm \triangleq 1 kNForce diagram 1 cm \triangleq 1 kN



Bogen-Seil-Tragwerke

Arch-cable structures

Tragwirkung einfacher Bogen-Seil-Tragwerke

Structural behaviour of simple arch-cable structures

>>

Auflagerbedingungen

Support conditions

Aufteilung der äusseren Lasten

Distribution of external loads

Formfindung eines überspannenden Bogen-Seils

Form-finding of a spanning arch-cable

Konsolenartige Bogen-Seil-Tragwerke

Cantilevering arch-cable structures

Geometrische Variation

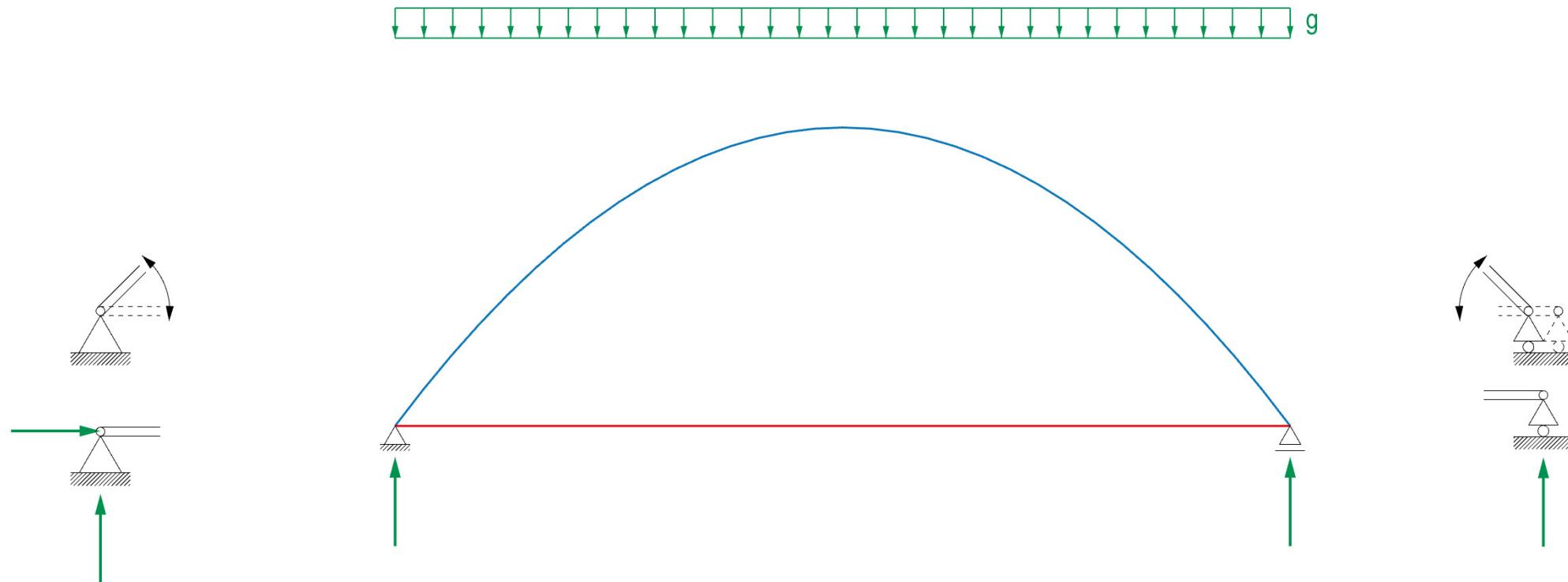
Geometric variation

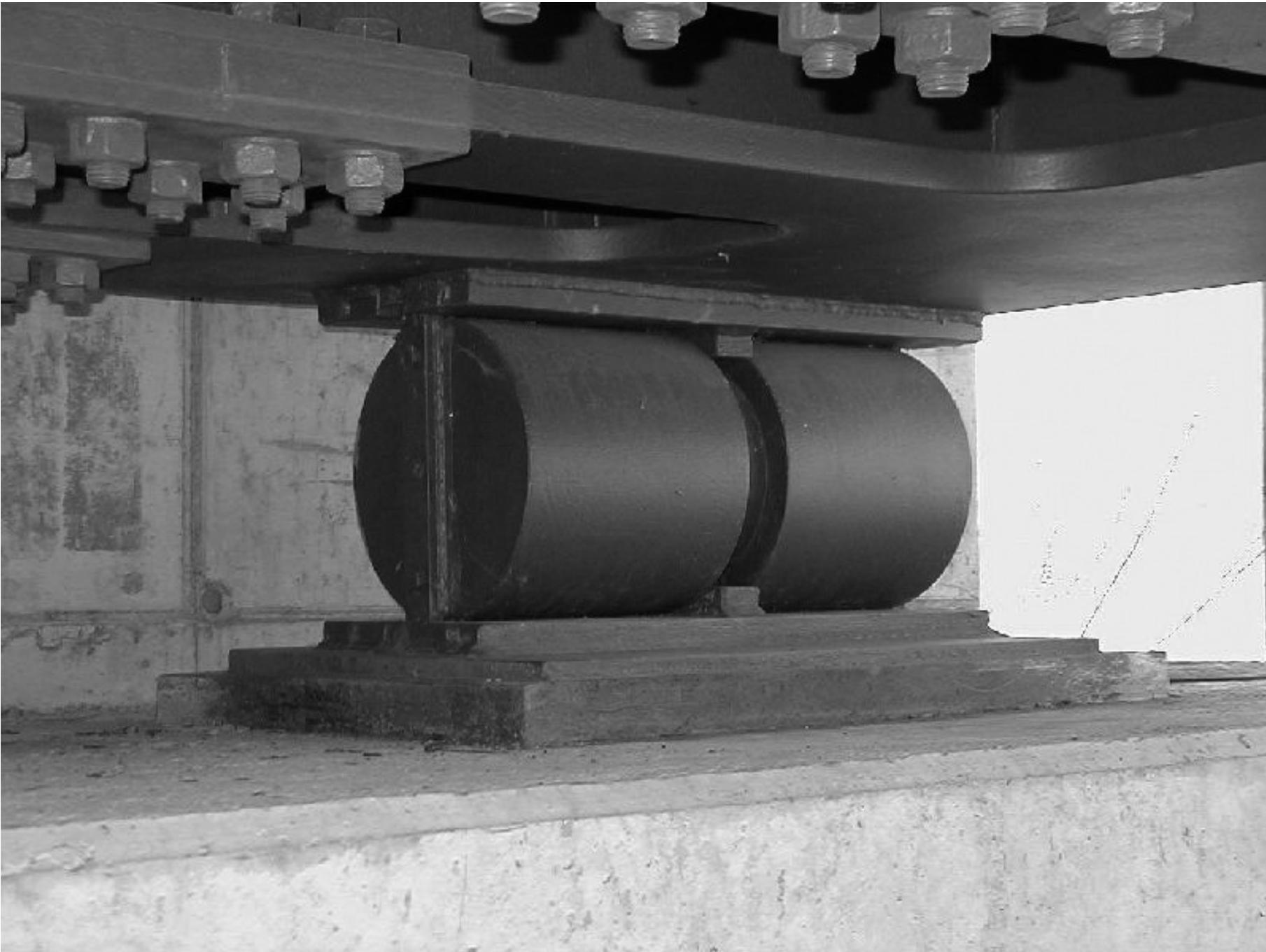
Zusammengesetzte Bogen-Seil-Tragwerke

Combined arch-cables

Fallbeispiele

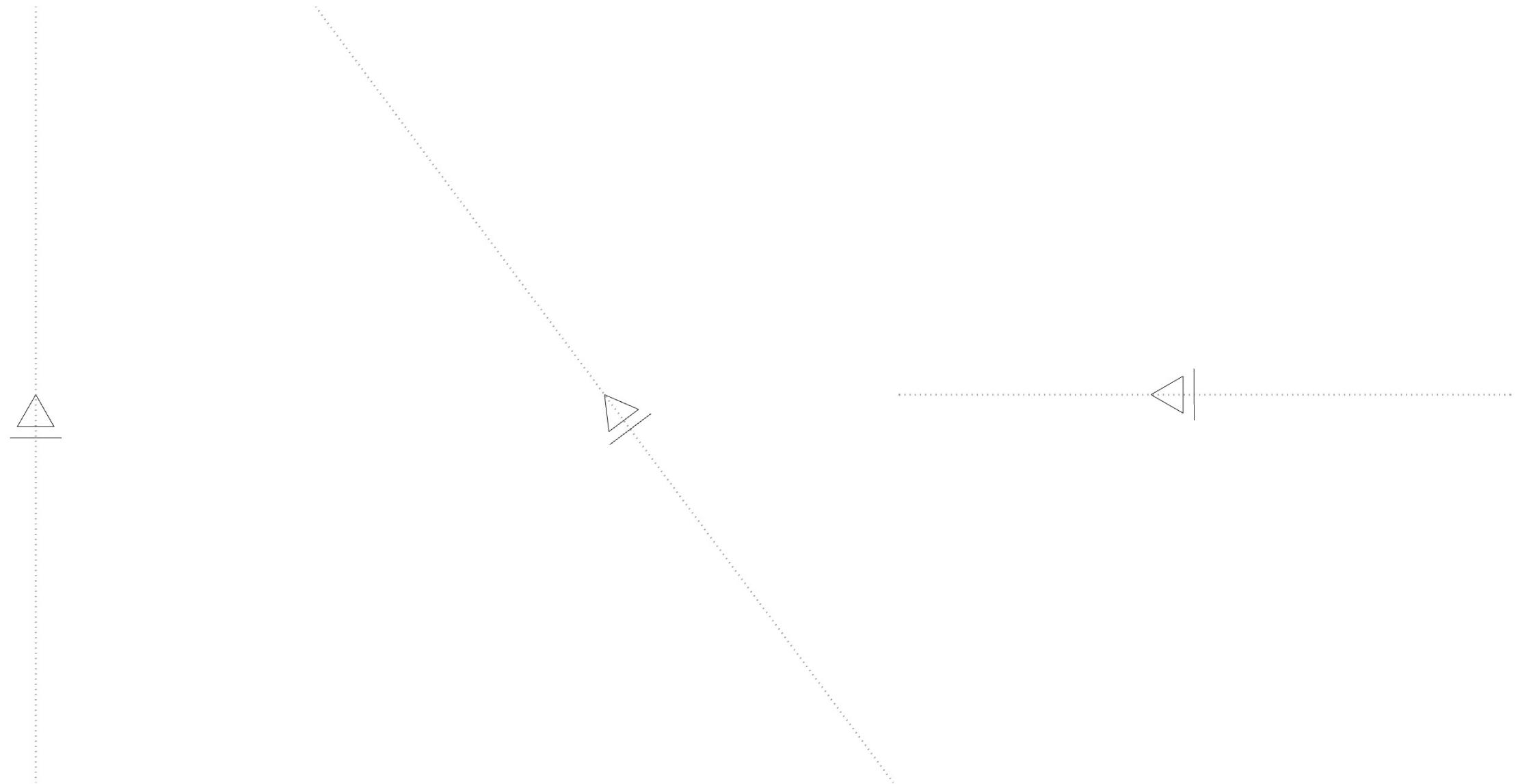
Case studies

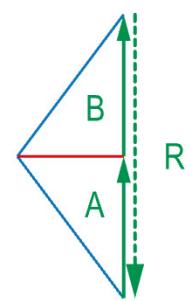
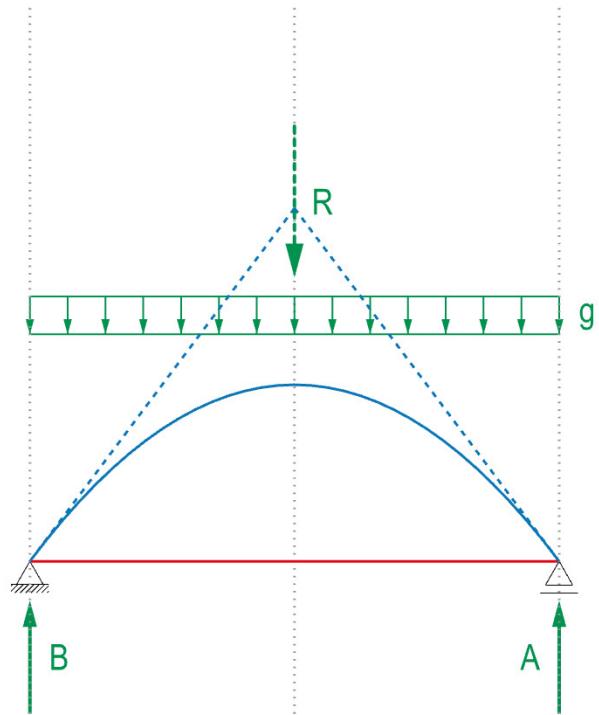






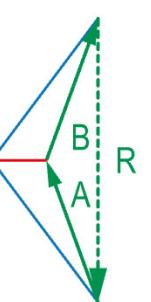
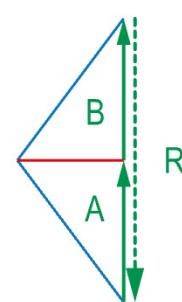
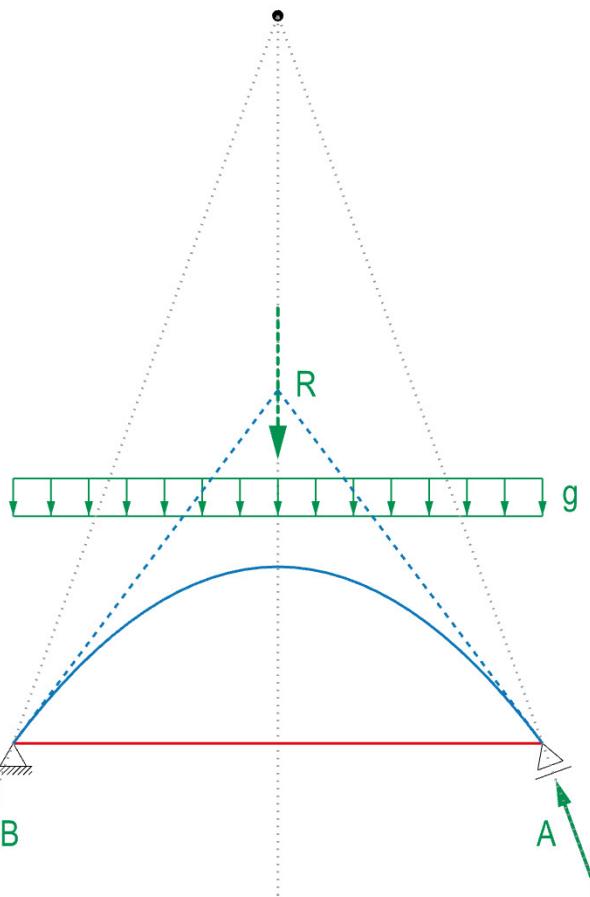
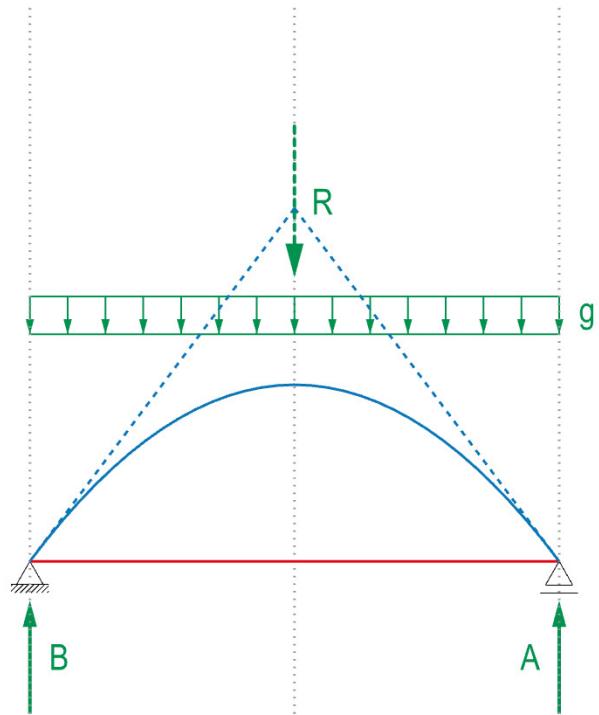






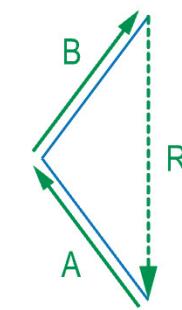
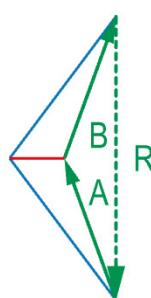
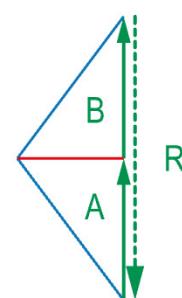
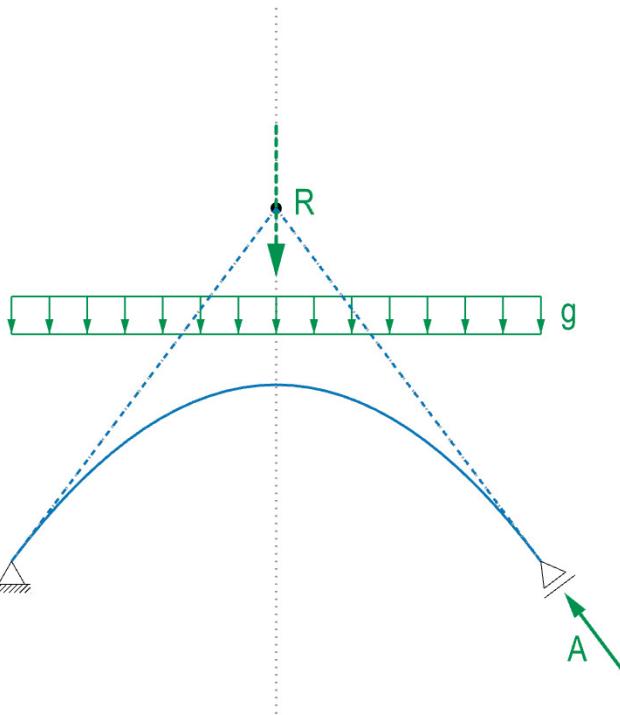
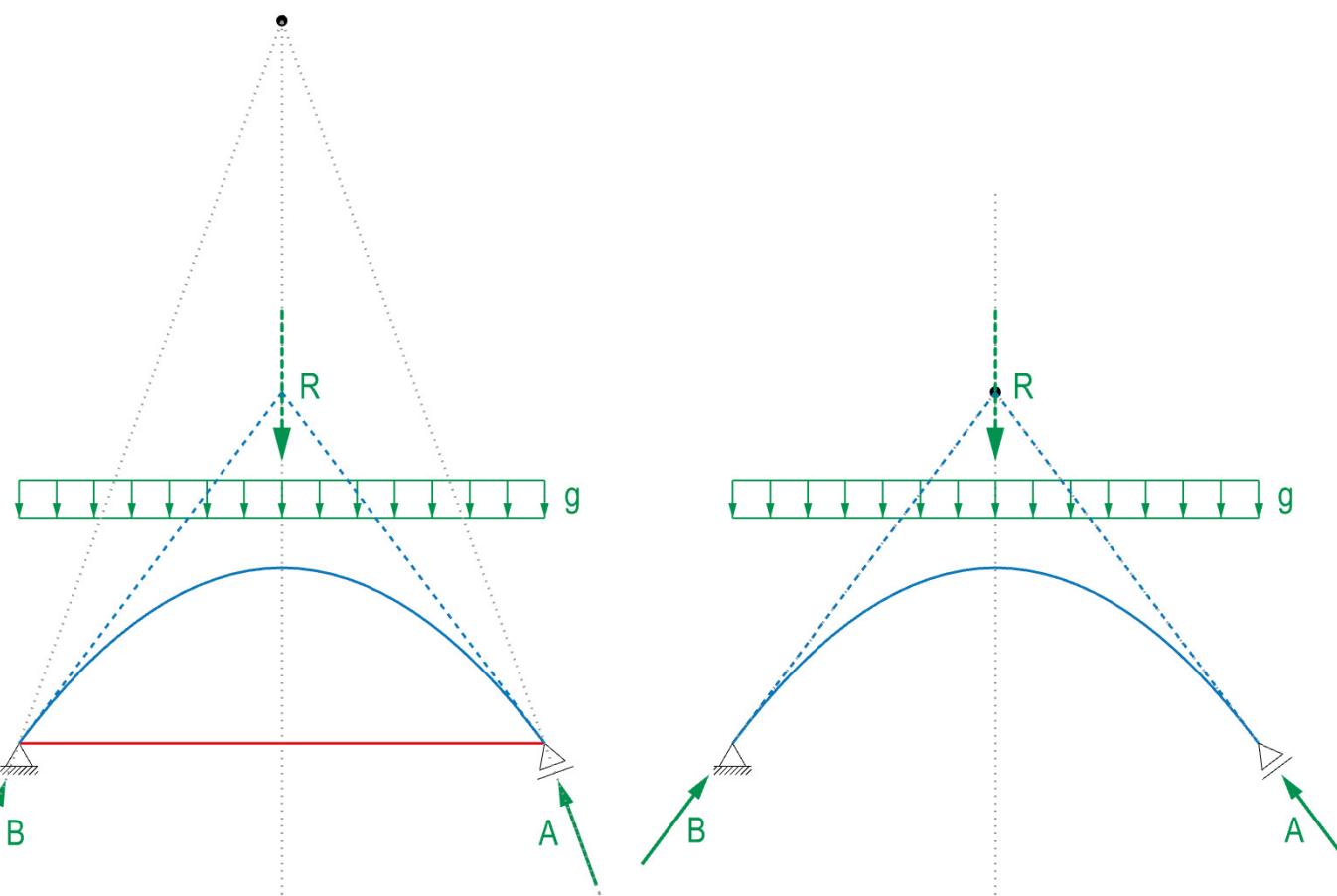
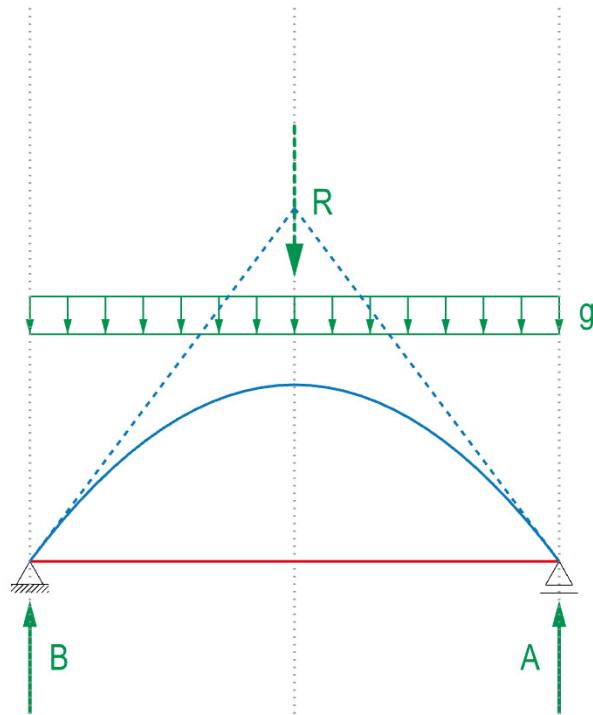
Auflagerbedingungen

Support conditions



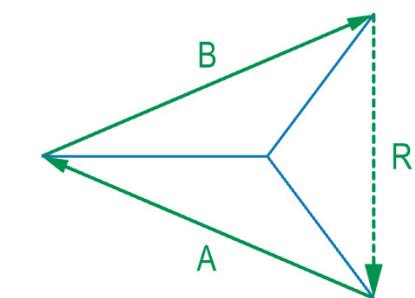
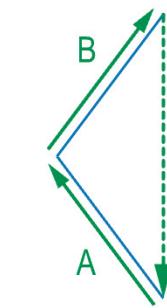
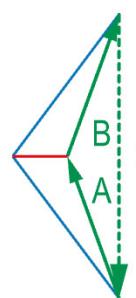
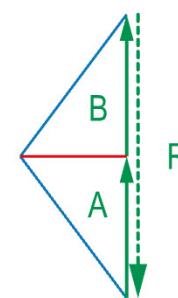
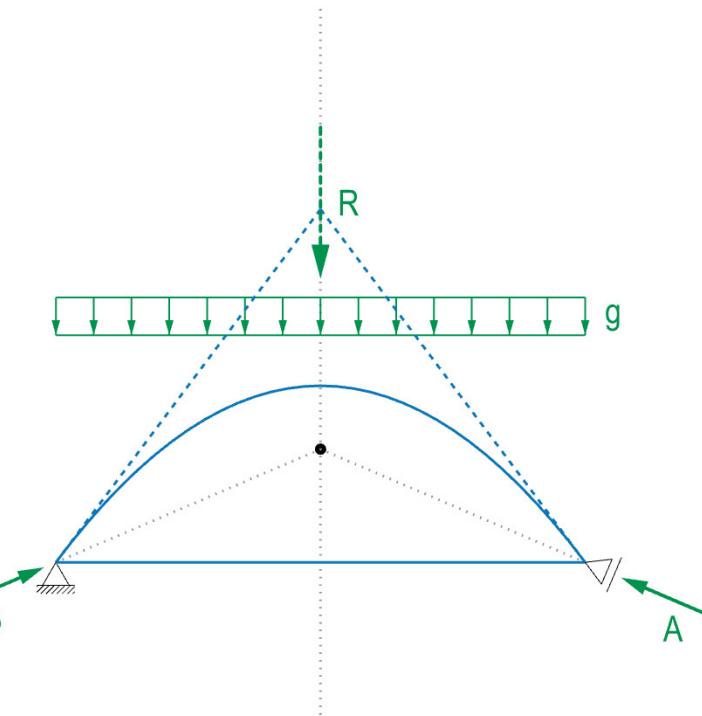
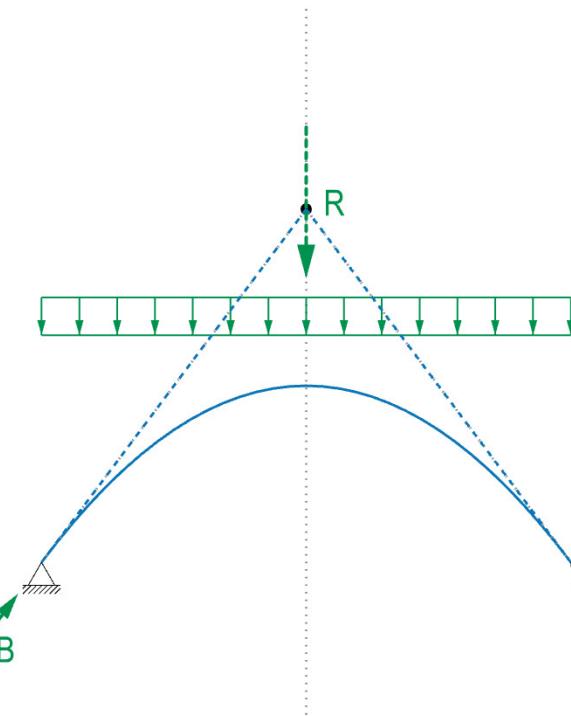
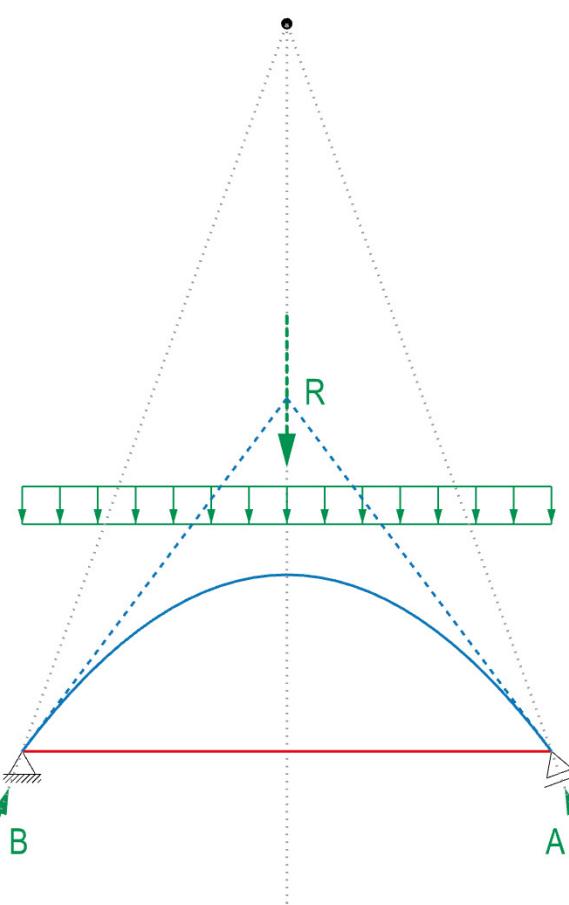
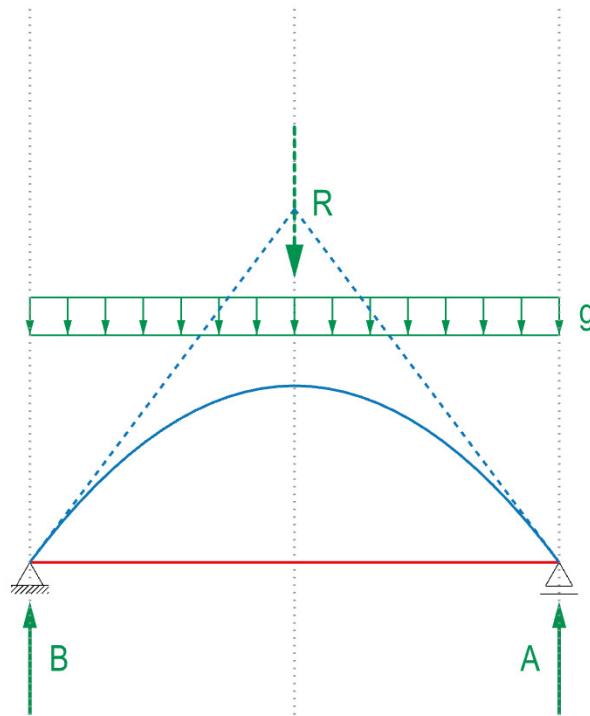
Auflagerbedingungen

Support conditions



Auflagerbedingungen

Support conditions



Bogen-Seil-Tragwerke

Arch-cable structures

Tragwirkung einfacher Bogen-Seil-Tragwerke

Structural behaviour of simple arch-cable structures

Auflagerbedingungen

Support conditions

>> Aufteilung der äusseren Lasten

Distribution of external loads

Formfindung eines überspannenden Bogen-Seils

Form-finding of a spanning arch-cable

Konsolenartige Bogen-Seil-Tragwerke

Cantilevering arch-cable structures

Geometrische Variation

Geometric variation

Zusammengesetzte Bogen-Seil-Tragwerke

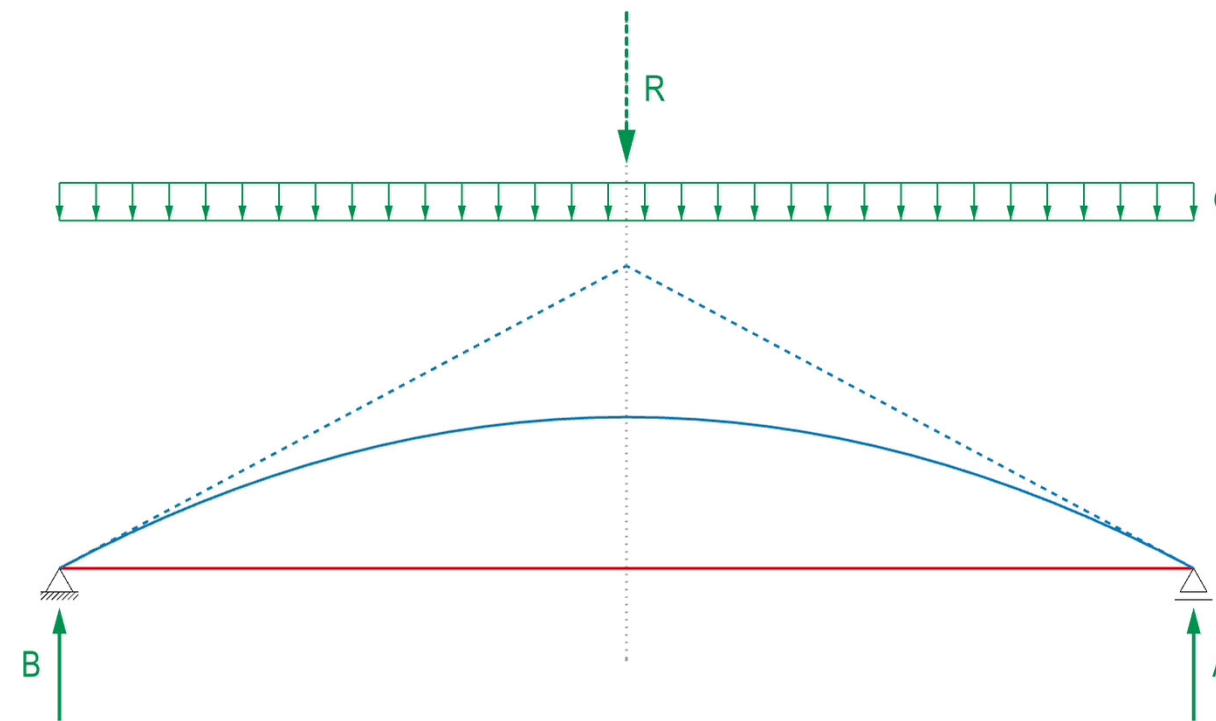
Combined arch-cables

Fallbeispiele

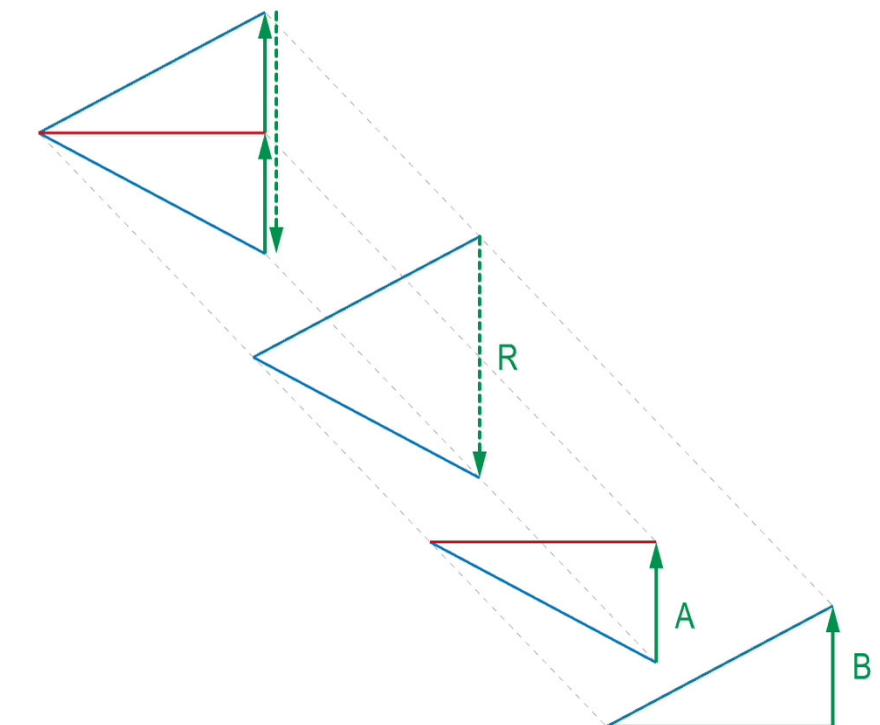
Case studies



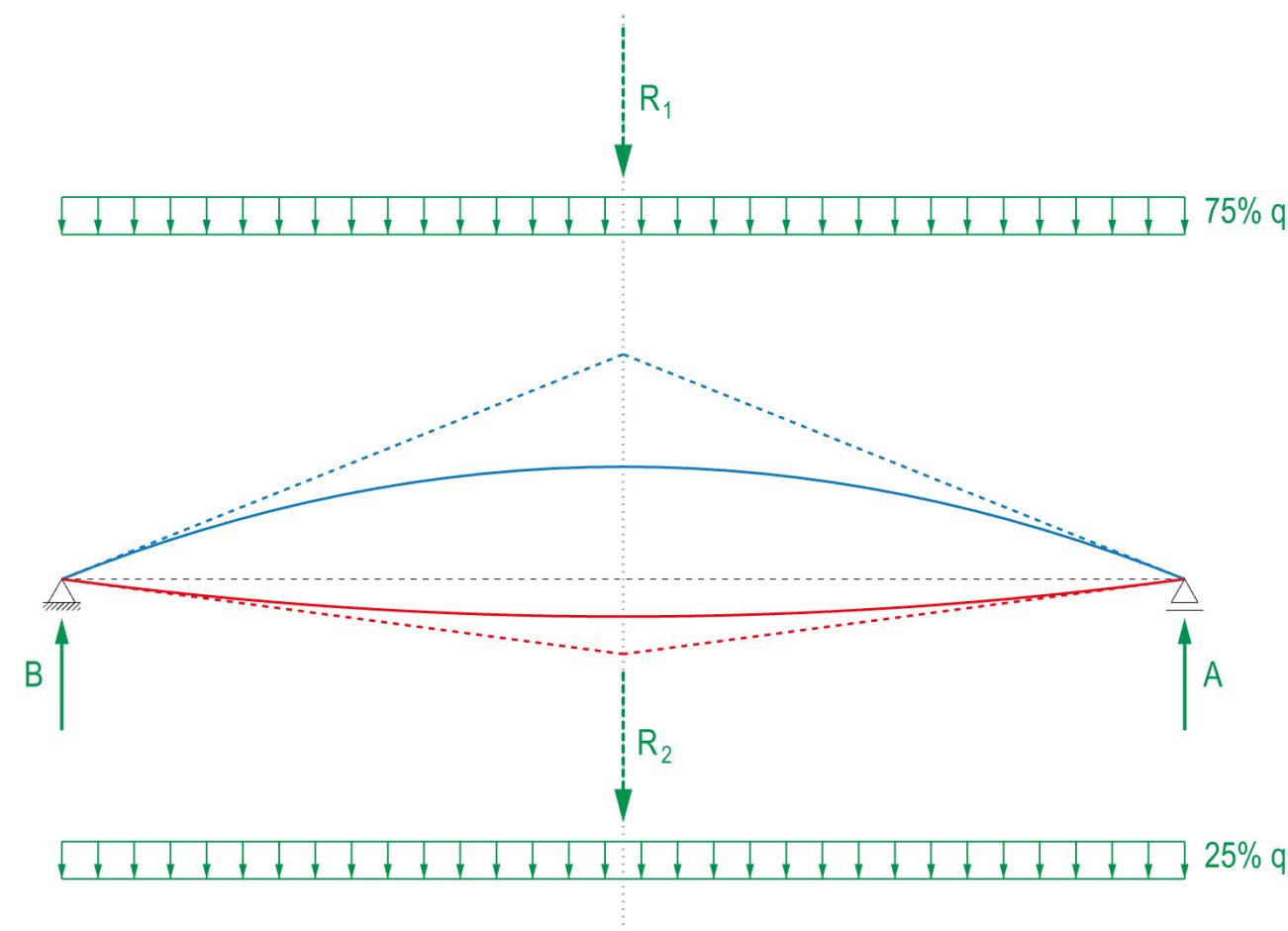
Eugène Freyssinet: Pont Albert Louppe, Bretagne, 1930



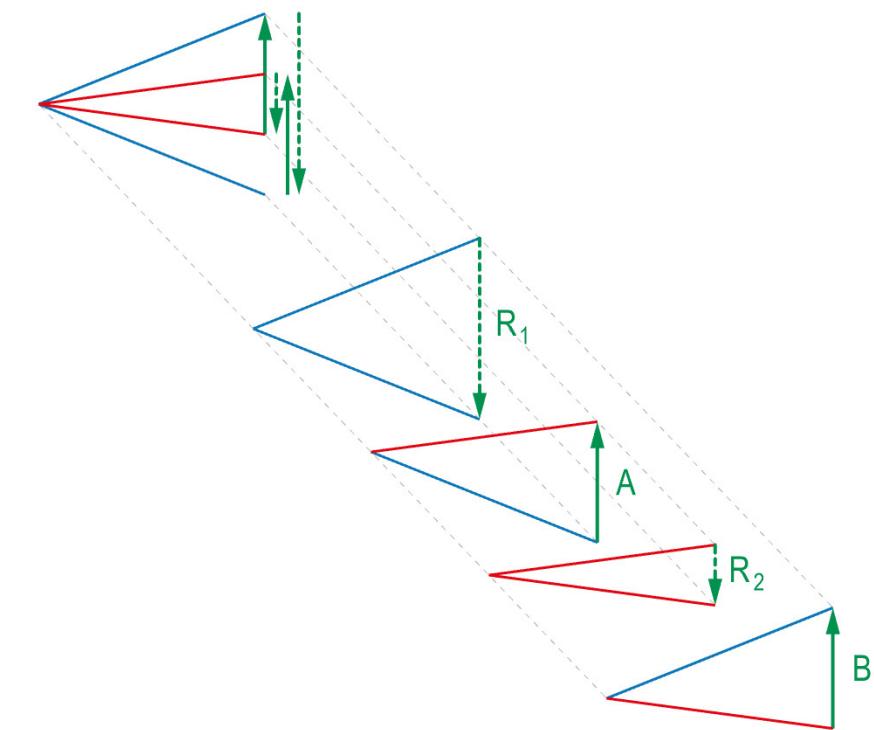
Lageplan 1:100
Form diagram 1:100



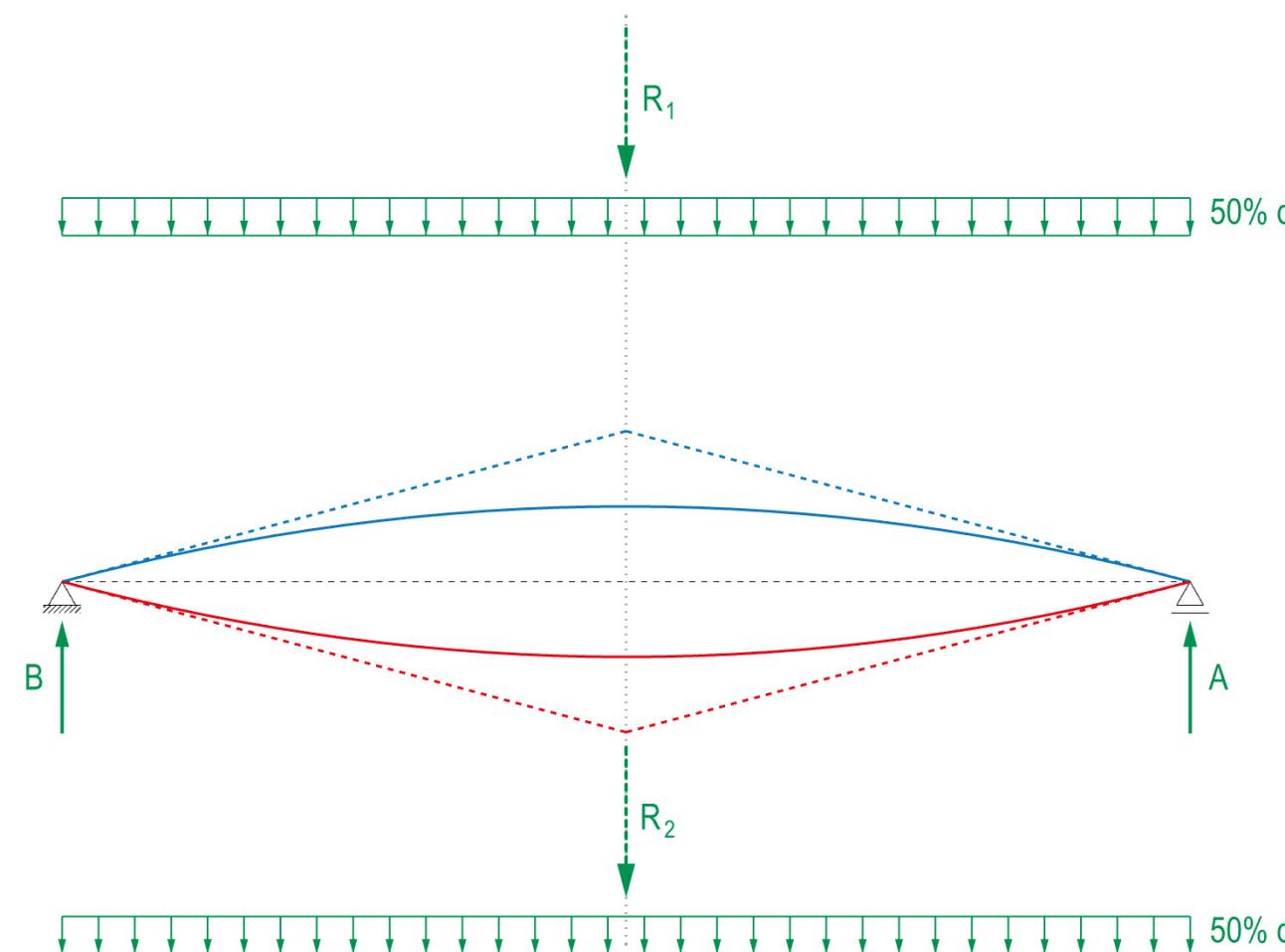
Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN



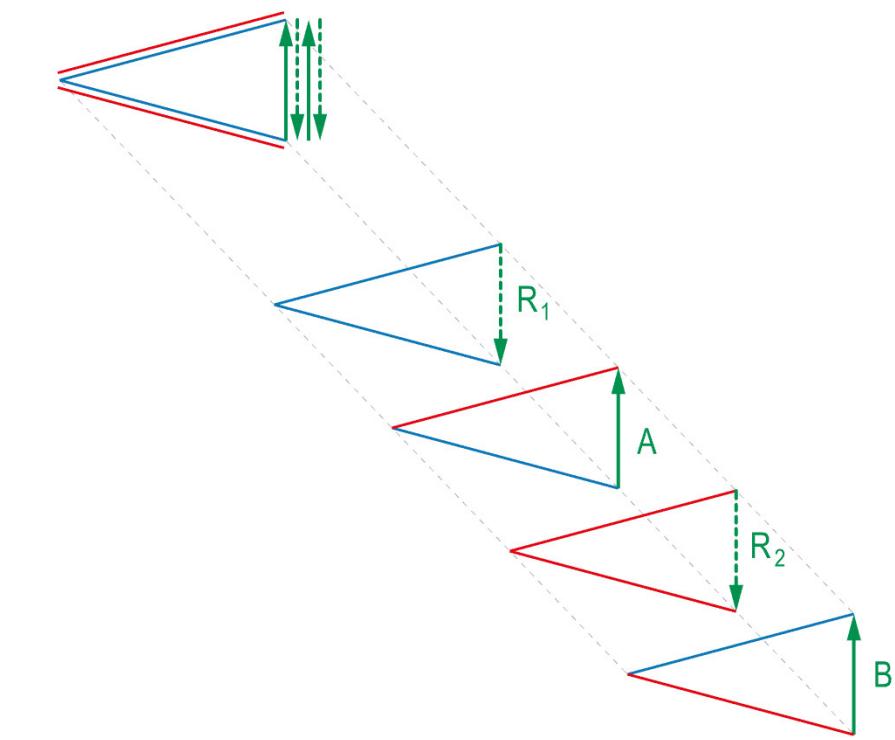
Lageplan 1:100
Form diagram 1:100



Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN



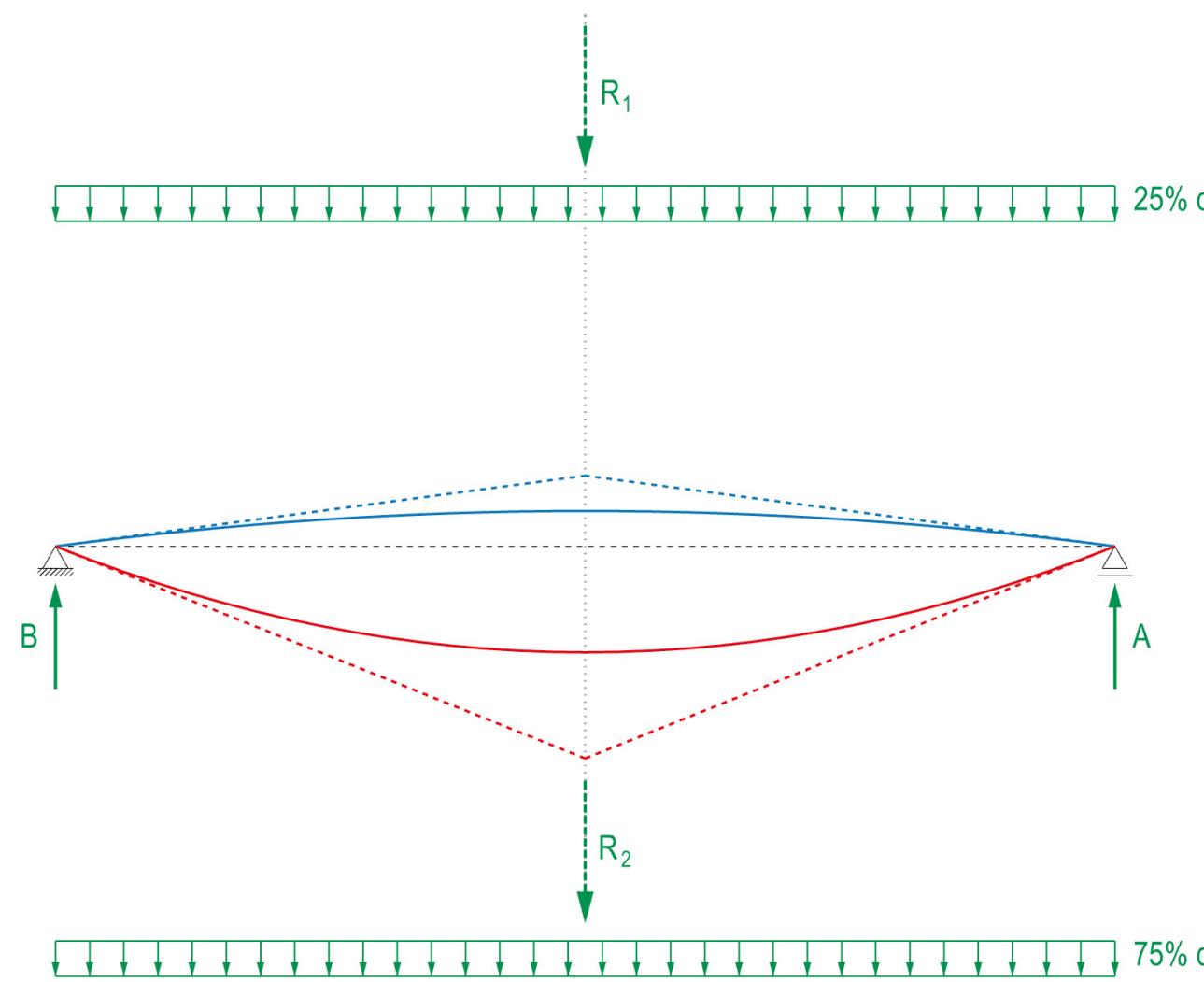
Lageplan 1:100
Form diagram 1:100



Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN

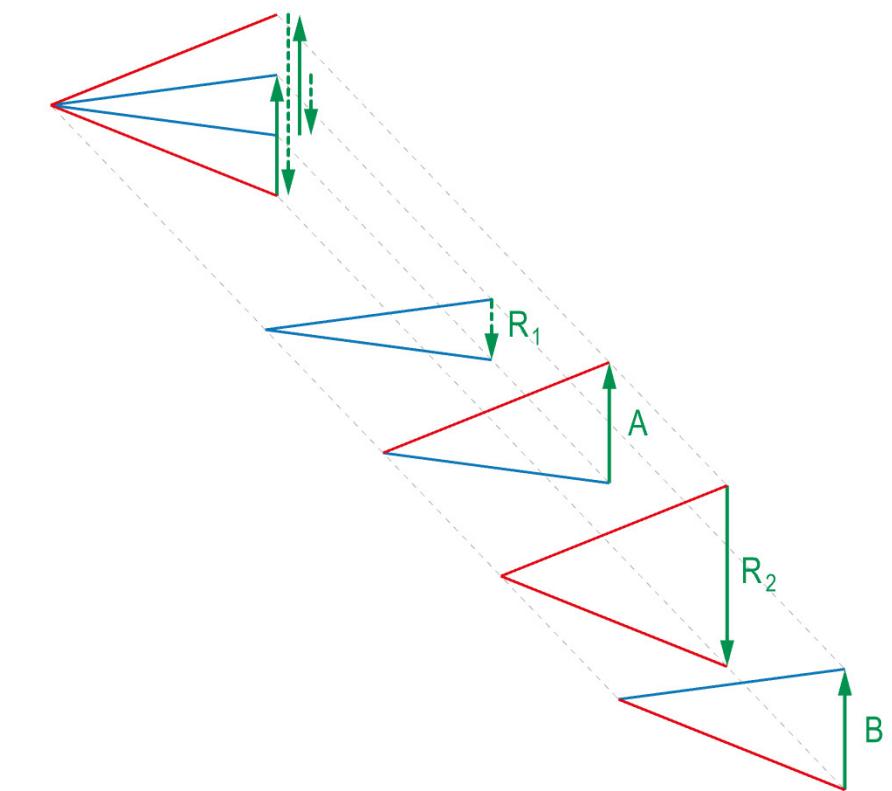


G.H. Lohse: Neue Elbbrücke, Hamburg, 1868



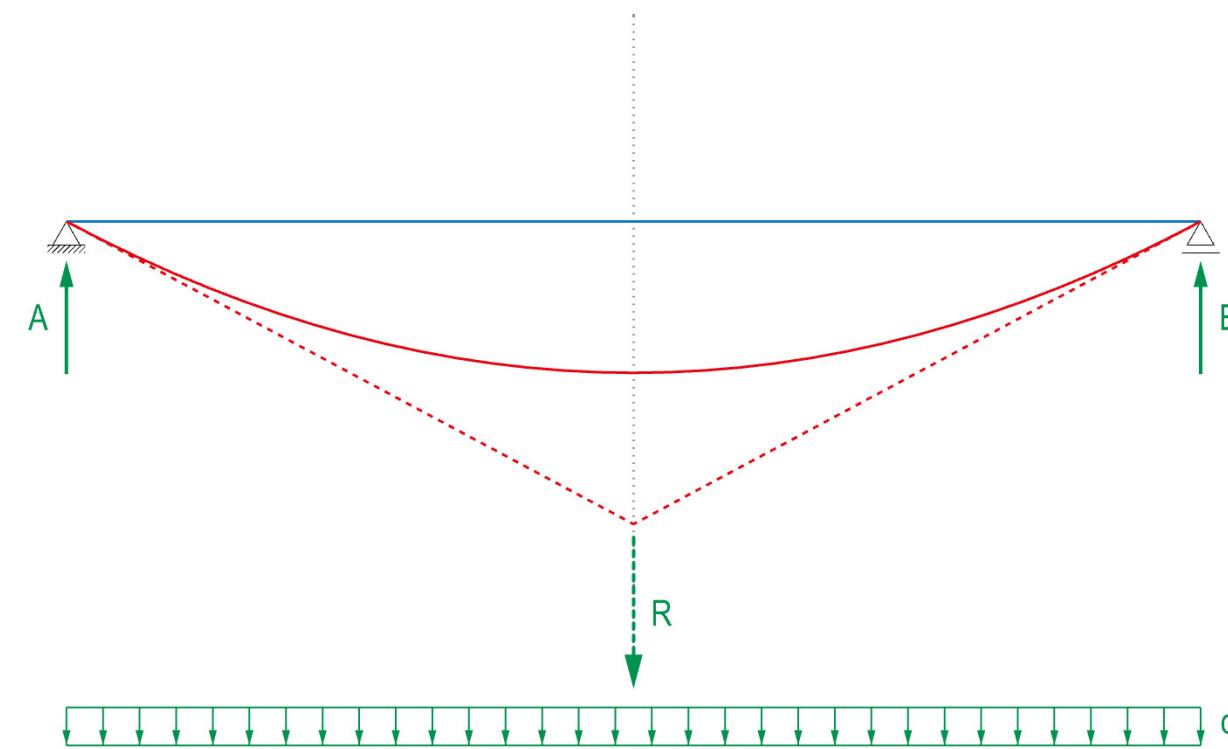
Lageplan 1:100

Form diagram 1:100

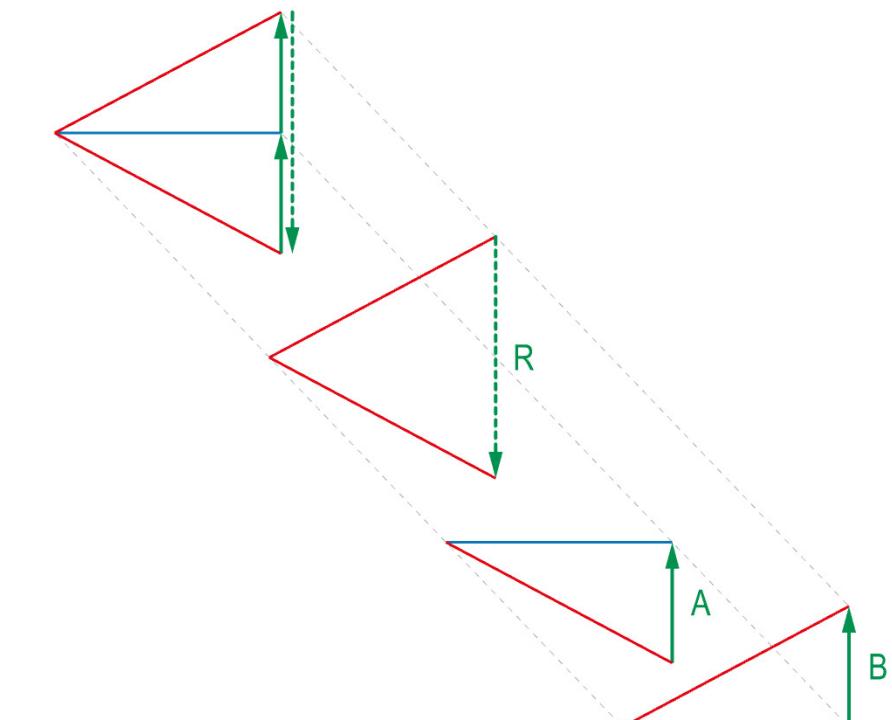


Kräfteplan 1 cm ≈ 1 kN

Force diagram 1 cm ≈ 1 kN



Lageplan 1:100
Form diagram 1:100



Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN

Bogen-Seil-Tragwerke

Arch-cable structures

Tragwirkung einfacher Bogen-Seil-Tragwerke

Structural behaviour of simple arch-cable structures

Auflagerbedingungen

Support conditions

Aufteilung der äusseren Lasten

Distribution of external loads

>> Formfindung eines überspannenden Bogen-Seils

Form-finding of a spanning arch-cable

Konsolenartige Bogen-Seil-Tragwerke

Cantilevering arch-cable structures

Geometrische Variation

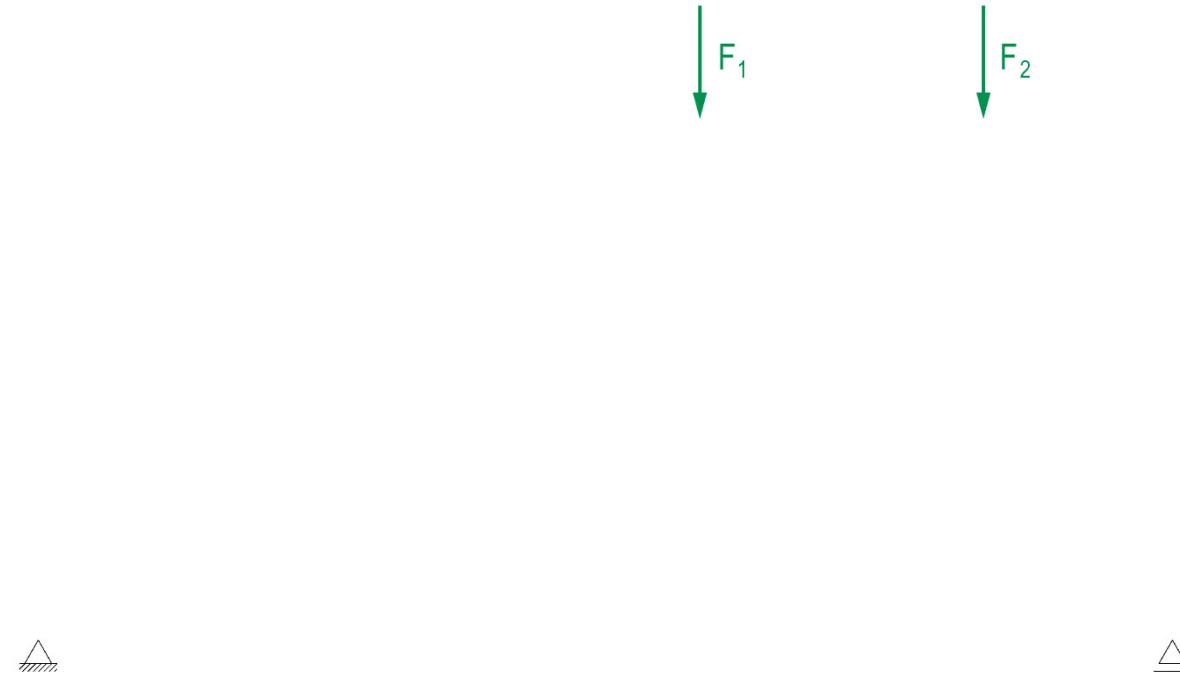
Geometric variation

Zusammengesetzte Bogen-Seil-Tragwerke

Combined arch-cables

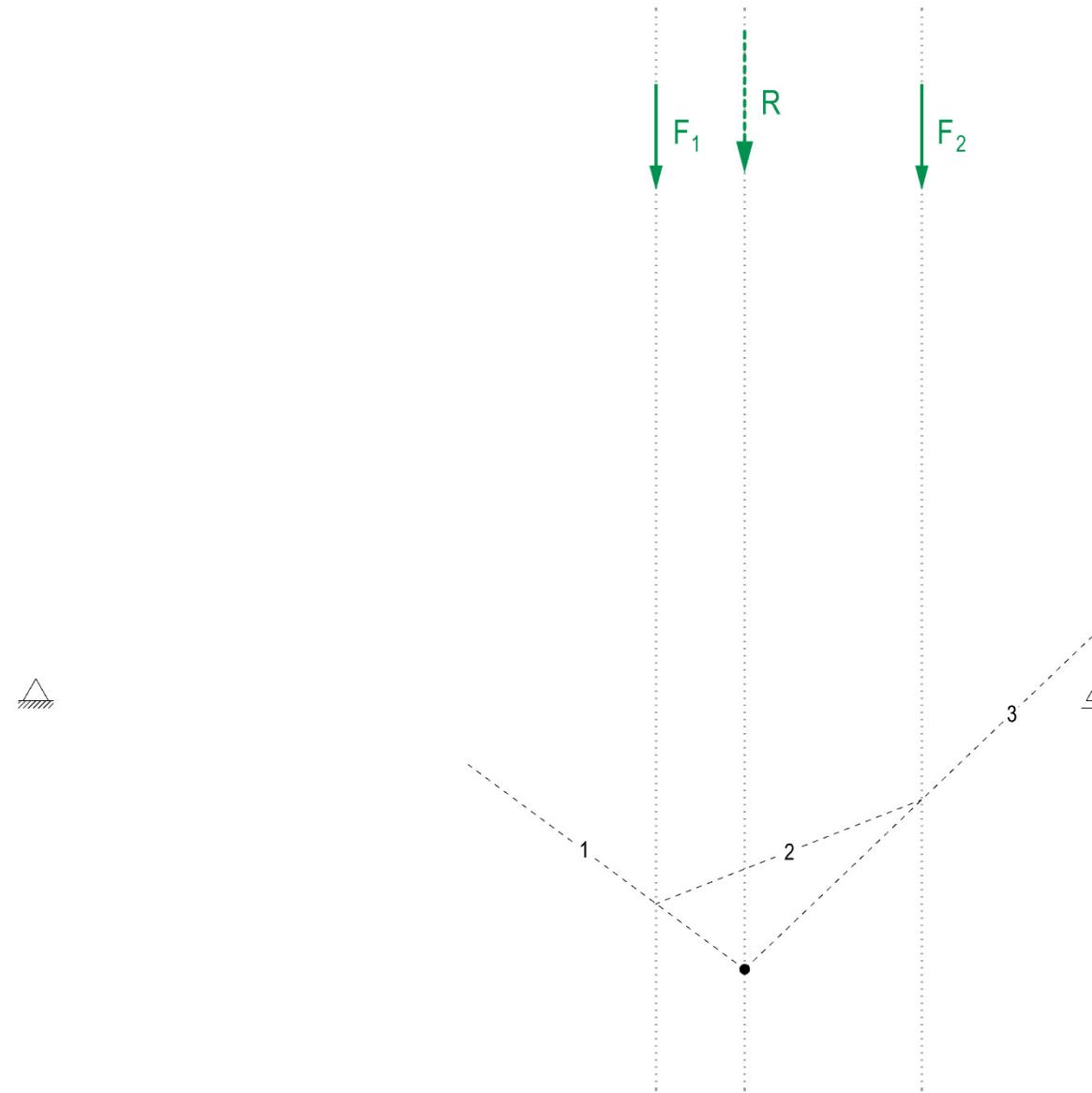
Fallbeispiele

Case studies

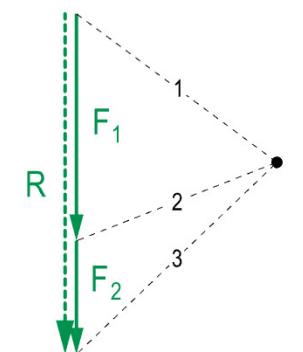


Lageplan 1:100
Form diagram 1:100

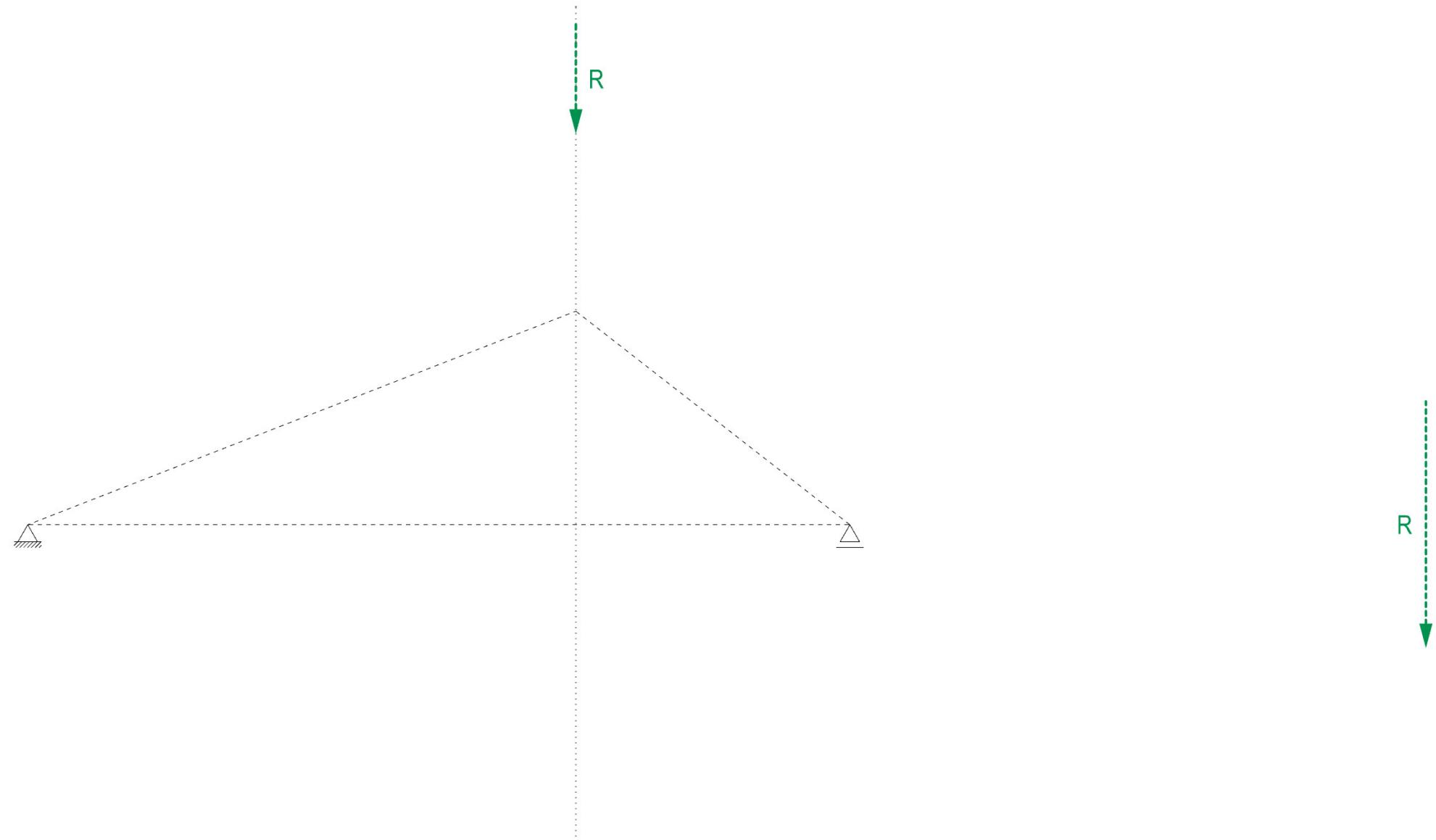
Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN



Lageplan 1:100
Form diagram 1:100

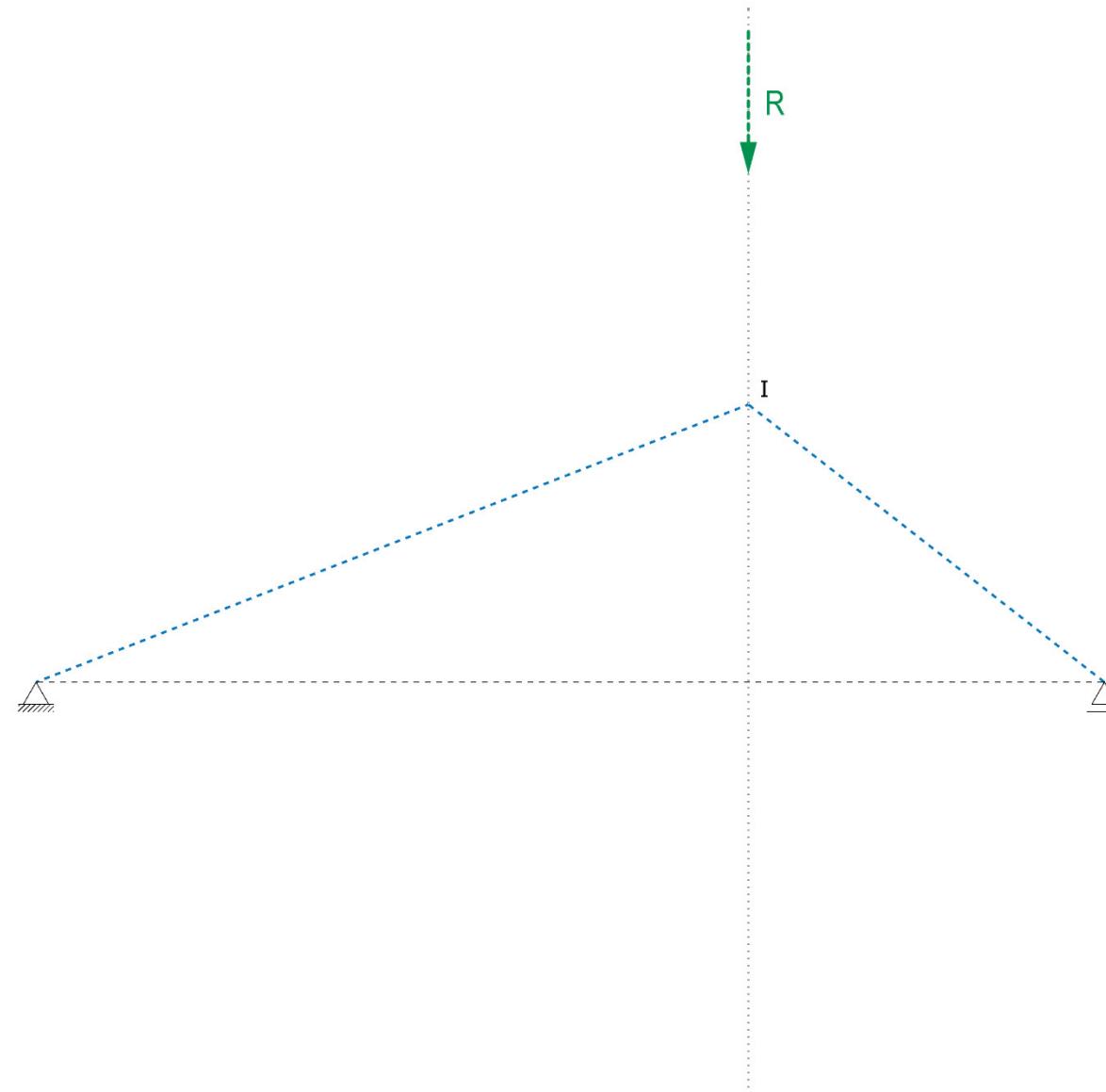


Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN

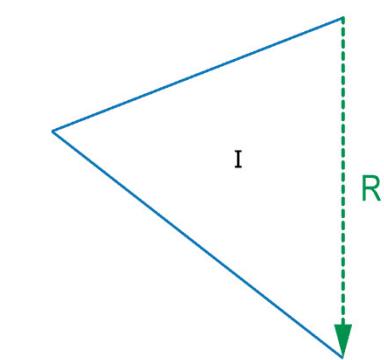


Lageplan 1:100
Form diagram 1:100

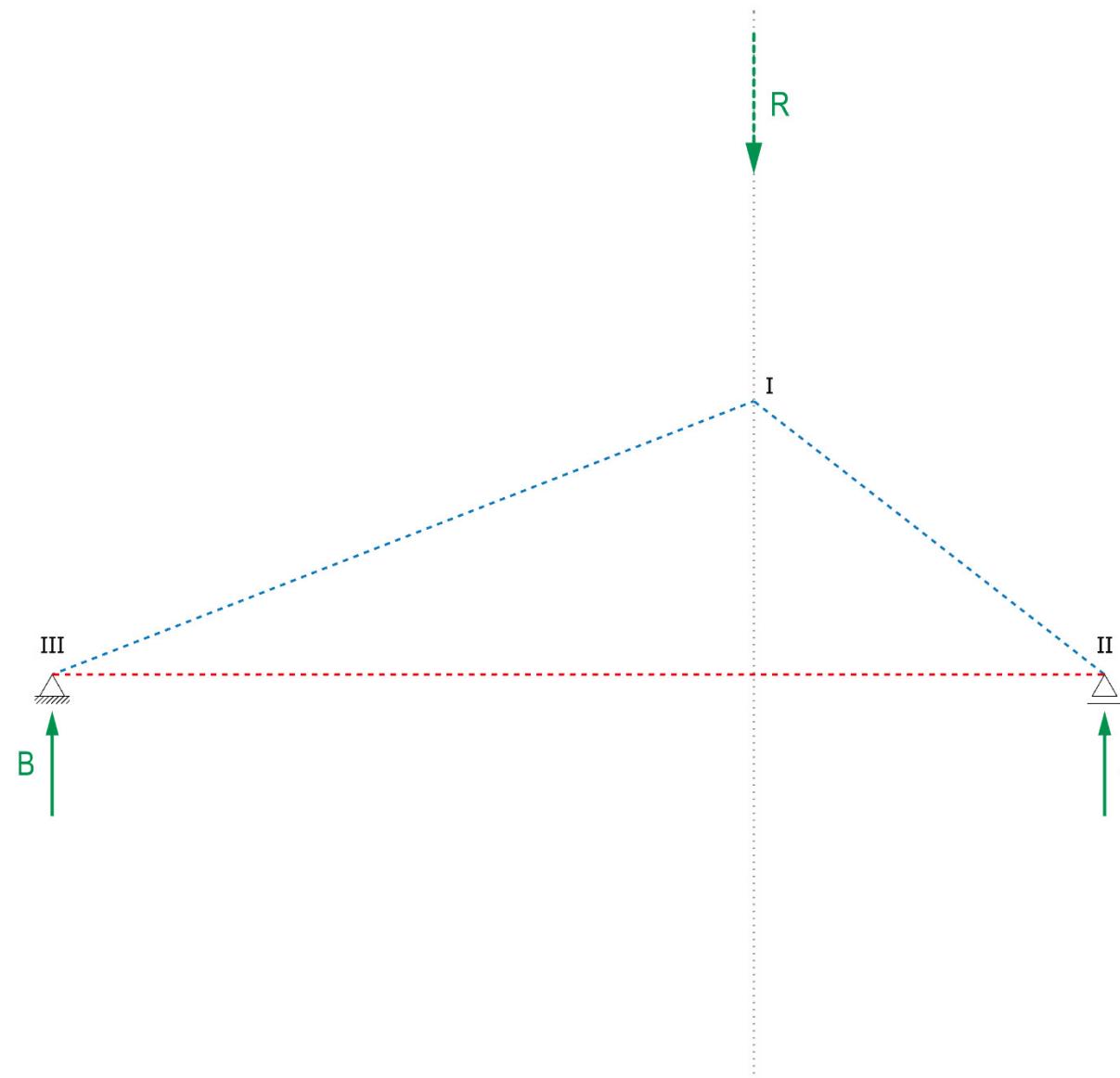
Kräfteplan 1 cm $\hat{=}$ 1 kN
Force diagram 1 cm $\hat{=}$ 1 kN



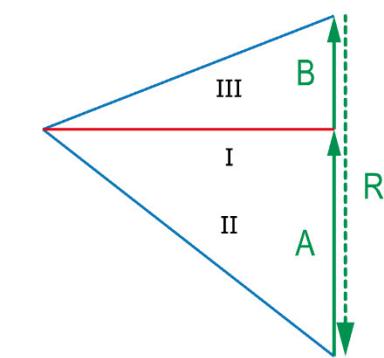
Lageplan 1:100
Form diagram 1:100



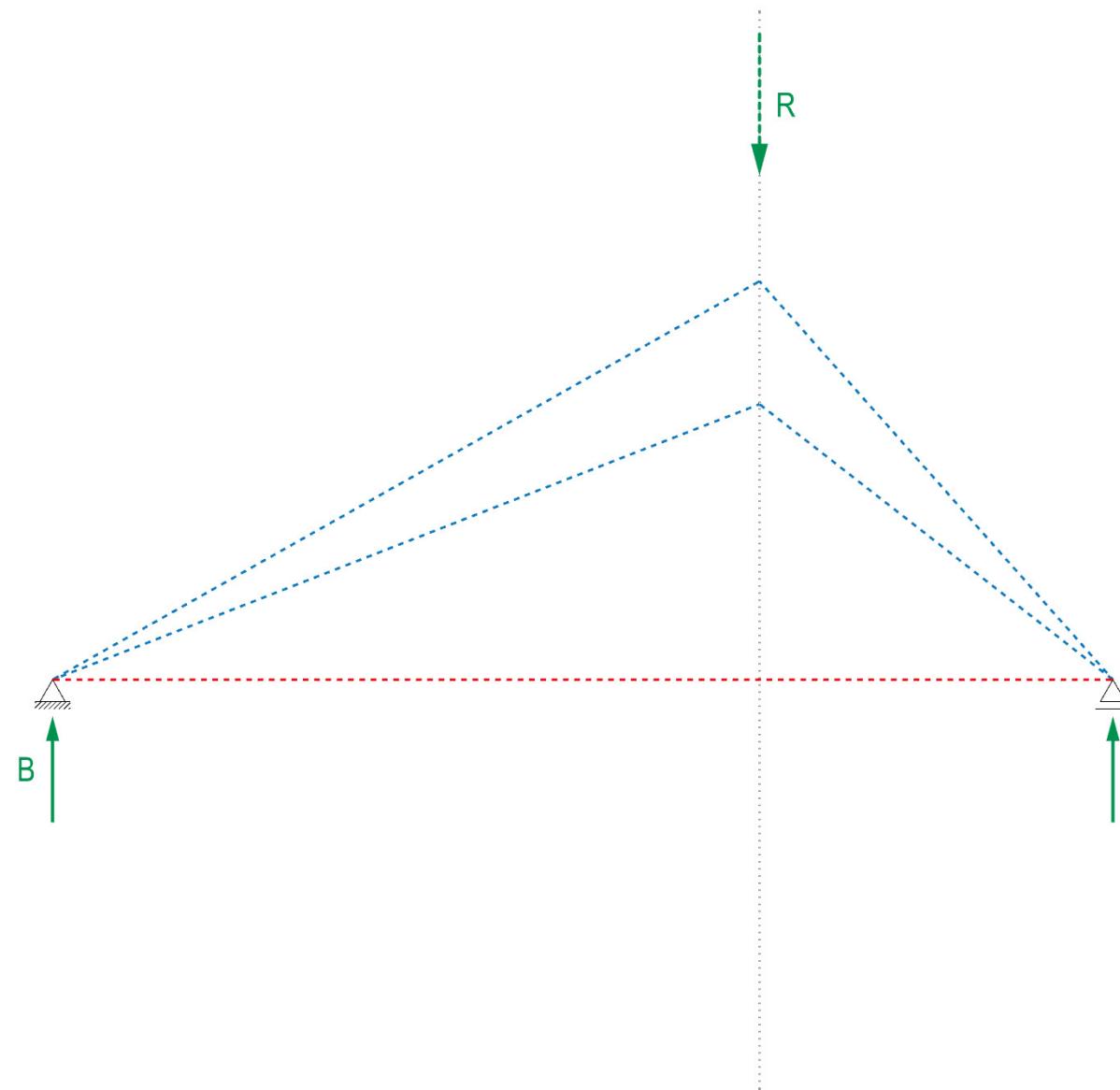
Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN



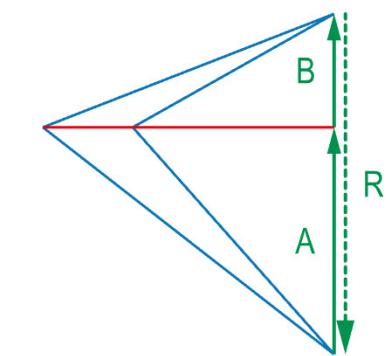
Lageplan 1:100
Form diagram 1:100



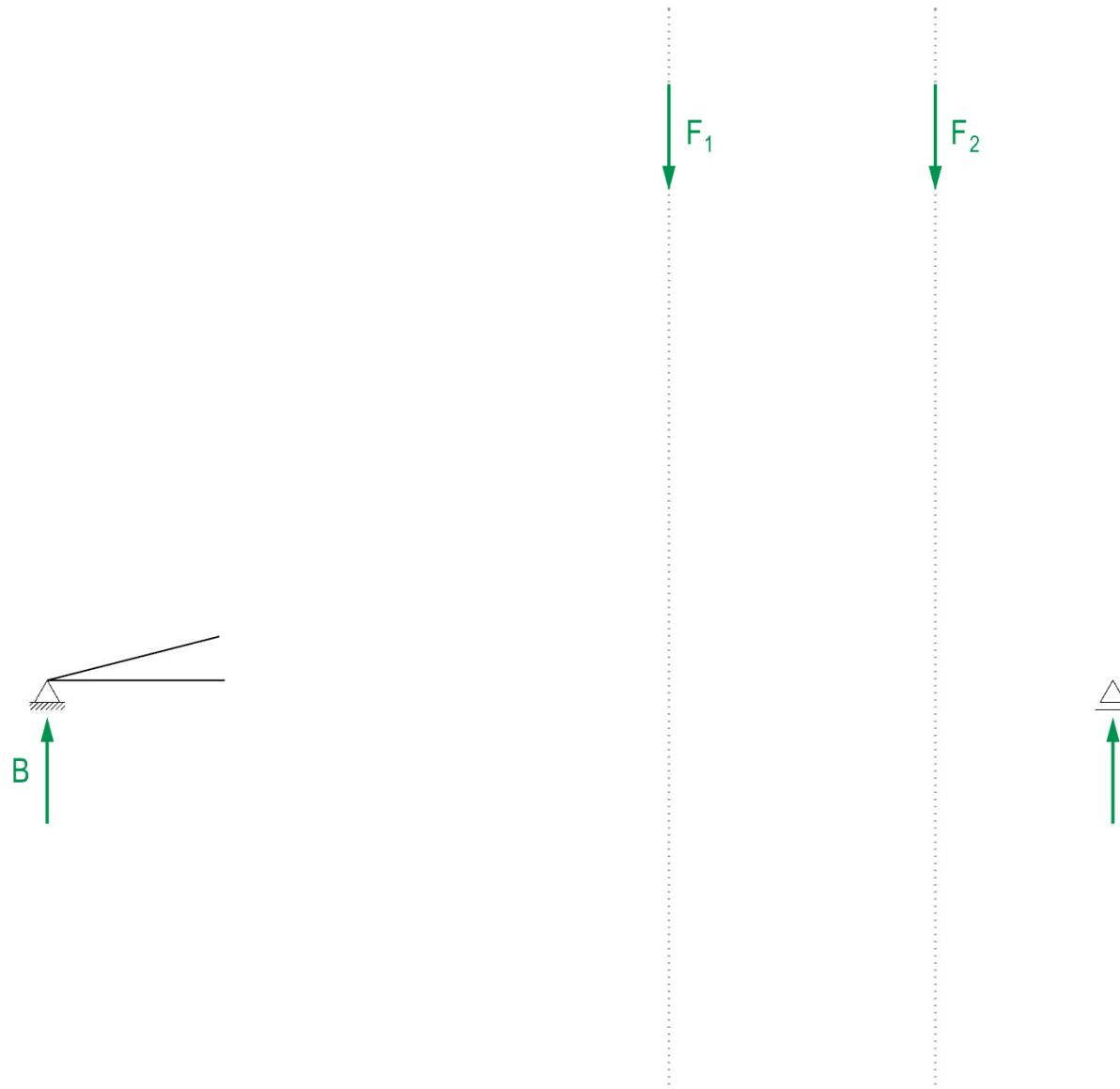
Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN



Lageplan 1:100
Form diagram 1:100



Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN

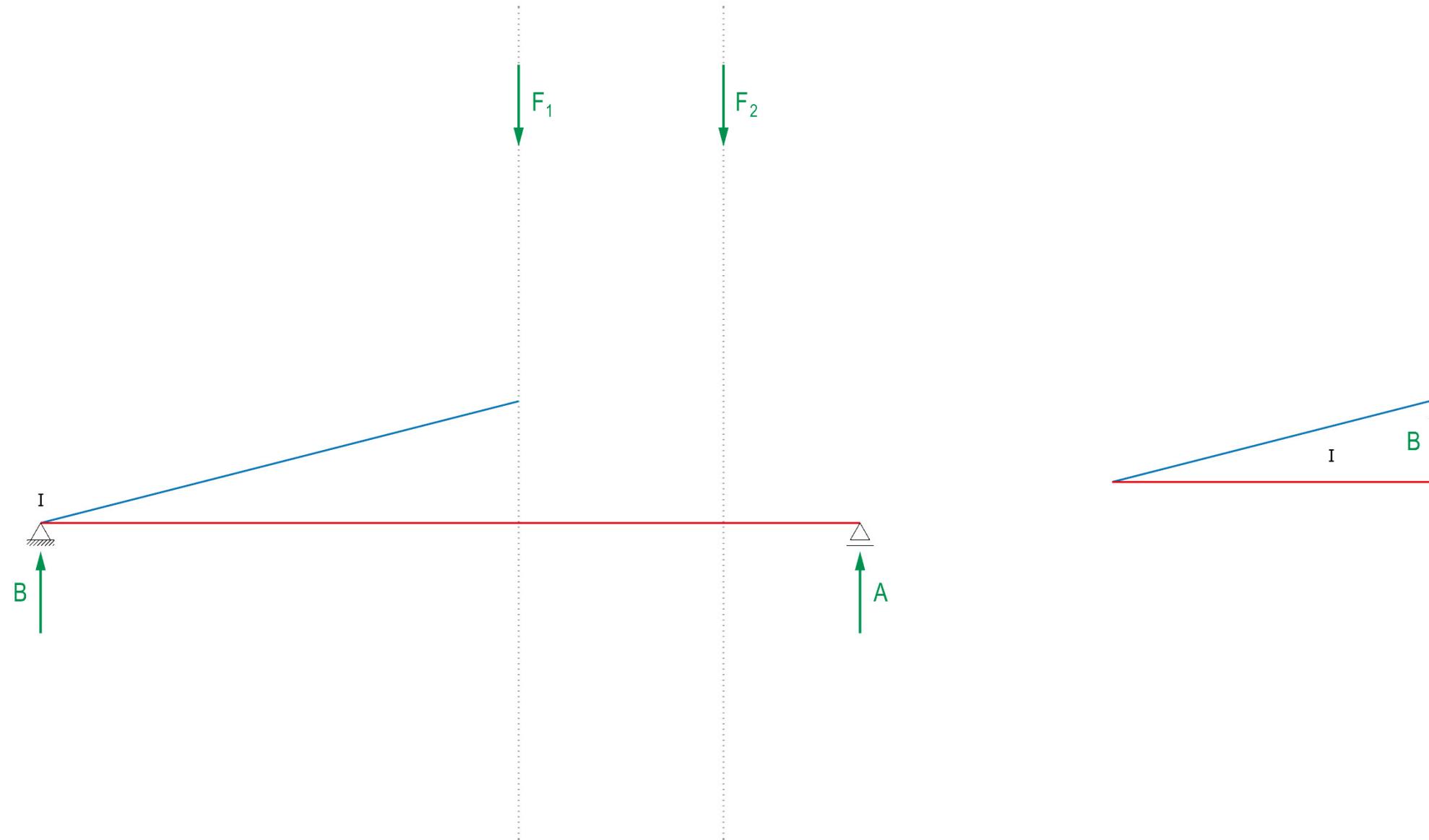


Lageplan 1:100

Form diagram 1:100

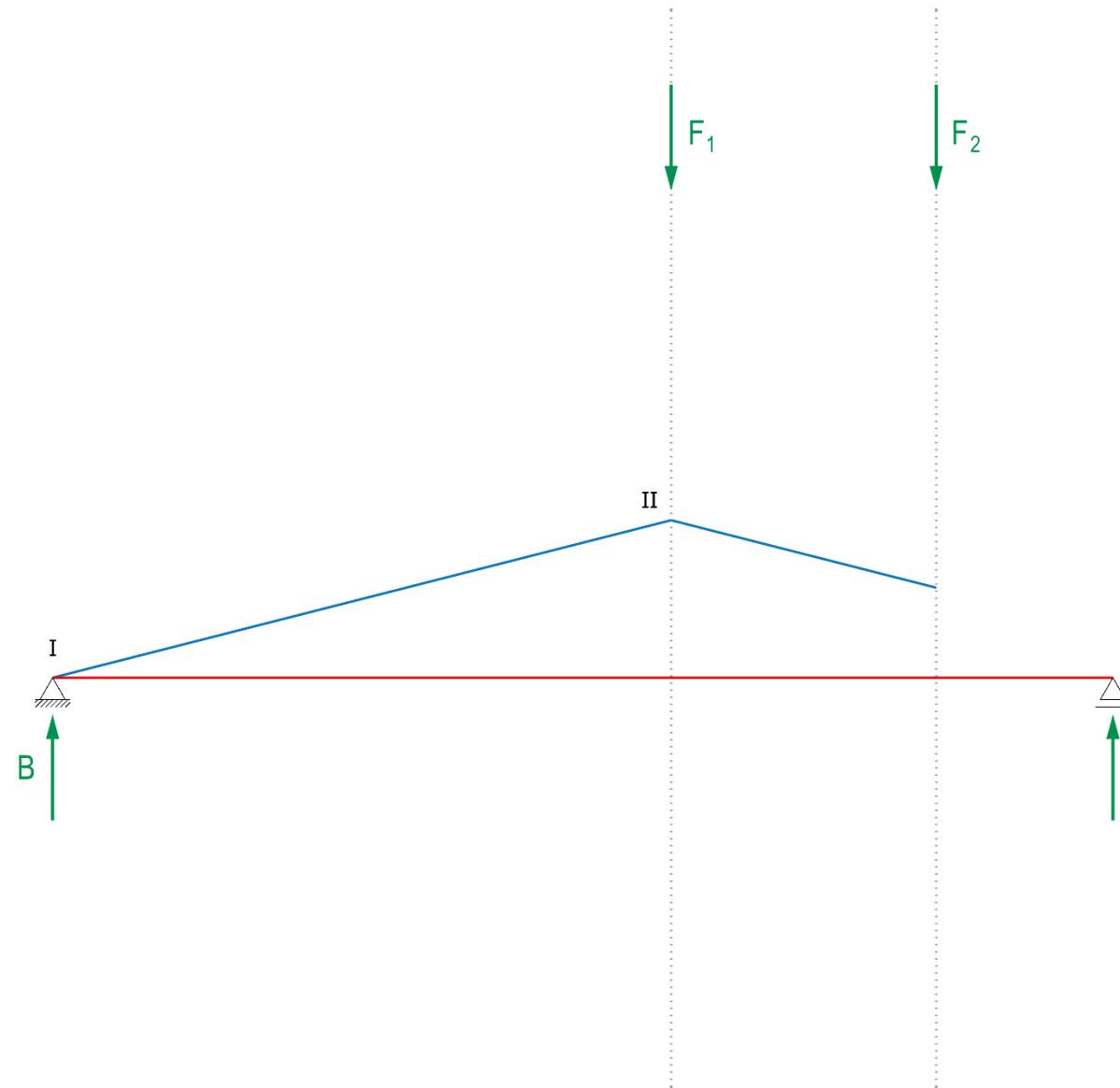
Kräfteplan 1 cm \triangleq 1 kN

Force diagram 1 cm \triangleq 1 kN

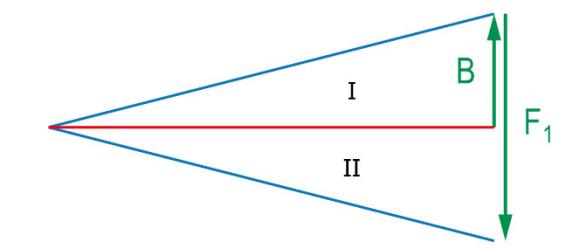


Lageplan 1:100
Form diagram 1:100

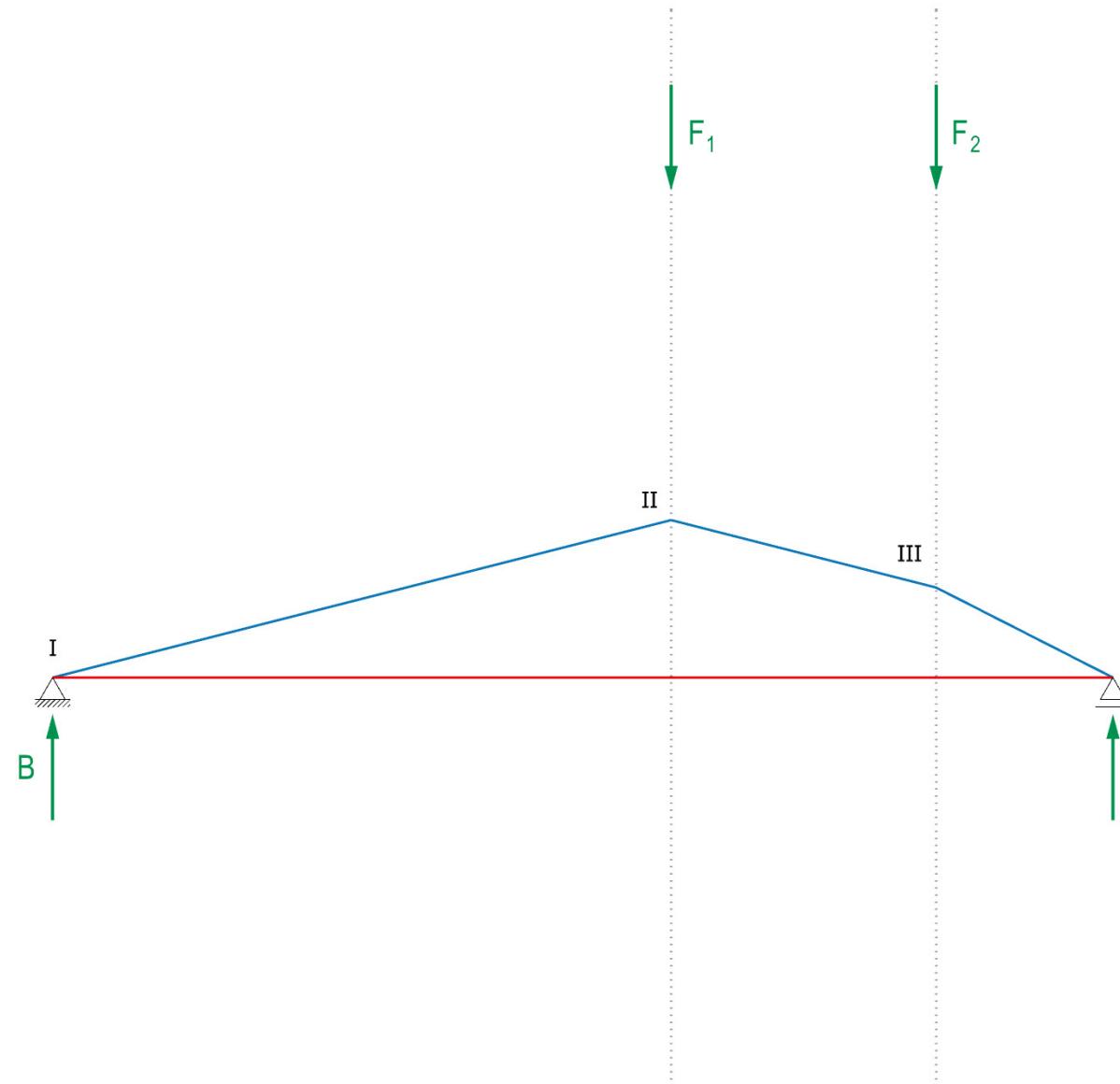
Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN



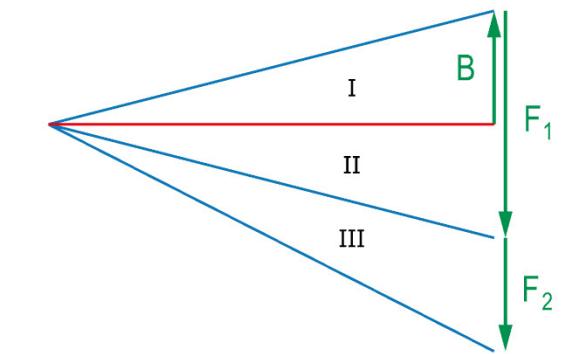
Lageplan 1:100
Form diagram 1:100



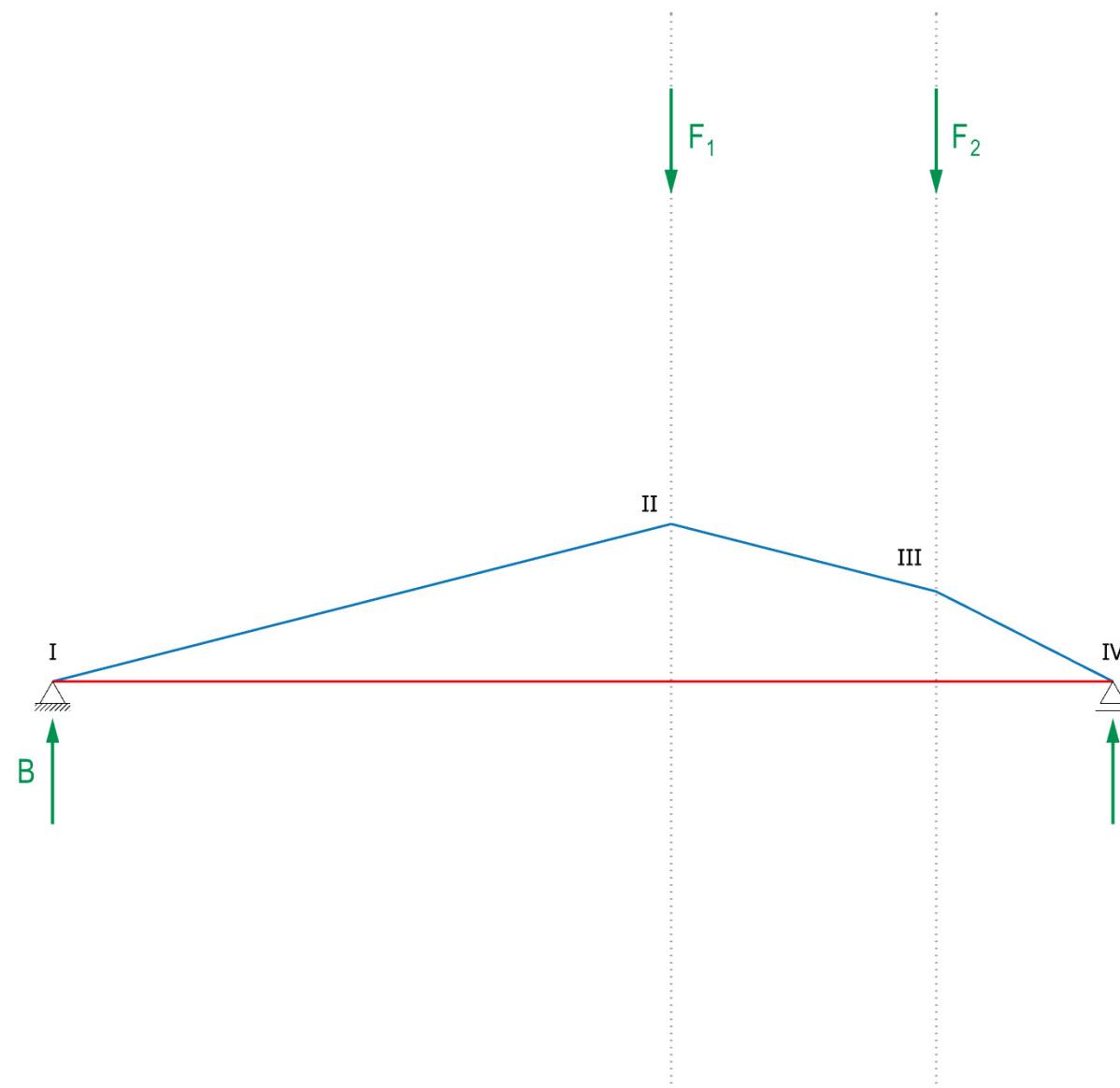
Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN



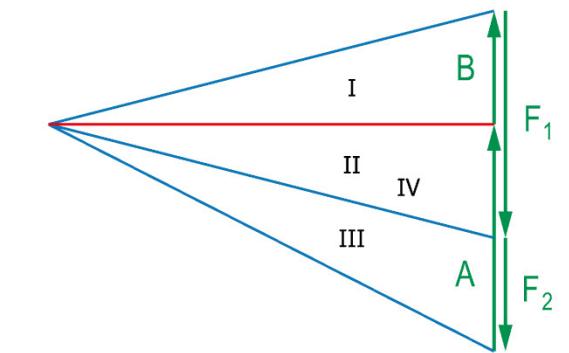
Lageplan 1:100
Form diagram 1:100



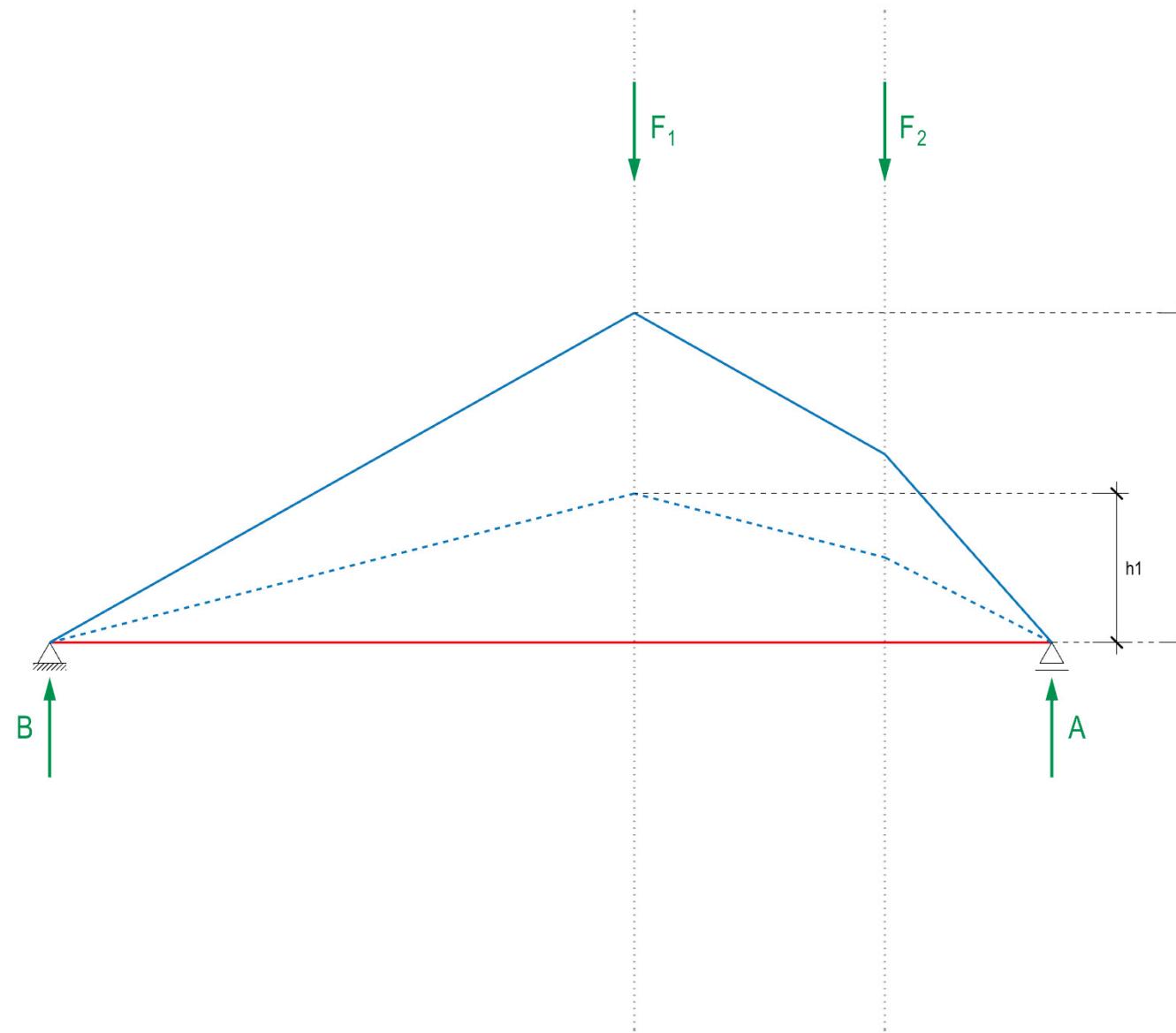
Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN



Lageplan 1:100
Form diagram 1:100

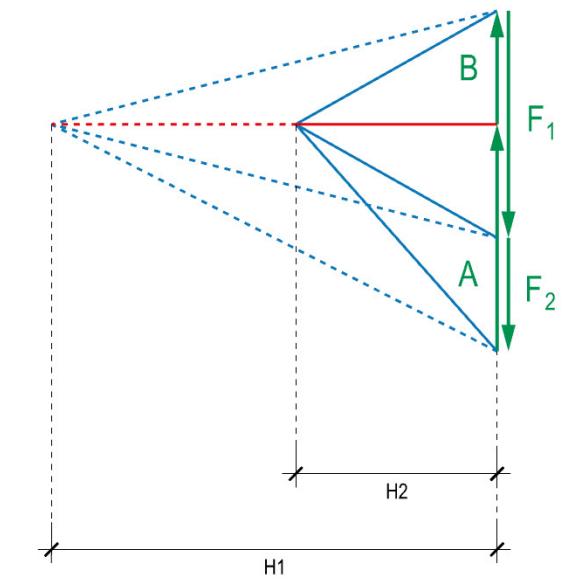


Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN



Lageplan 1:100
Form diagram 1:100

$$\frac{h1}{h2} = \frac{H2}{H1}$$



Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN

Bogen-Seil-Tragwerke

Arch-cable structures

Tragwirkung einfacher Bogen-Seil-Tragwerke

Structural behaviour of simple arch-cable structures

Auflagerbedingungen

Support conditions

Aufteilung der äusseren Lasten

Distribution of external loads

Formfindung eines überspannenden Bogen-Seils

Form-finding of a spanning arch-cable

>> Konsolenartige Bogen-Seil-Tragwerke

Cantilevering arch-cable structures

Geometrische Variation

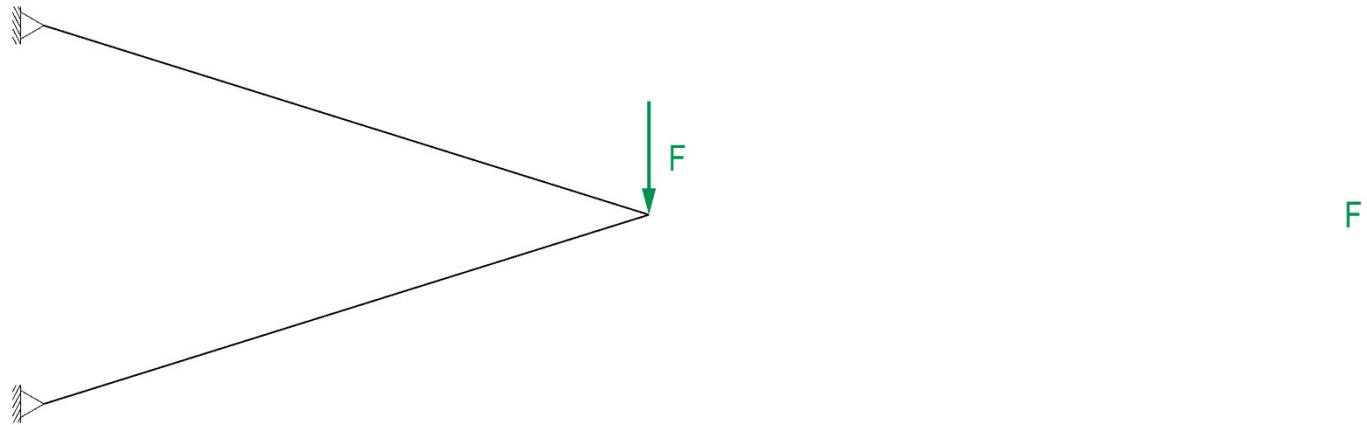
Geometric variation

Zusammengesetzte Bogen-Seil-Tragwerke

Combined arch-cables

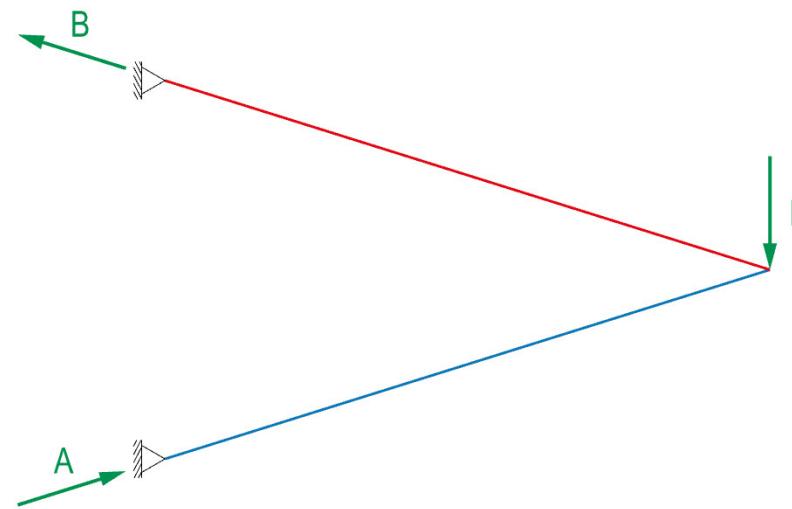
Fallbeispiele

Case studies

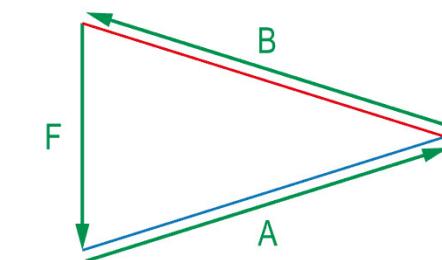


Lageplan 1:100
Form diagram 1:100

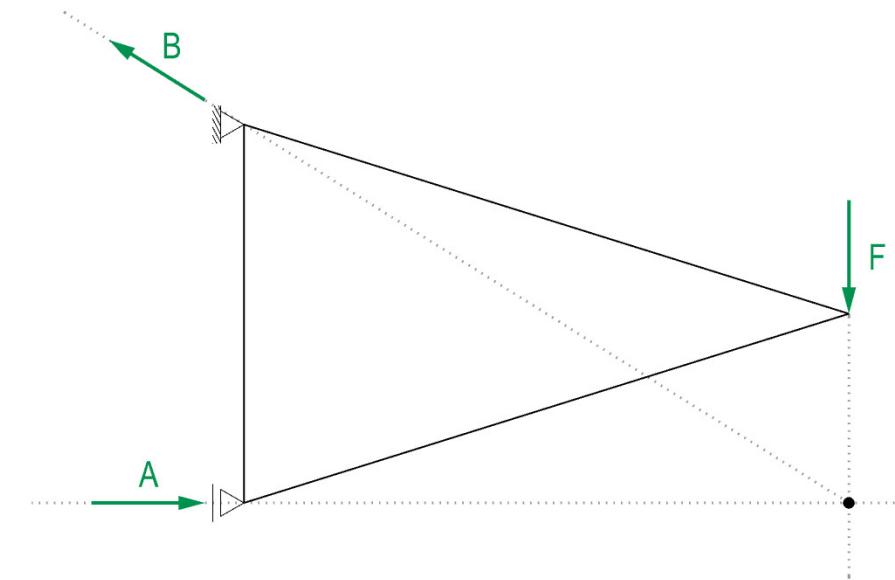
Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN



Lageplan 1:100
Form diagram 1:100

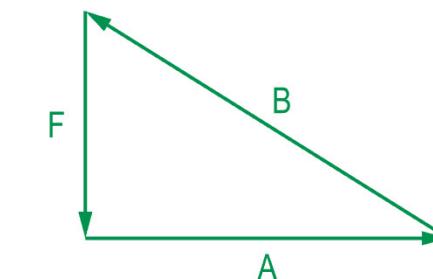


Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN



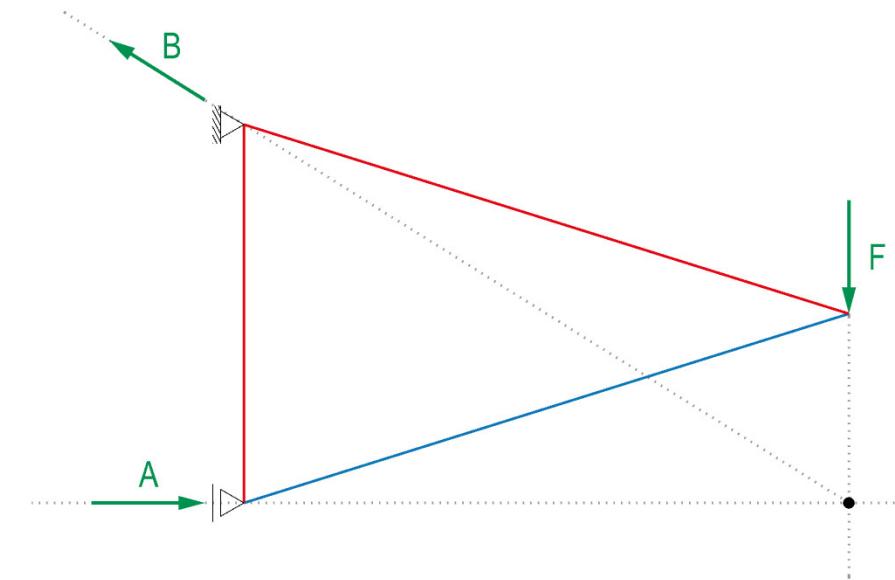
Lageplan 1:100

Form diagram 1:100



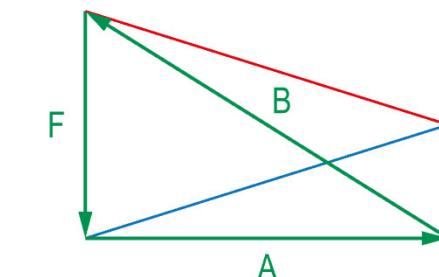
Kräfteplan 1 cm \triangleq 1 kN

Force diagram 1 cm \triangleq 1 kN



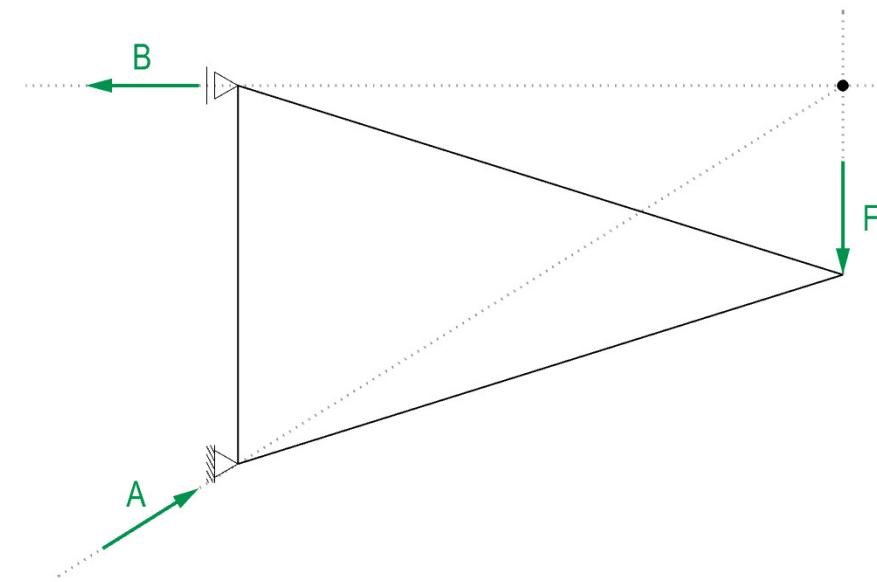
Lageplan 1:100

Form diagram 1:100



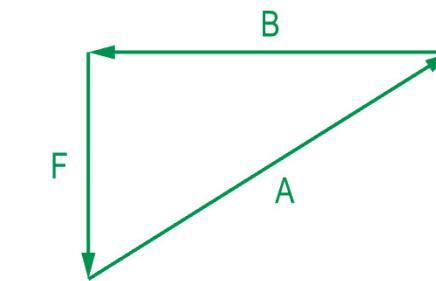
Kräfteplan 1 cm \triangleq 1 kN

Force diagram 1 cm \triangleq 1 kN



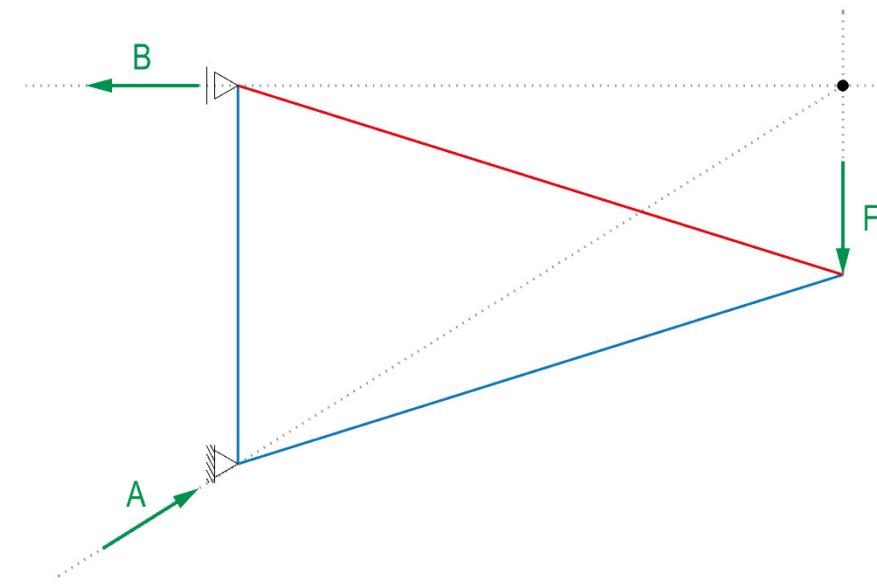
Lageplan 1:100

Form diagram 1:100



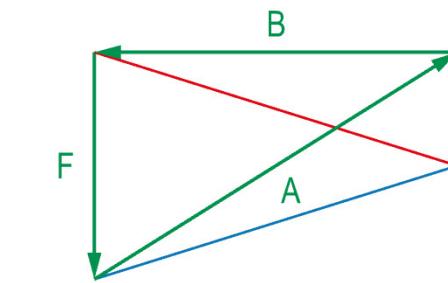
Kräfteplan 1 cm \triangleq 1 kN

Force diagram 1 cm \triangleq 1 kN



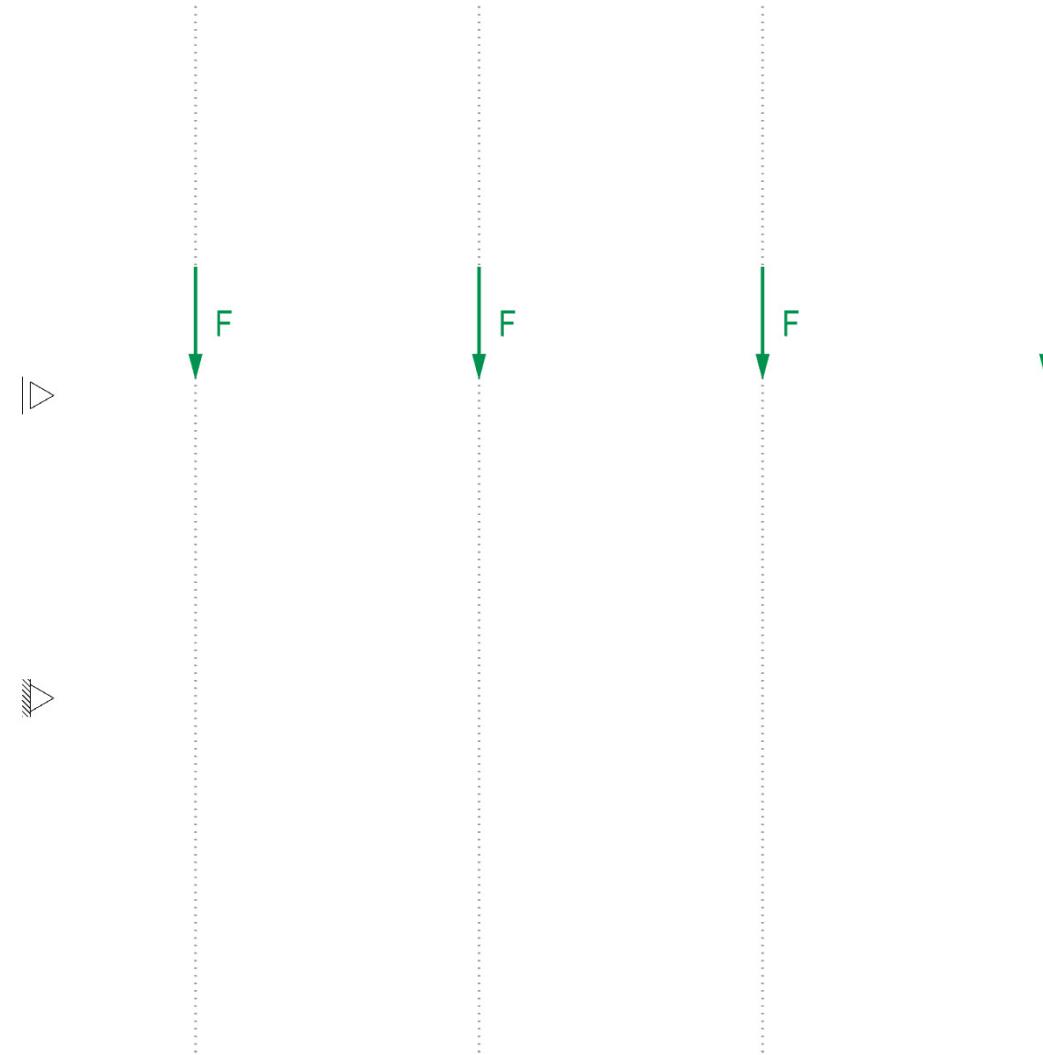
Lageplan 1:100

Form diagram 1:100



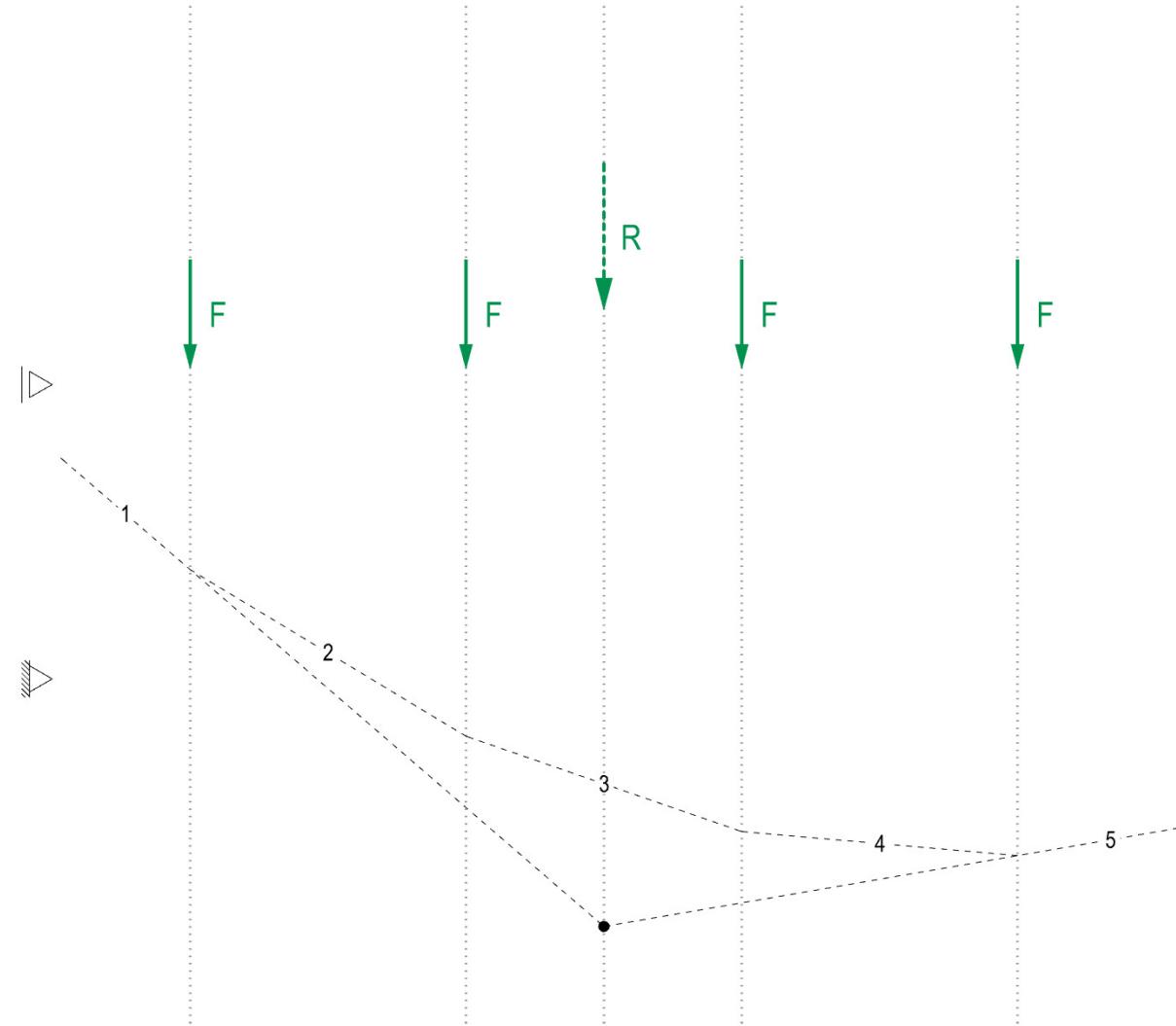
Kräfteplan 1 cm \triangleq 1 kN

Force diagram 1 cm \triangleq 1 kN

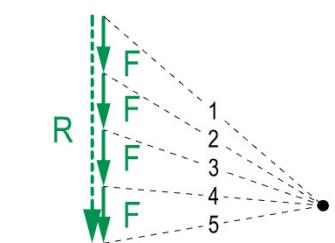


Lageplan 1:100
Form diagram 1:100

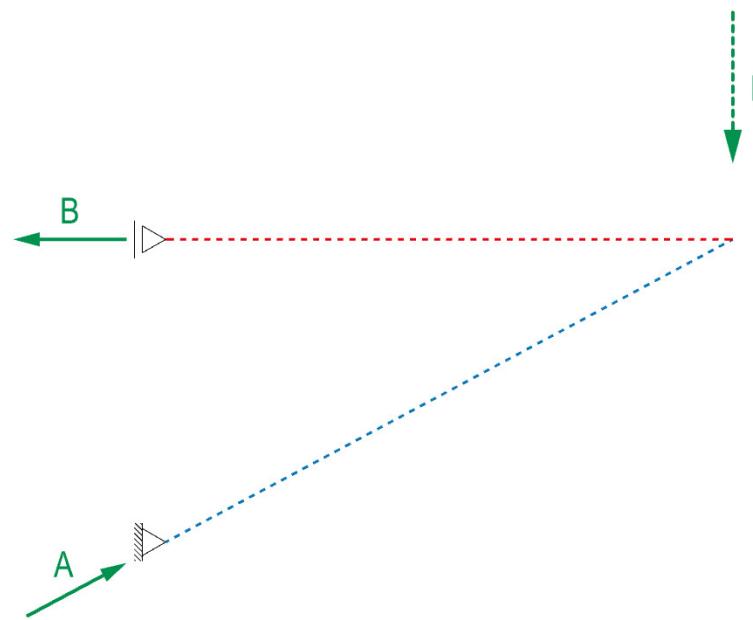
Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN



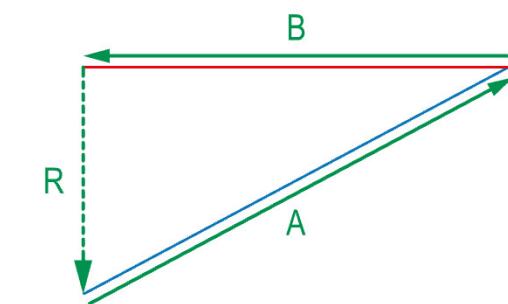
Lageplan 1:100
Form diagram 1:100



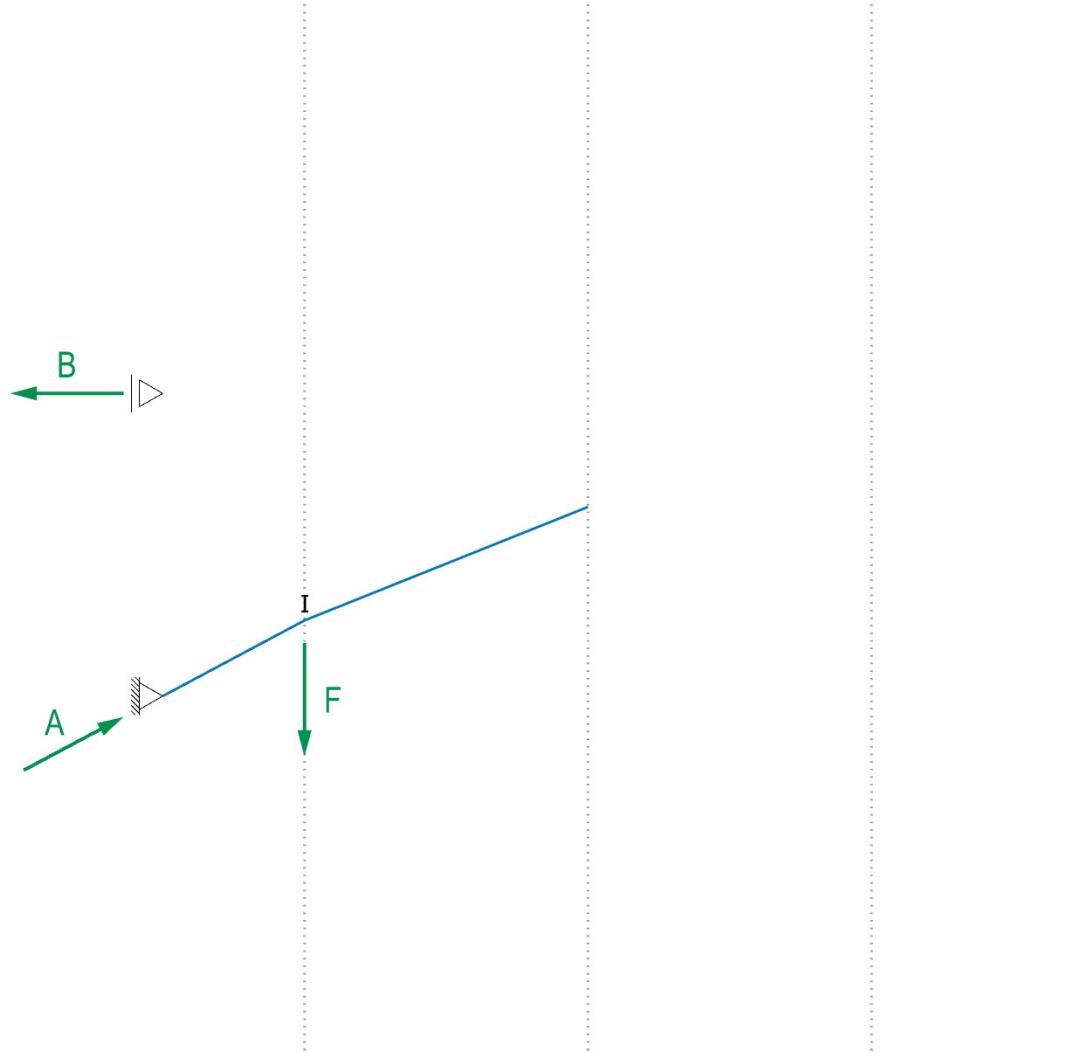
Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN



Lageplan 1:100
Form diagram 1:100

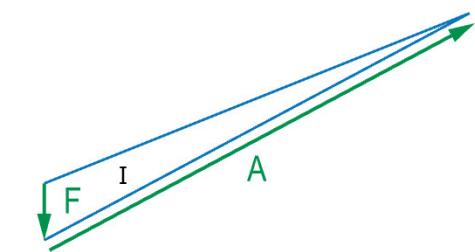


Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN



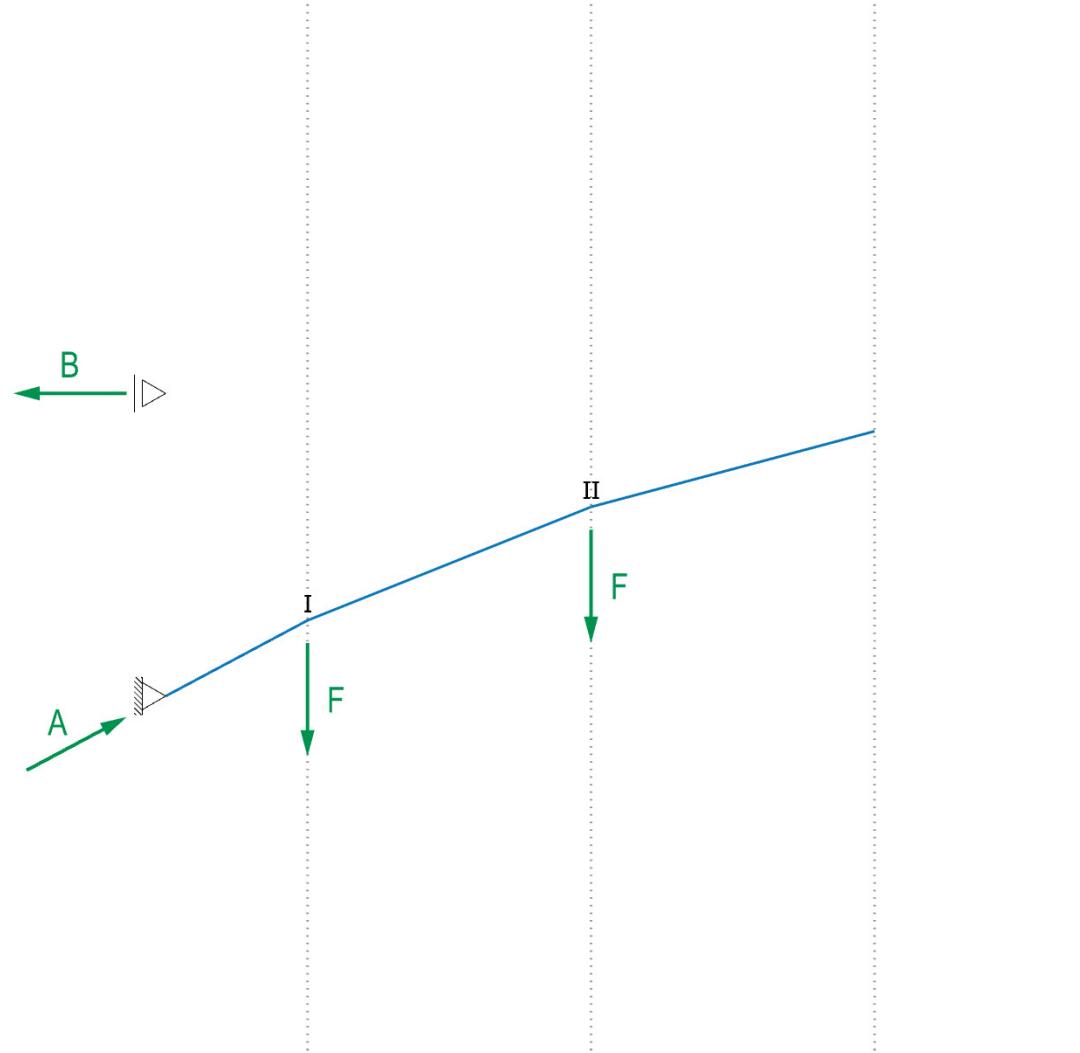
Lageplan 1:100

Form diagram 1:100



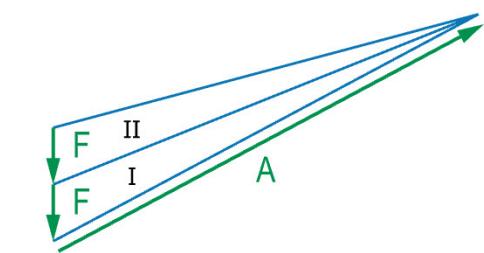
Kräfteplan 1 cm \triangleq 1 kN

Force diagram 1 cm \triangleq 1 kN



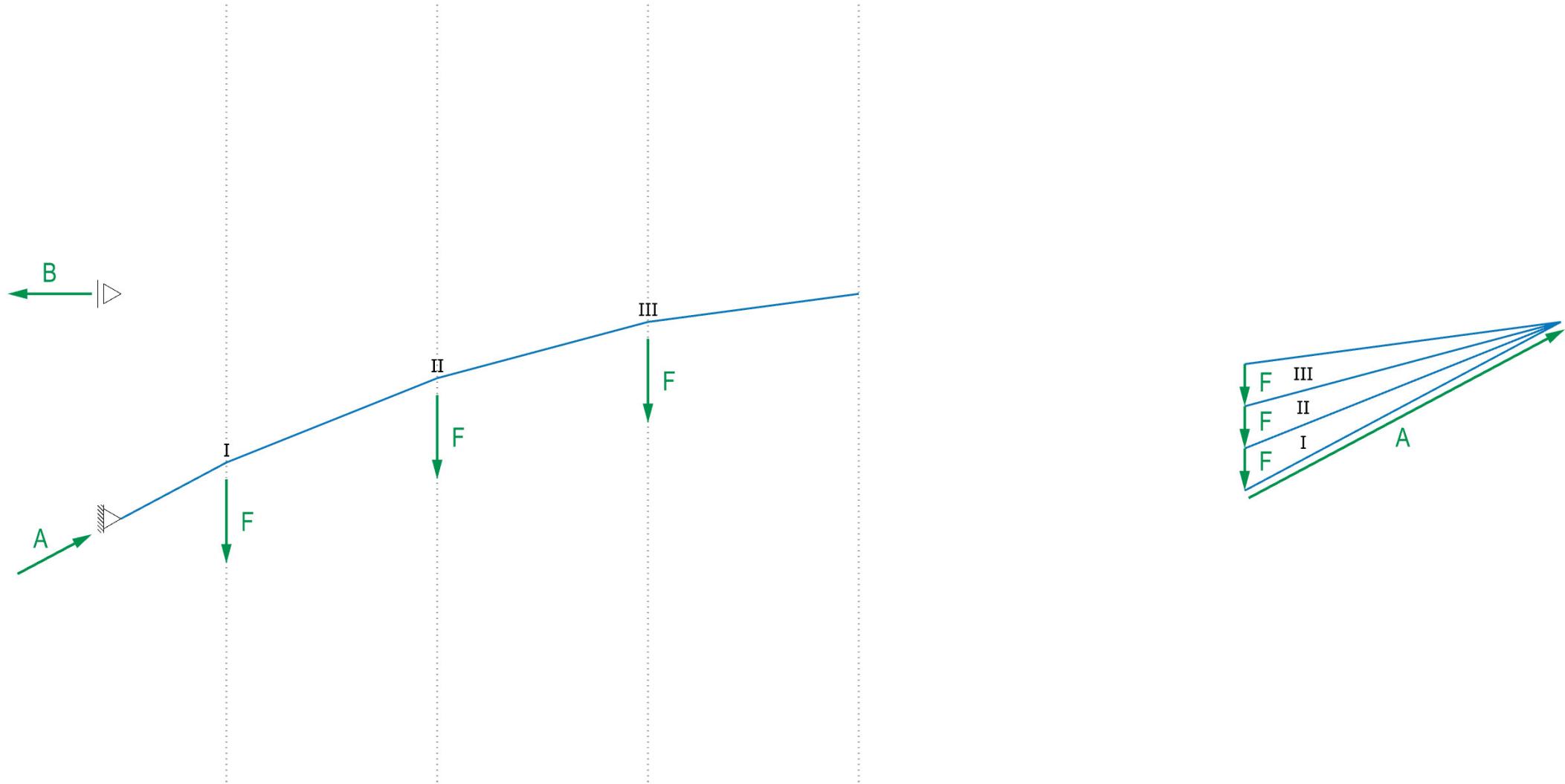
Lageplan 1:100

Form diagram 1:100



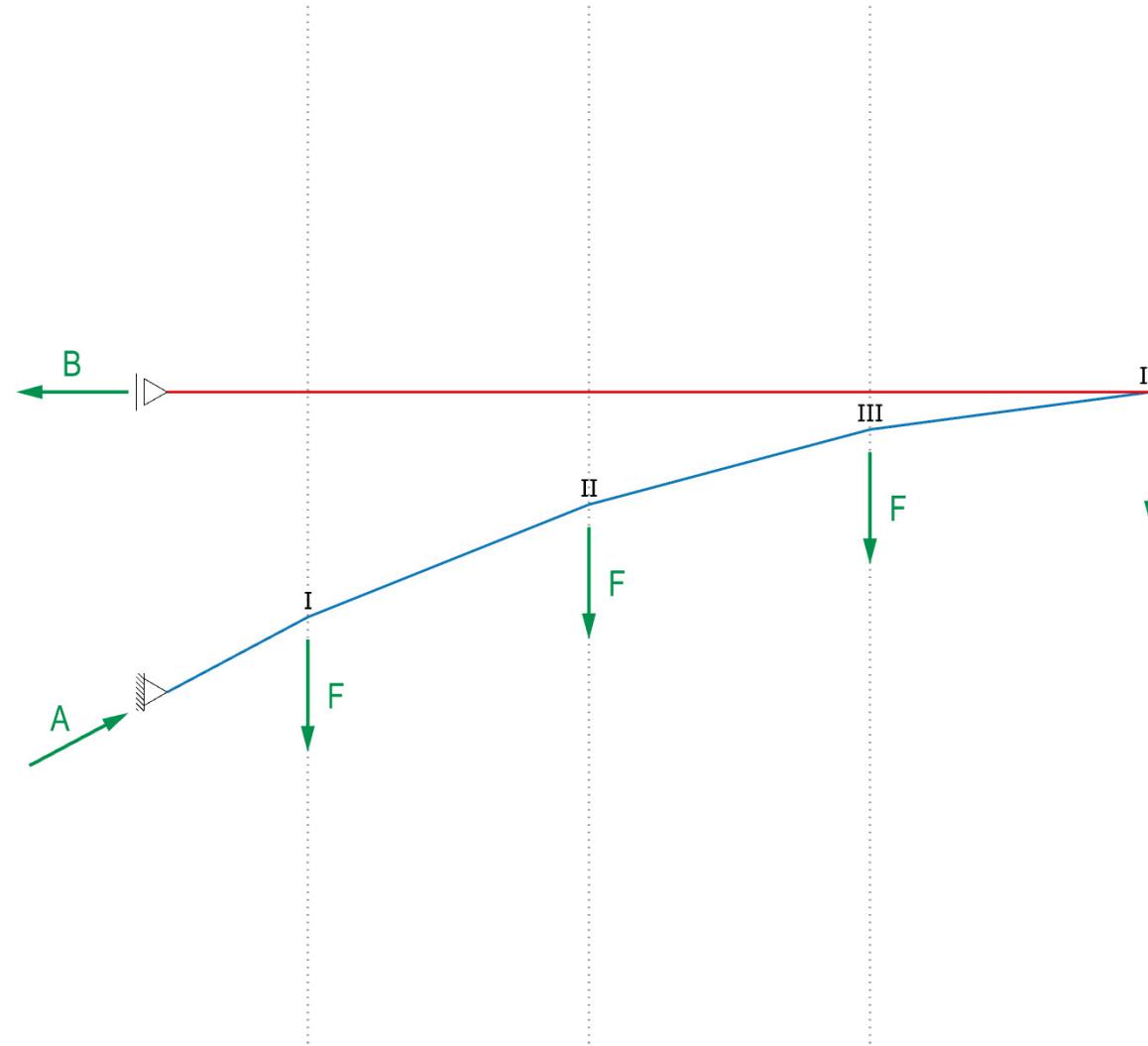
Kräfteplan 1 cm \triangleq 1 kN

Force diagram 1 cm \triangleq 1 kN



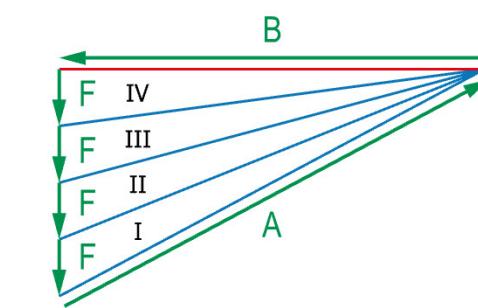
Lageplan 1:100

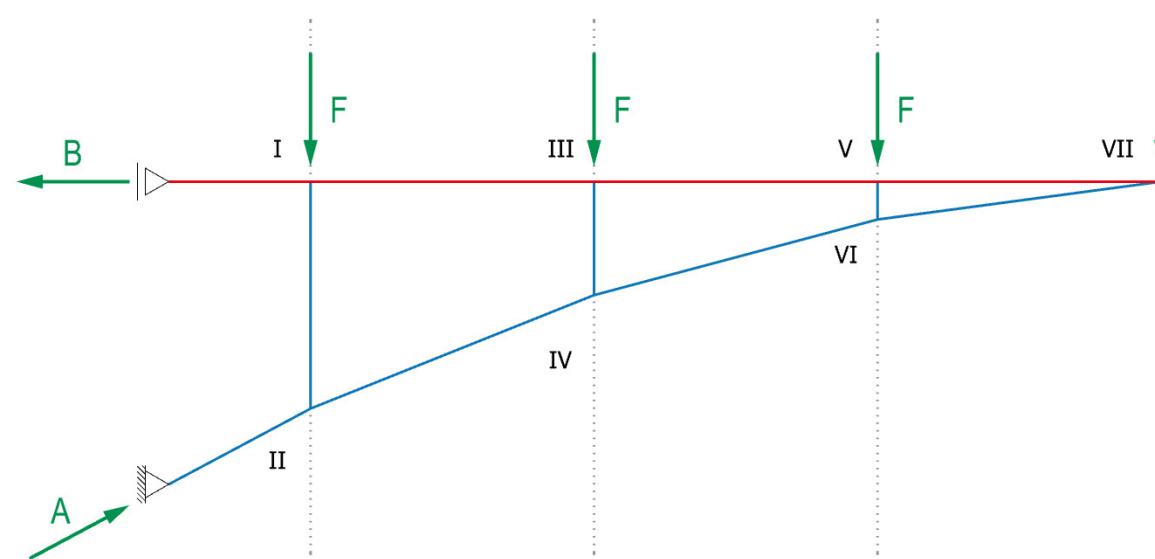
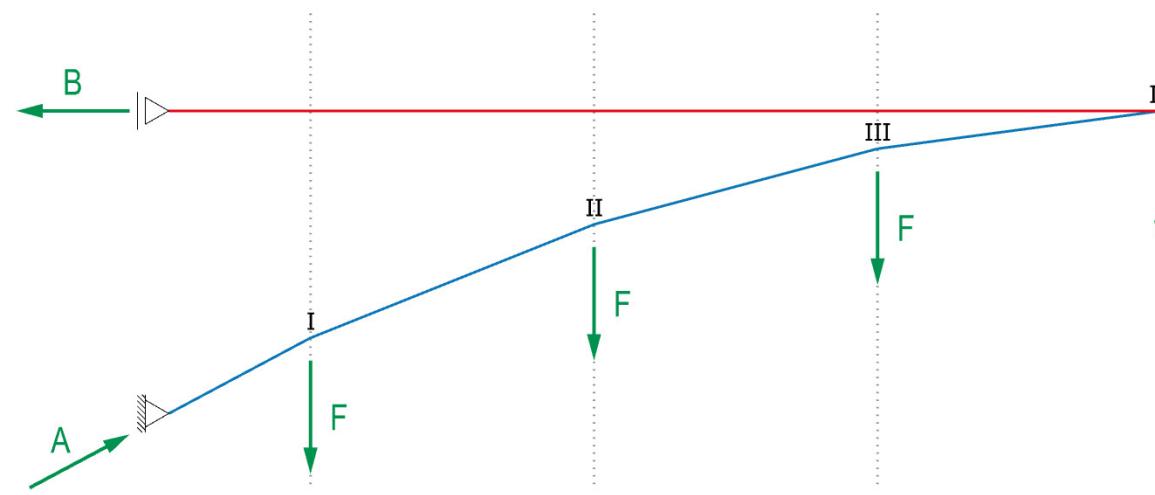
*Form diagram 1:100*Kräfteplan 1 cm \triangleq 1 kN*Force diagram 1 cm \triangleq 1 kN*



Lageplan 1:100

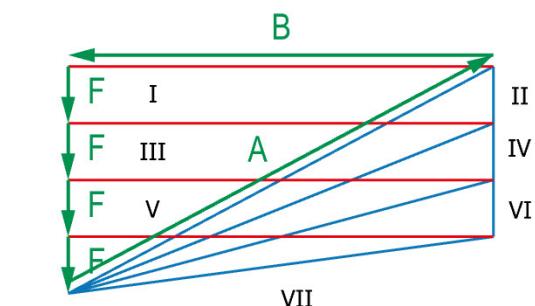
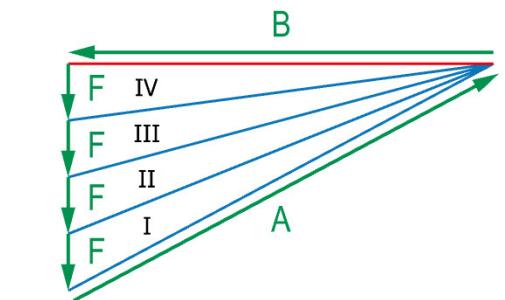
Form diagram 1:100

Kräfteplan 1 cm \triangleq 1 kNForce diagram 1 cm \triangleq 1 kN



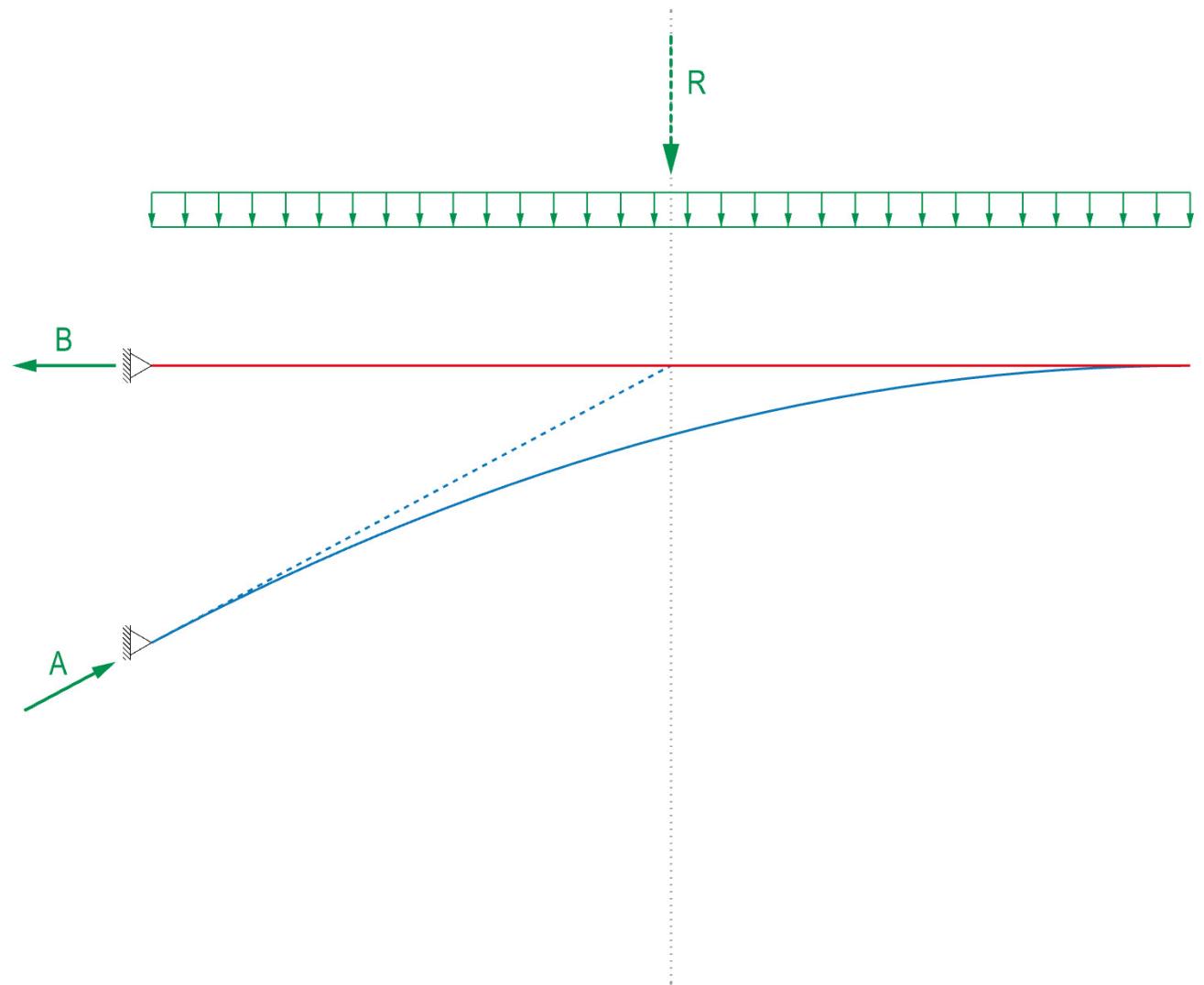
Lageplan 1:100

Form diagram 1:100



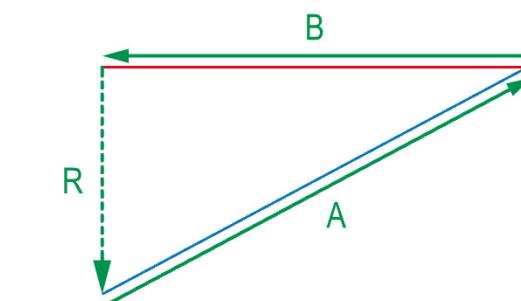
Kräfteplan 1 cm \triangleq 1 kN

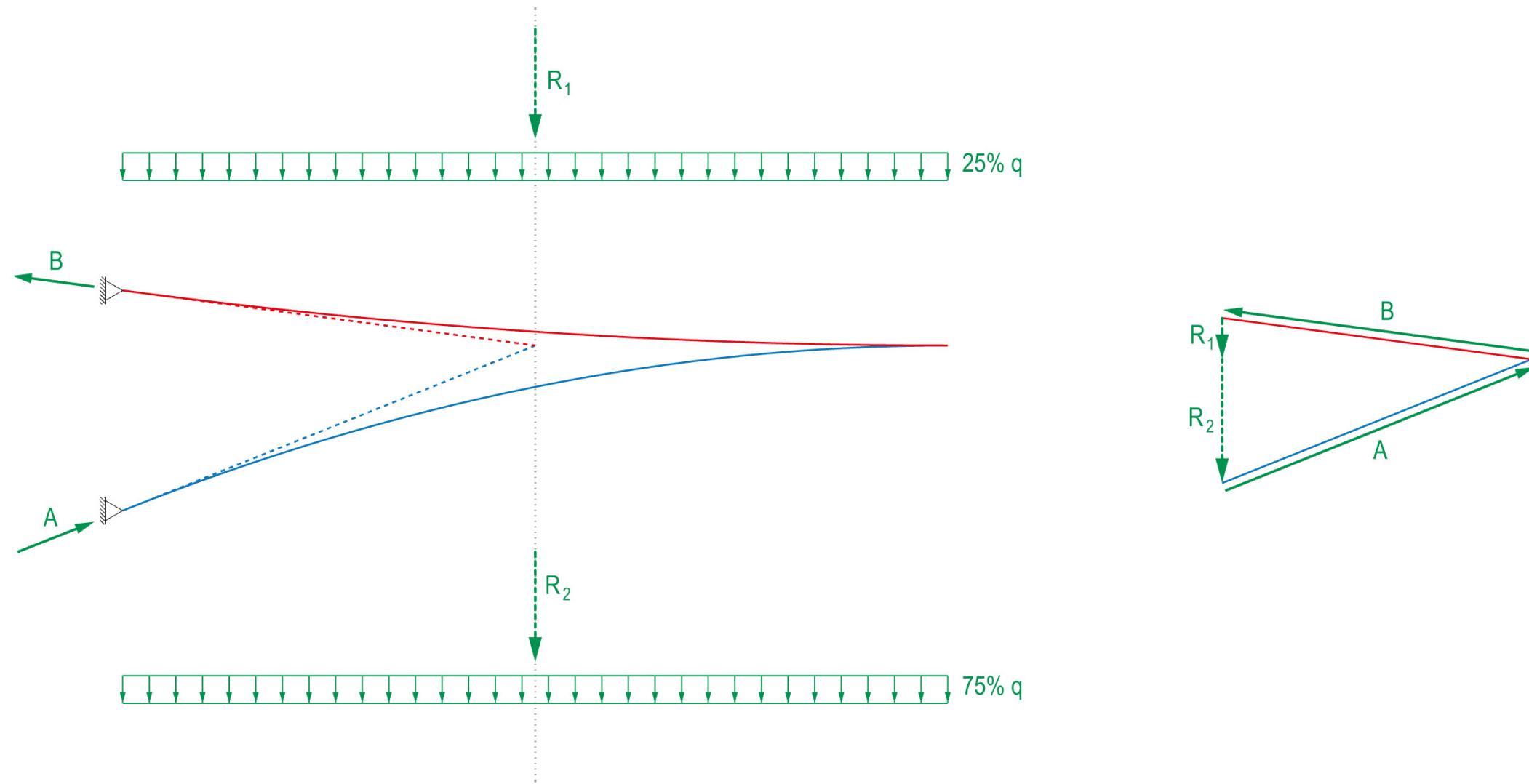
Force diagram 1 cm \triangleq 1 kN



Lageplan 1:100

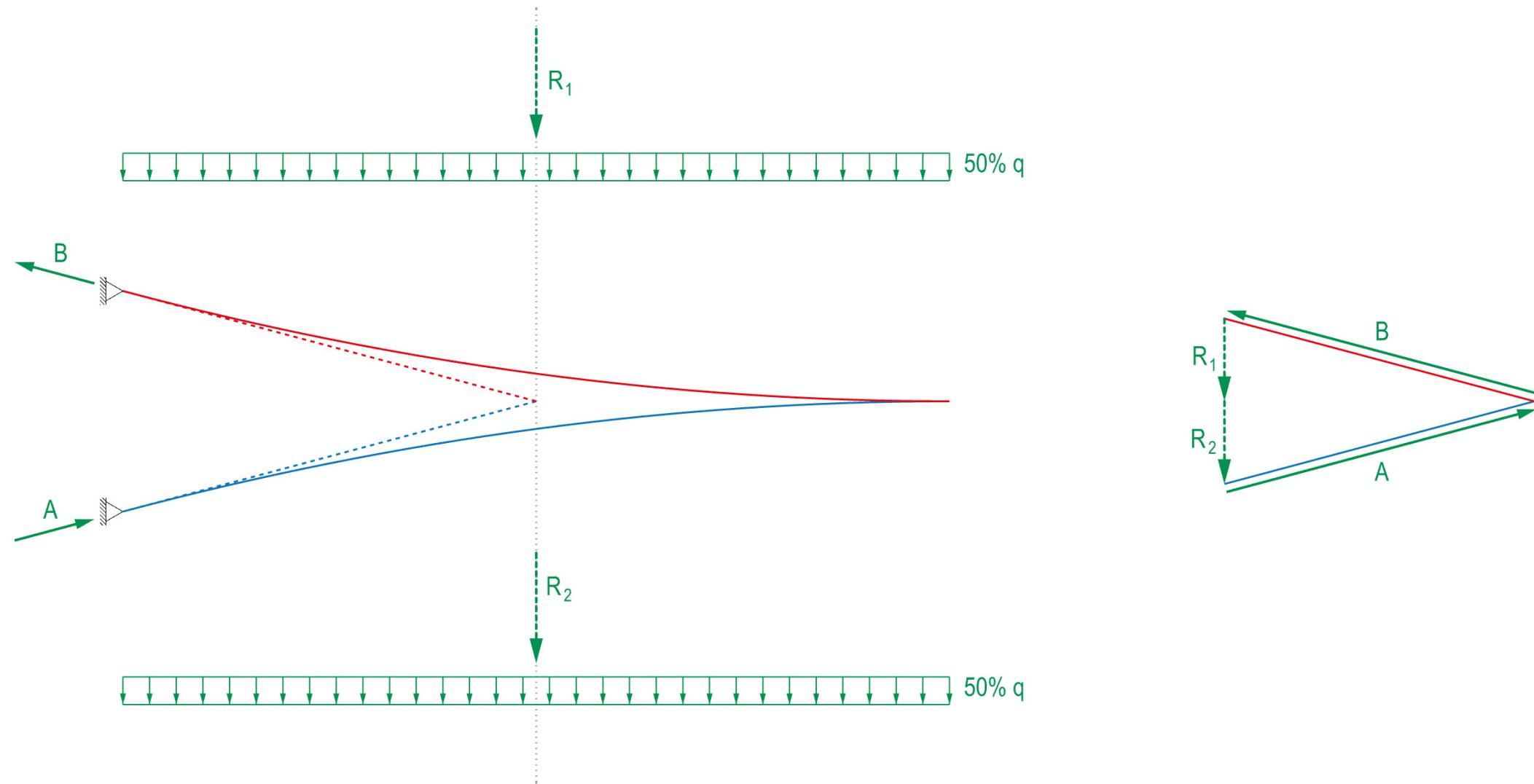
Form diagram 1:100

Kräfteplan 1 cm \triangleq 1 kNForce diagram 1 cm \triangleq 1 kN



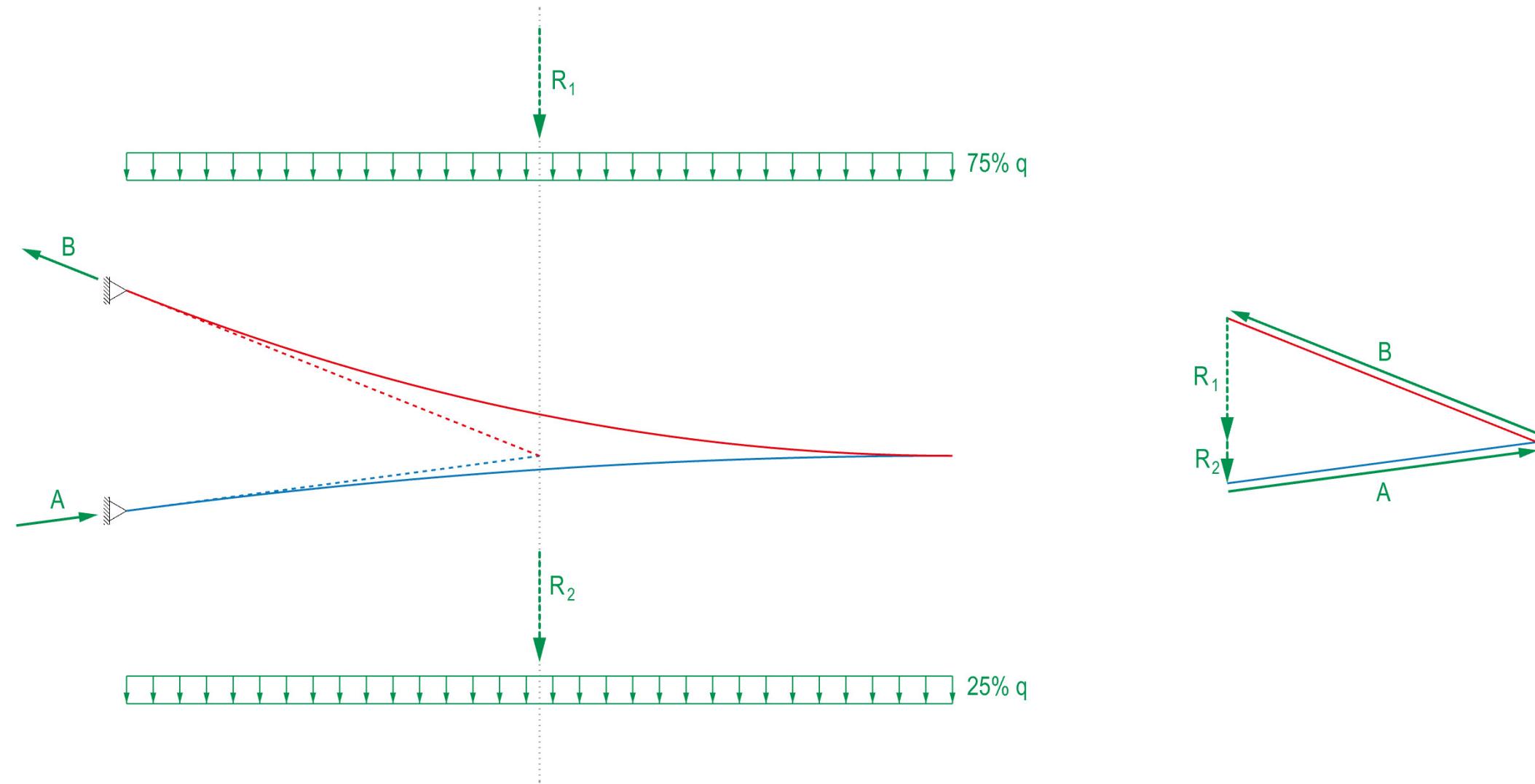
Lageplan 1:100
Form diagram 1:100

Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN



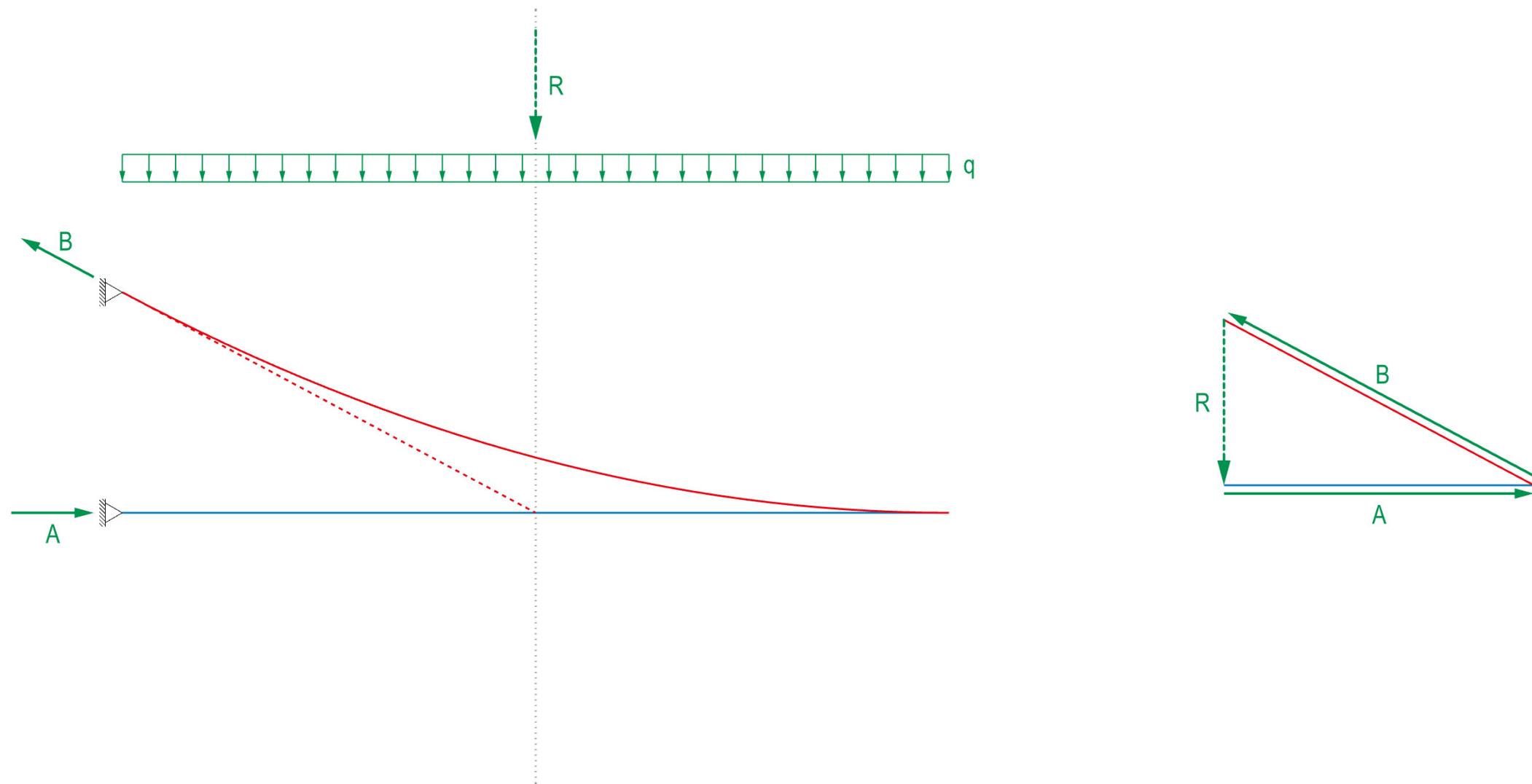
Lageplan 1:100
Form diagram 1:100

Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN



Lageplan 1:100

*Form diagram 1:100*Kräfteplan 1 cm \triangleq 1 kN*Force diagram 1 cm \triangleq 1 kN*



Lageplan 1:100

Form diagram 1:100

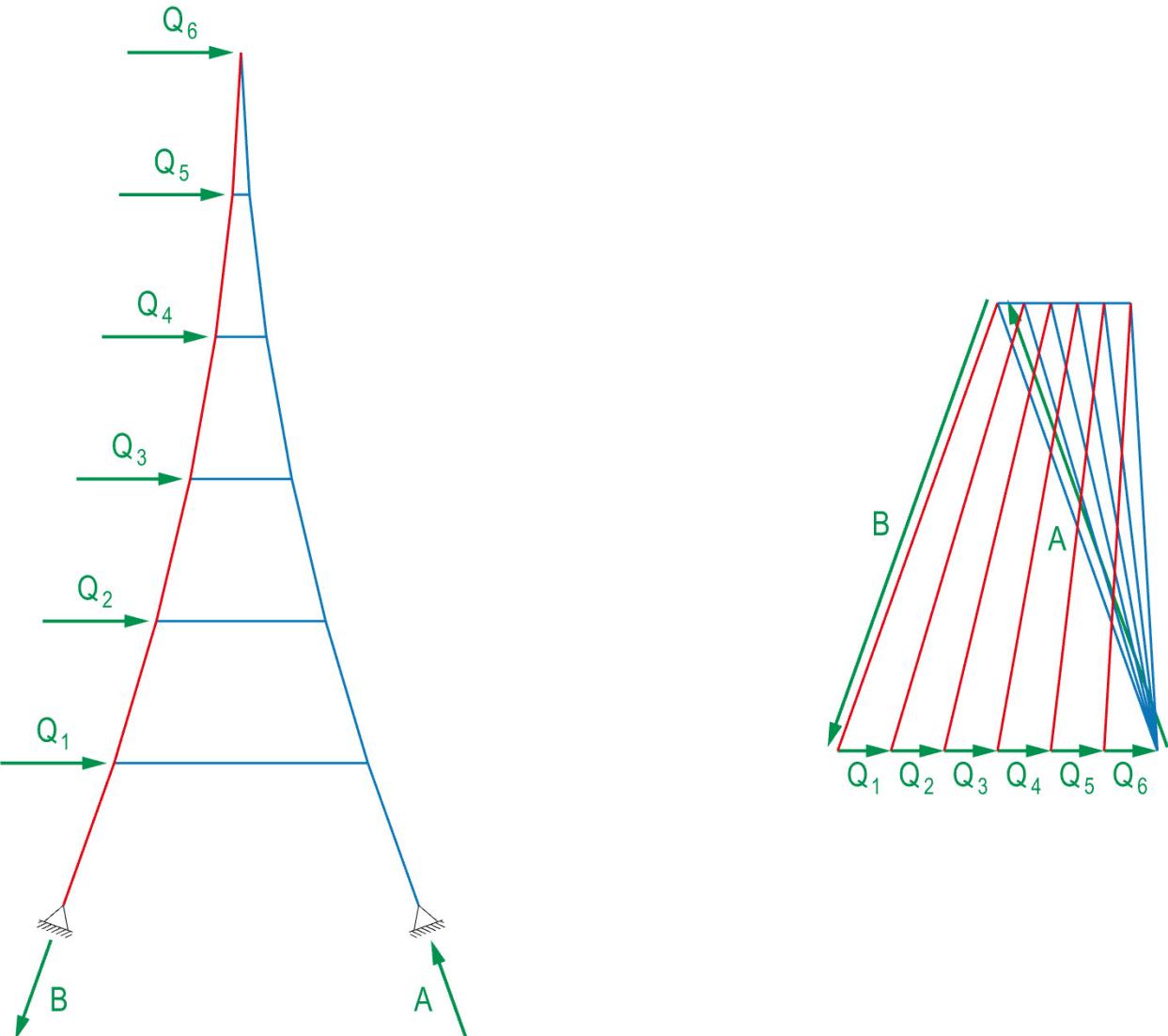
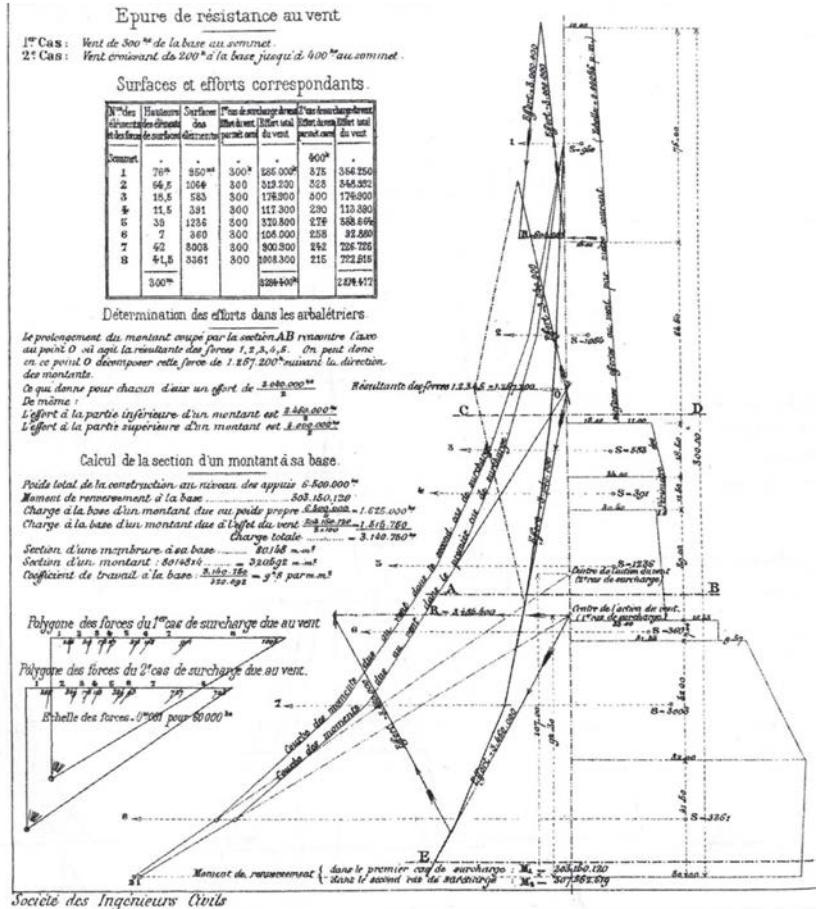
Kräfteplan 1 cm \triangleq 1 kNForce diagram 1 cm \triangleq 1 kN



P.L. Nervi: Papierfabrik Burgo, Mantua, Italy, 1962

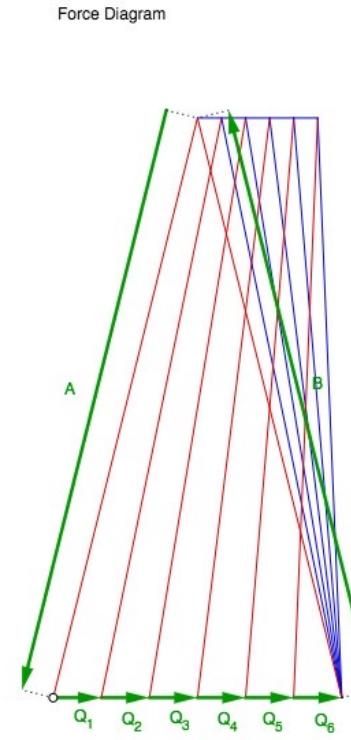
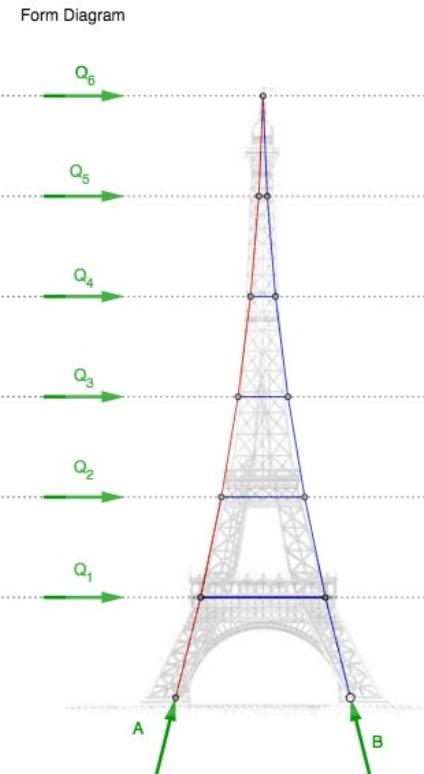
Konsolenartige Bogen-Seil-Tragwerke

Cantilevering arch-cable structures



Maurice Koechlin, Gustave Eiffel: La Tour Eiffel, Paris, 1889

eQ: Eiffel Tower



<http://www.block.arch.ethz.ch/eq/drawing/view/31>

Bogen-Seil-Tragwerke

Arch-cable structures

Tragwirkung einfacher Bogen-Seil-Tragwerke

Structural behaviour of simple arch-cable structures

Auflagerbedingungen

Support conditions

Aufteilung der äusseren Lasten

Distribution of external loads

Formfindung eines überspannenden Bogen-Seils

Form-finding of a spanning arch-cable

Konsolenartige Bogen-Seil-Tragwerke

Cantilevering arch-cable structures

>>

Geometrische Variation

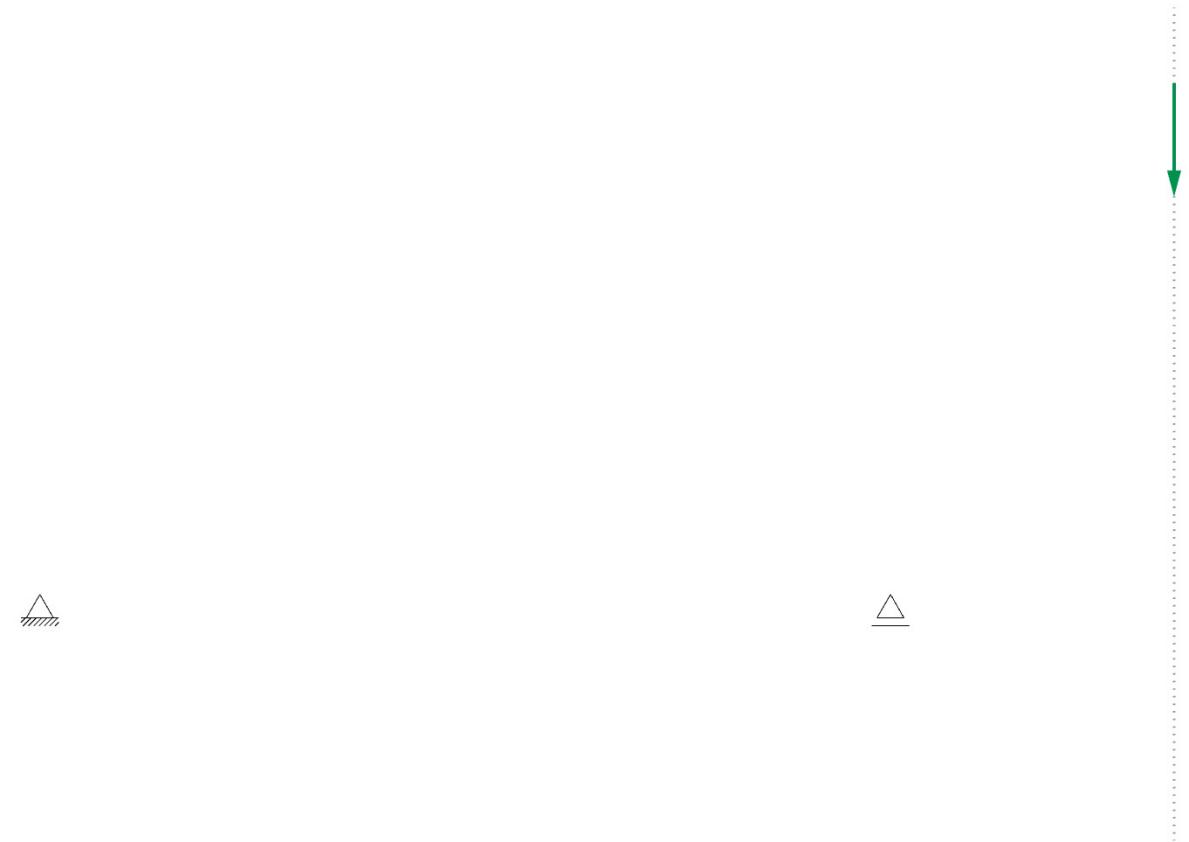
Geometric variation

Zusammengesetzte Bogen-Seil-Tragwerke

Combined arch-cables

Fallbeispiele

Case studies



Lageplan 1:100

Form diagram 1:100

Kräfteplan 1 cm \triangleq 1 kN

Force diagram 1 cm \triangleq 1 kN



Lageplan 1:100

Form diagram 1:100

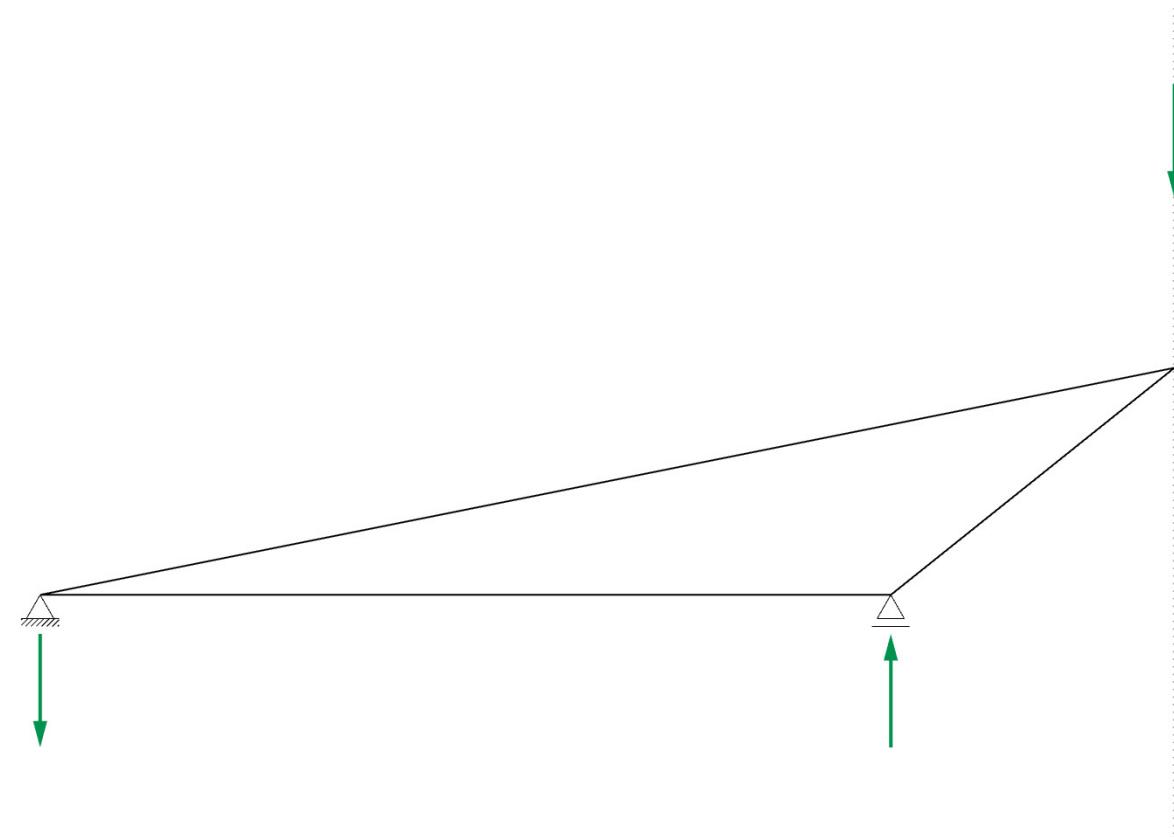


F



Kräfteplan 1 cm \triangleq 1 kN

Force diagram 1 cm \triangleq 1 kN

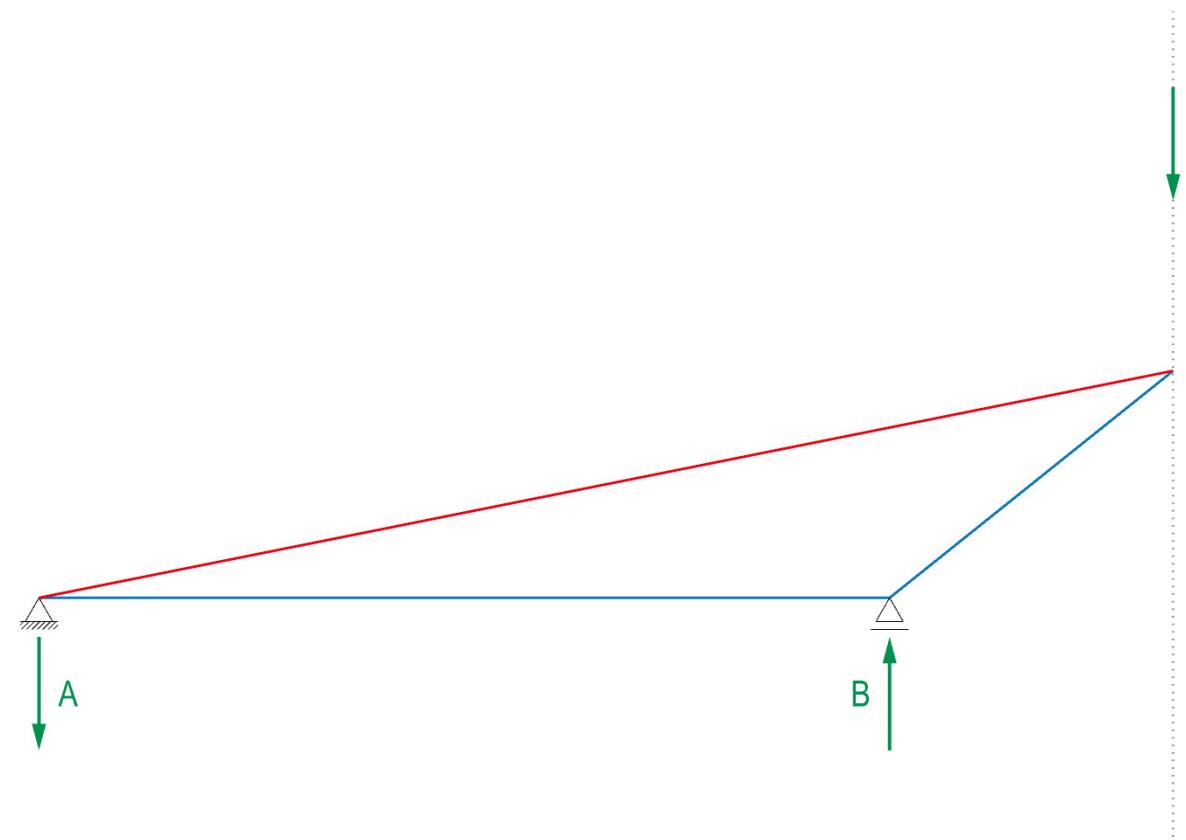


Lageplan 1:100

Form diagram 1:100

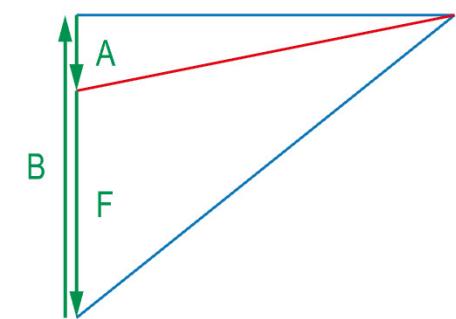
Kräfteplan 1 cm \triangleq 1 kN

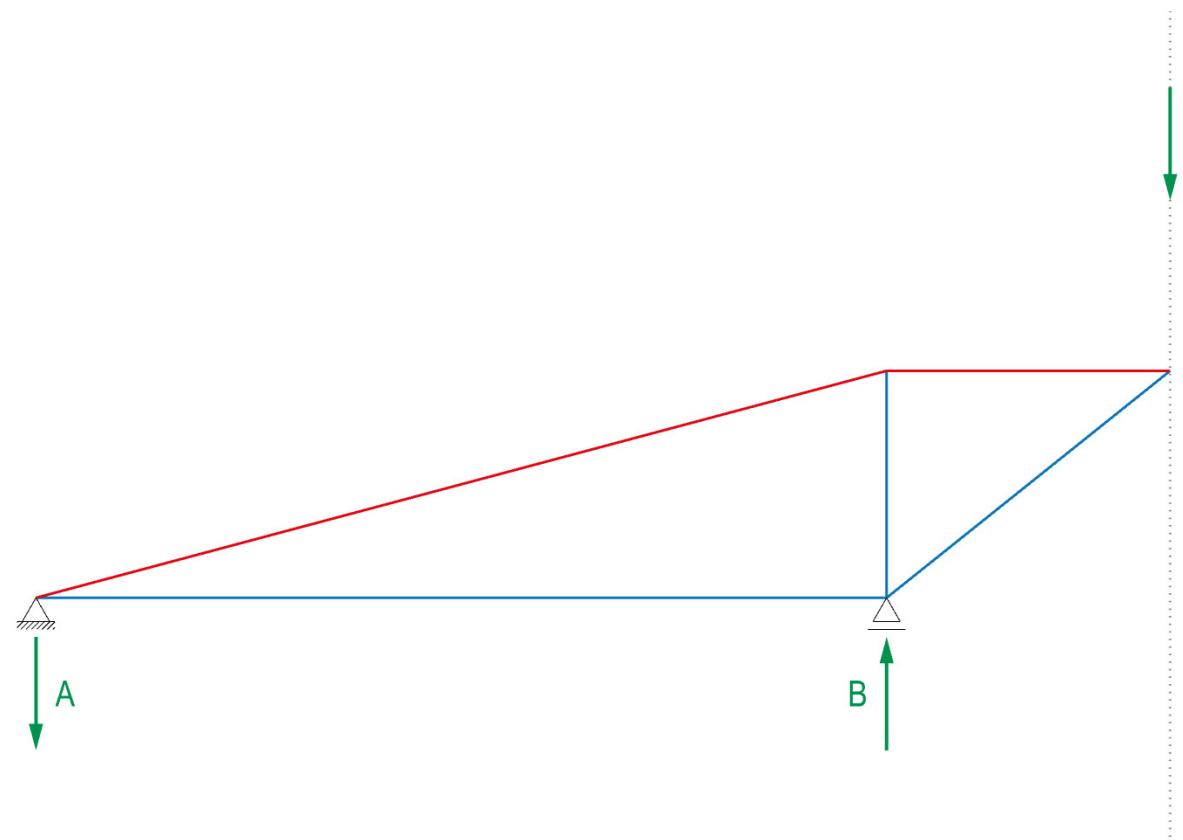
Force diagram 1 cm \triangleq 1 kN



Lageplan 1:100

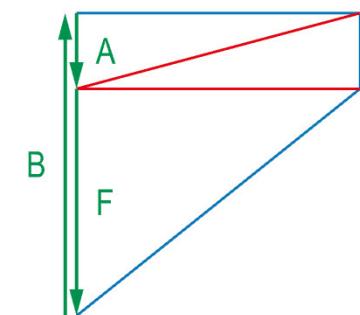
Form diagram 1:100

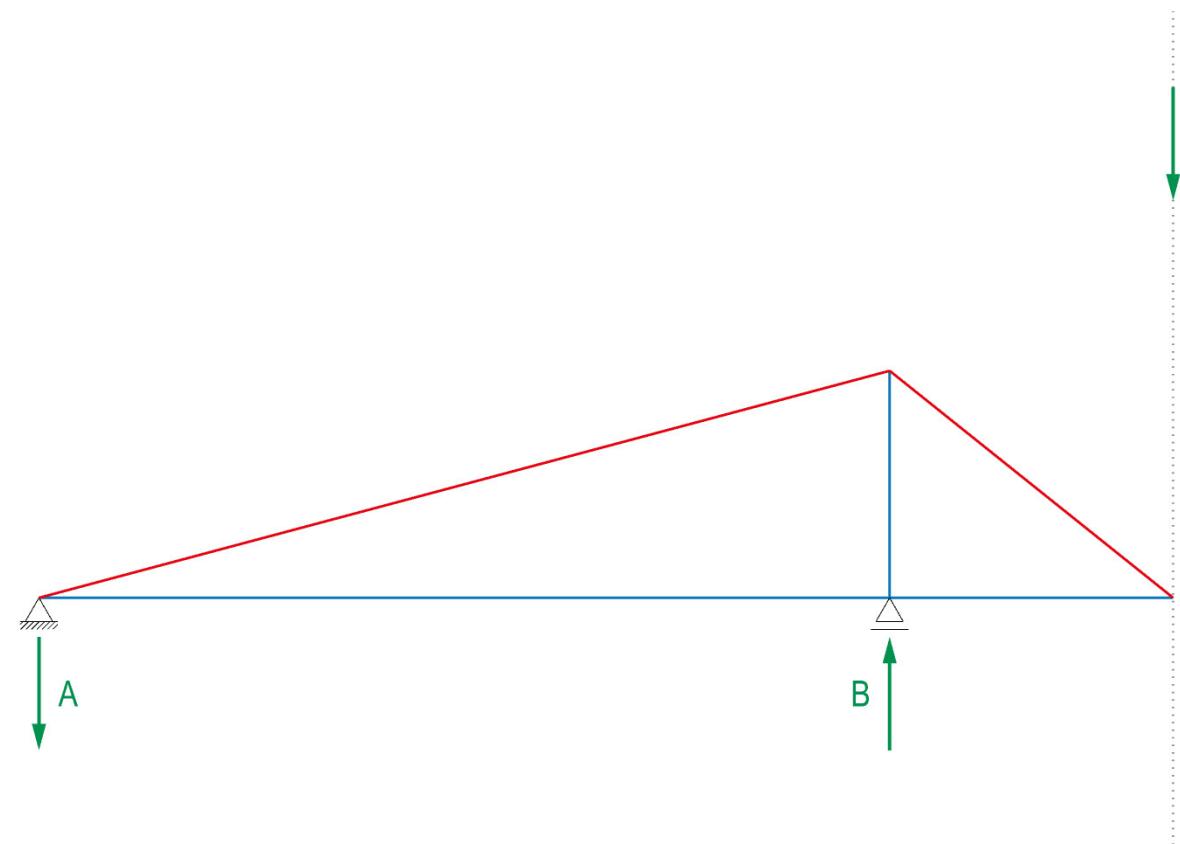
Kräfteplan 1 cm \triangleq 1 kNForce diagram 1 cm \triangleq 1 kN



Lageplan 1:100

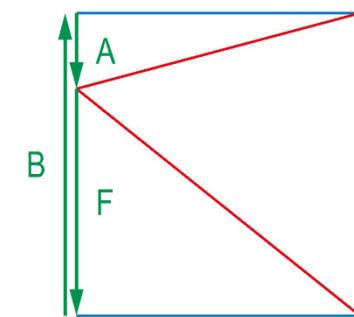
Form diagram 1:100

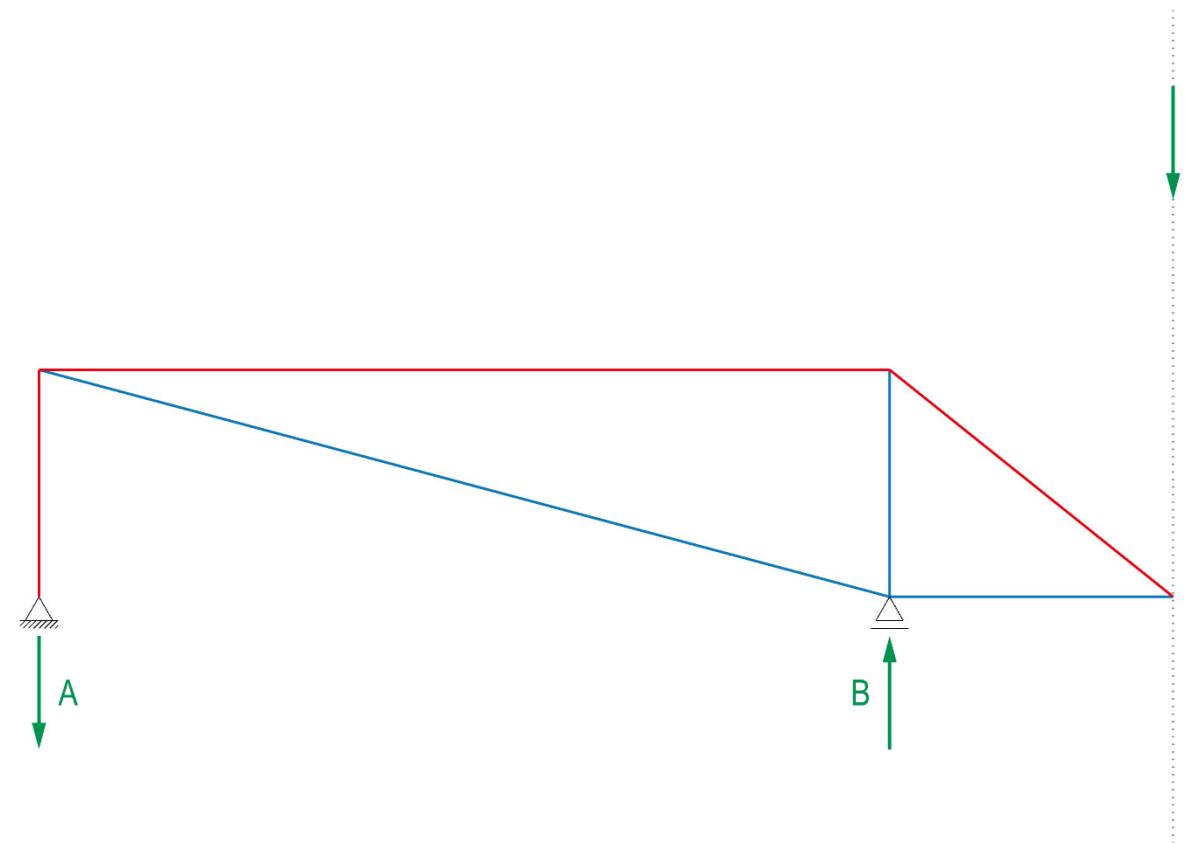
Kräfteplan 1 cm \triangleq 1 kNForce diagram 1 cm \triangleq 1 kN



Lageplan 1:100

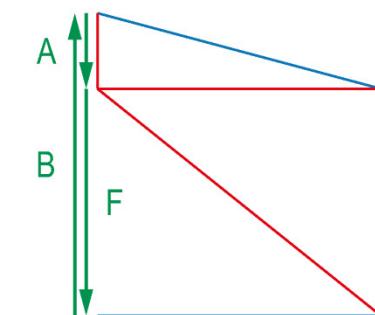
Form diagram 1:100

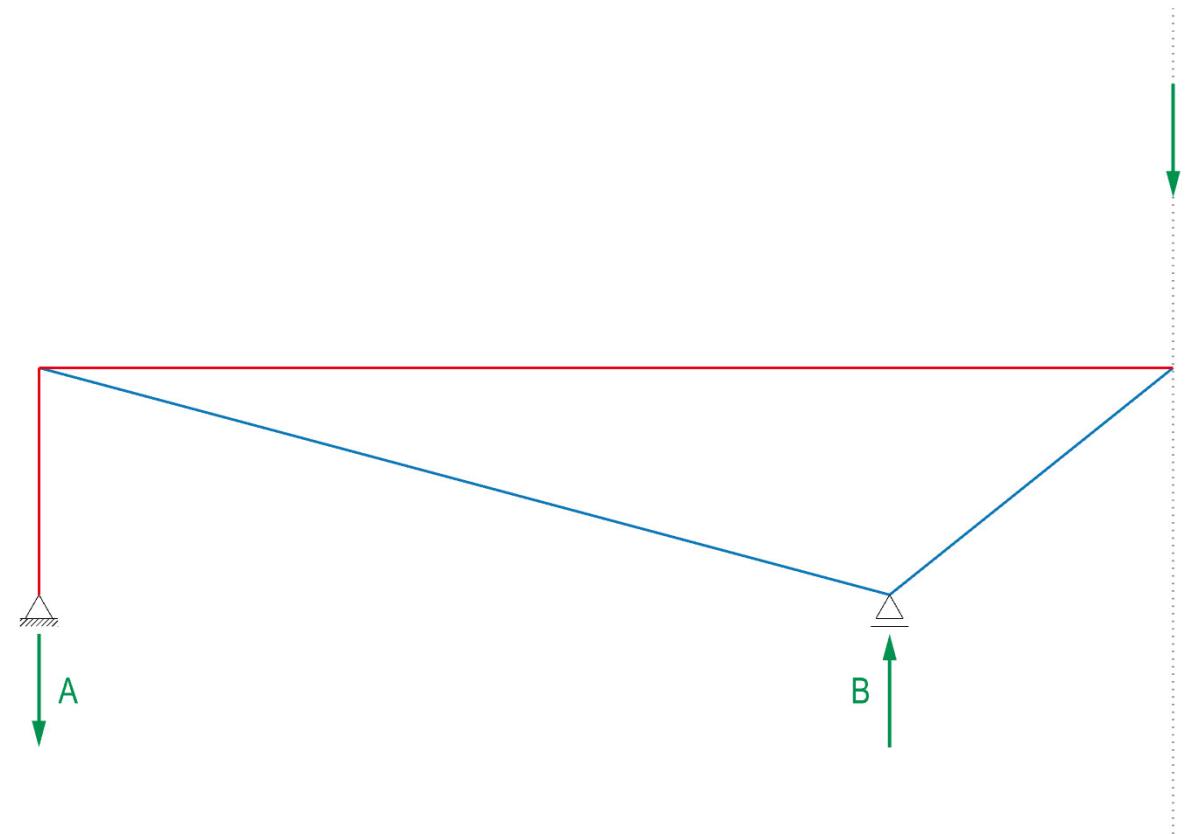
Kräfteplan 1 cm \triangleq 1 kNForce diagram 1 cm \triangleq 1 kN



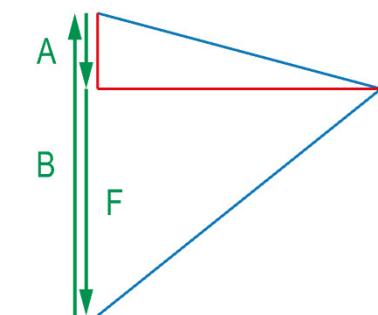
Lageplan 1:100

Form diagram 1:100

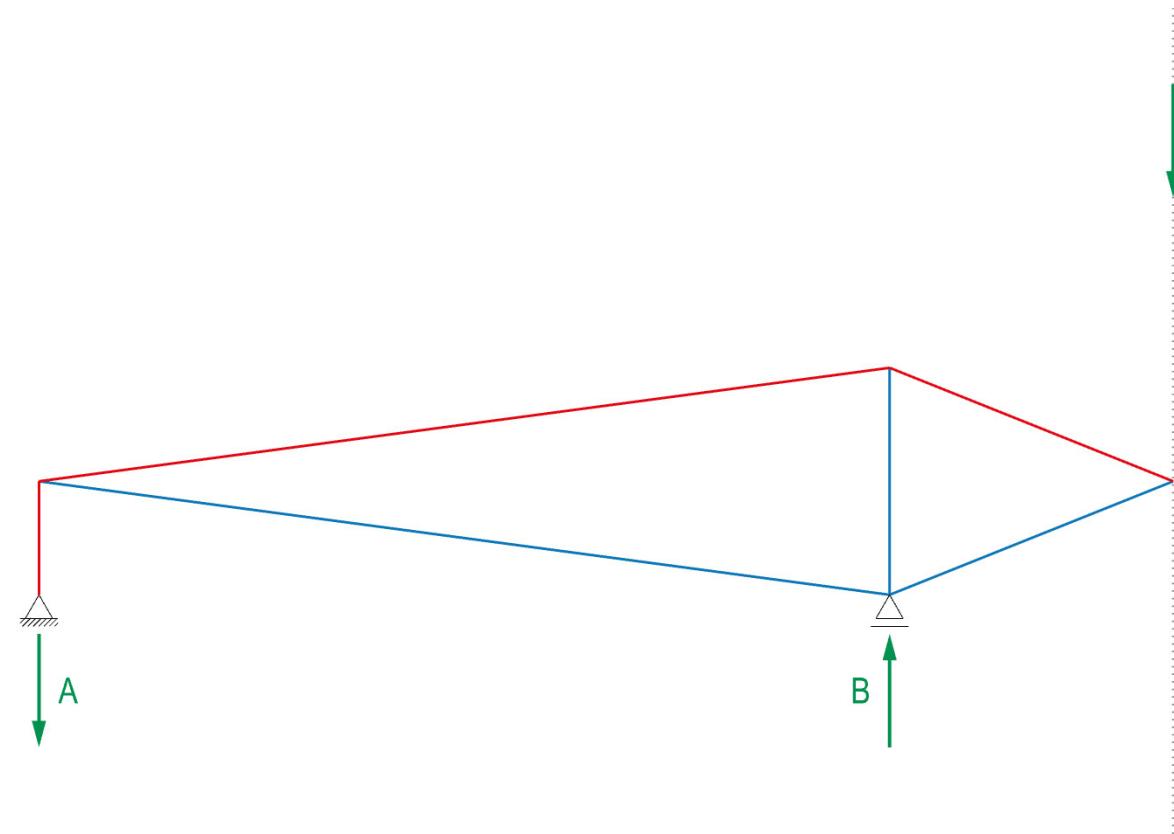
Kräfteplan 1 cm \triangleq 1 kNForce diagram 1 cm \triangleq 1 kN



Lageplan 1:100
Form diagram 1:100

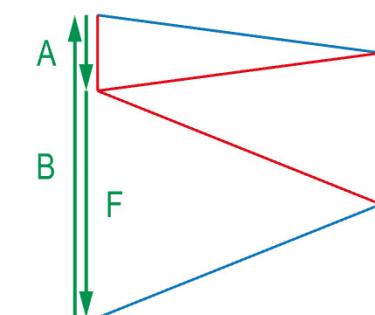


Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN

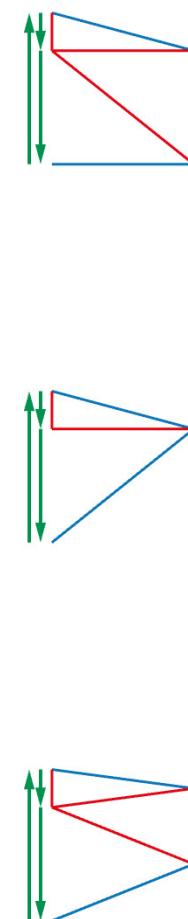
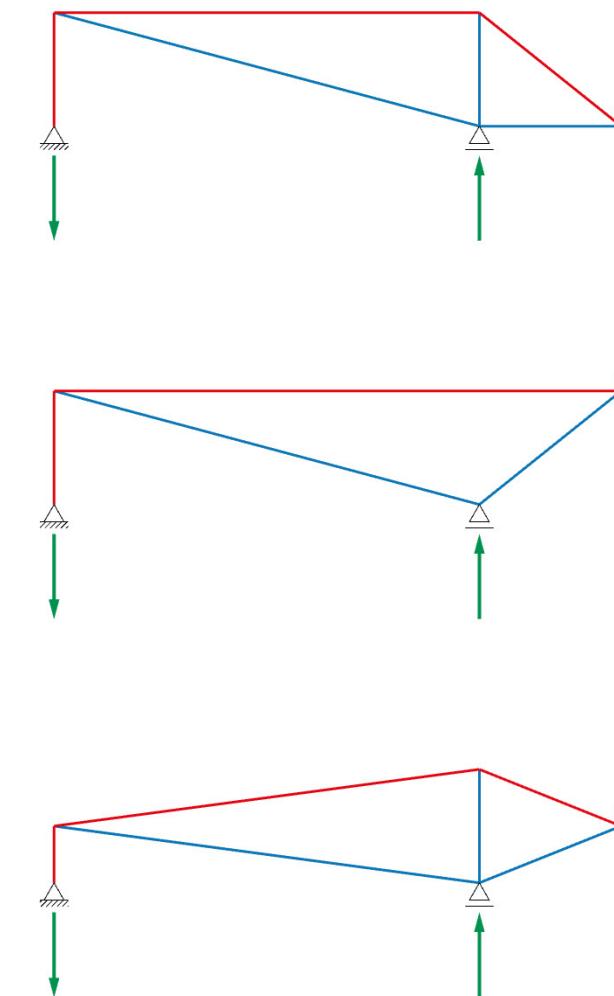
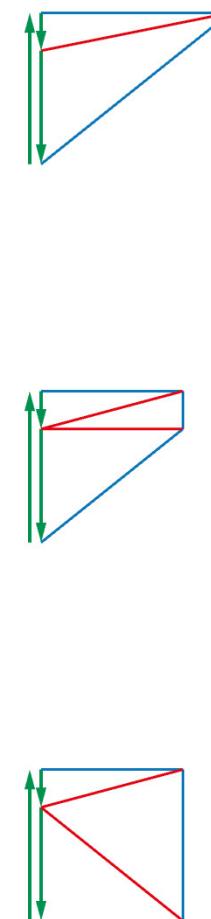
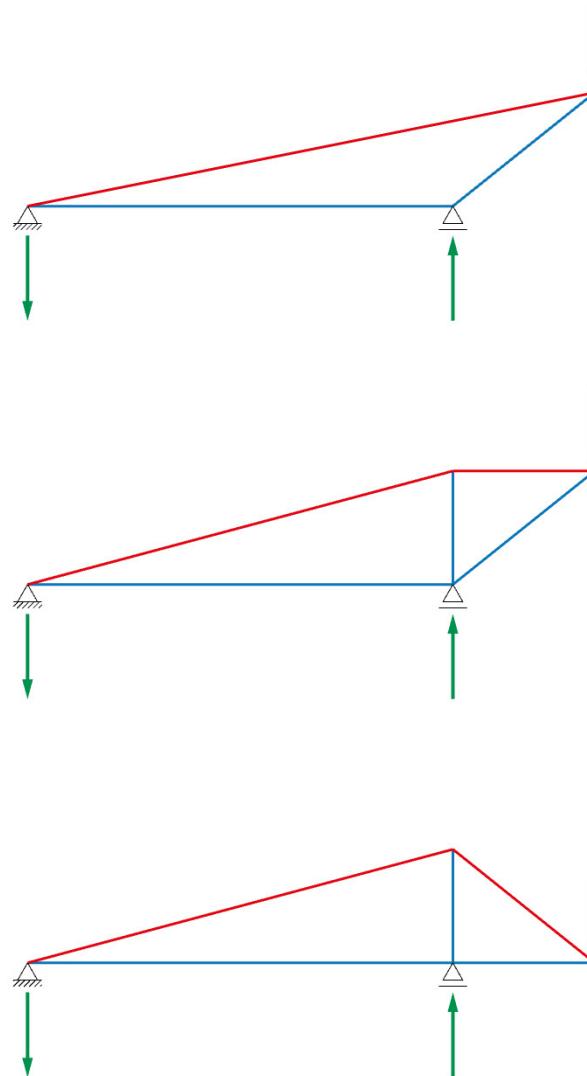


Lageplan 1:100

Form diagram 1:100

Kräfteplan 1 cm \triangleq 1 kNForce diagram 1 cm \triangleq 1 kN

Geometric variation



Bogen-Seil-Tragwerke

Arch-cable structures

Tragwirkung einfacher Bogen-Seil-Tragwerke

Structural behaviour of simple arch-cable structures

Auflagerbedingungen

Support conditions

Aufteilung der äusseren Lasten

Distribution of external loads

Formfindung eines überspannenden Bogen-Seils

Form-finding of a spanning arch-cable

Konsolenartige Bogen-Seil-Tragwerke

Cantilevering arch-cable structures

Geometrische Variation

Geometric variation

>>

Zusammengesetzte Bogen-Seil-Tragwerke

Combined arch-cables

Fallbeispiele

Case studies

F_1

F_2

F_3

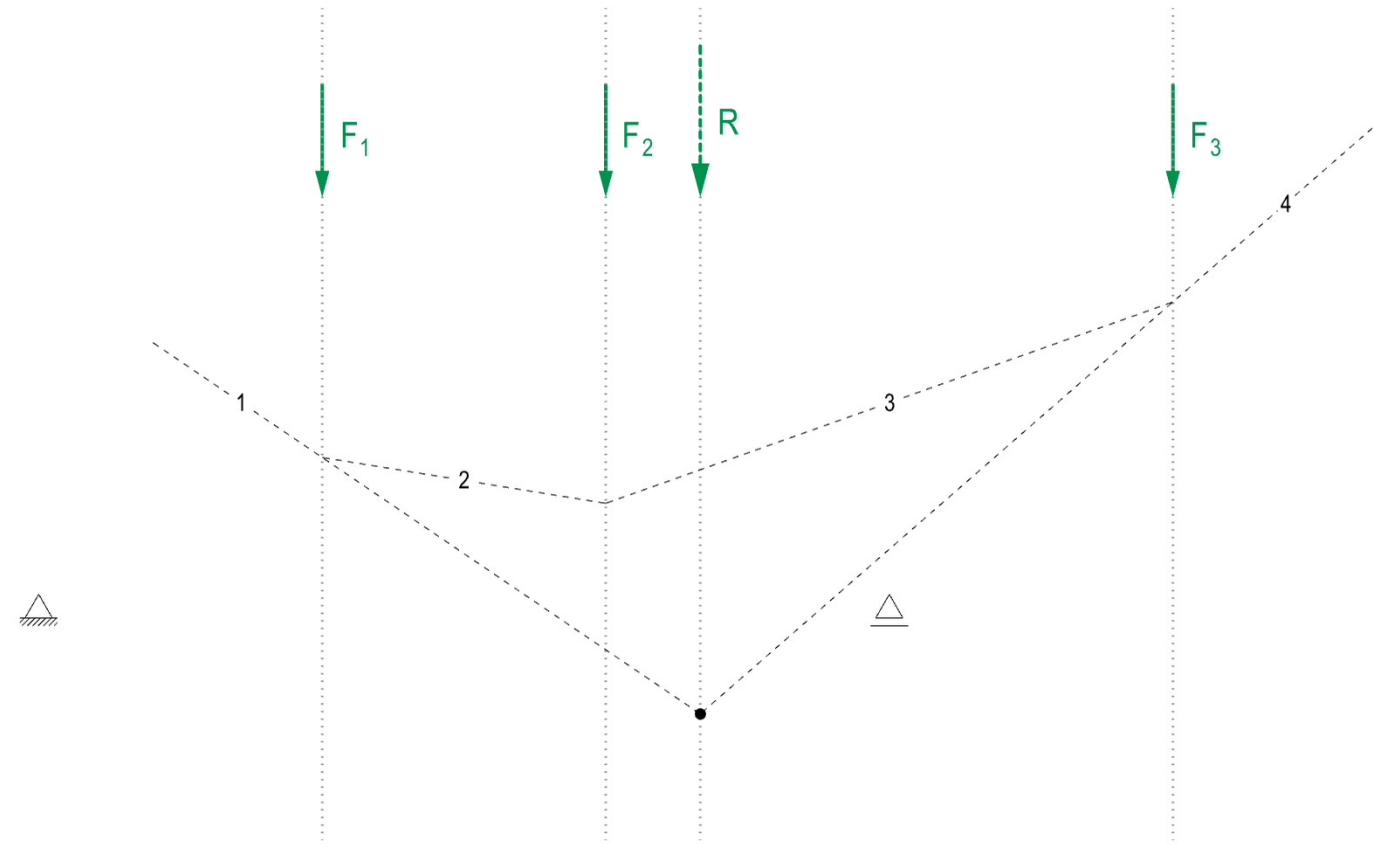


Lageplan 1:100

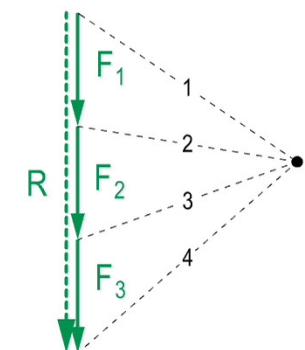
Form diagram 1:100

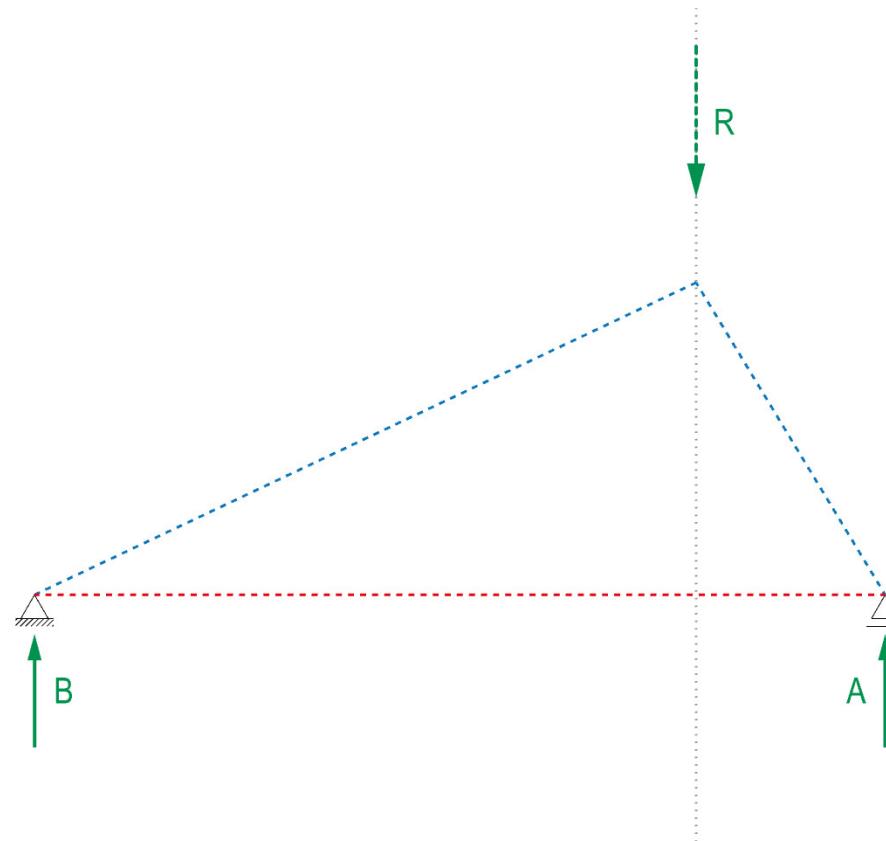
Kräfteplan 1 cm \triangleq 1 kN

Force diagram 1 cm \triangleq 1 kN



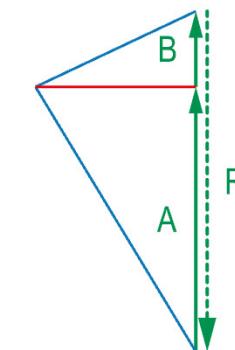
Lageplan 1:100

Form diagram 1:100Kräfteplan 1 cm \triangleq 1 kN*Force diagram 1 cm \triangleq 1 kN*



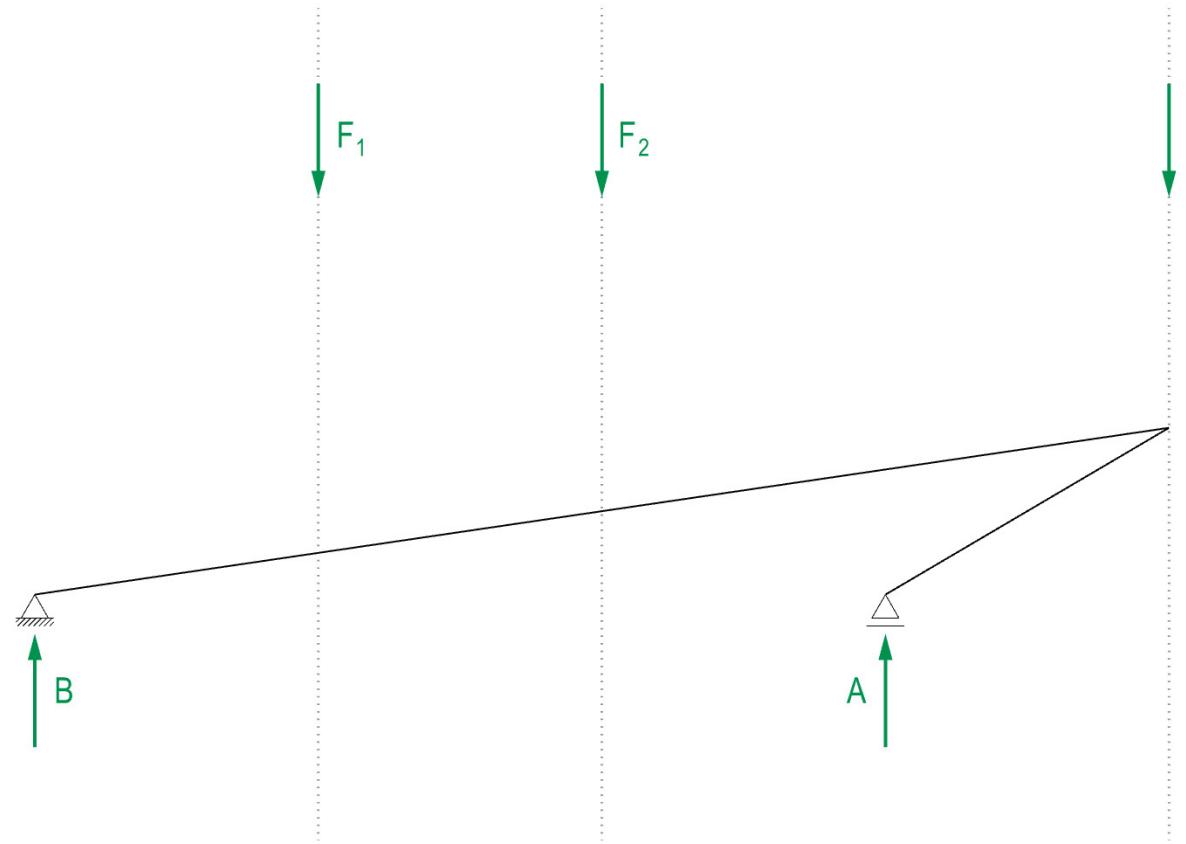
Lageplan 1:100

Form diagram 1:100



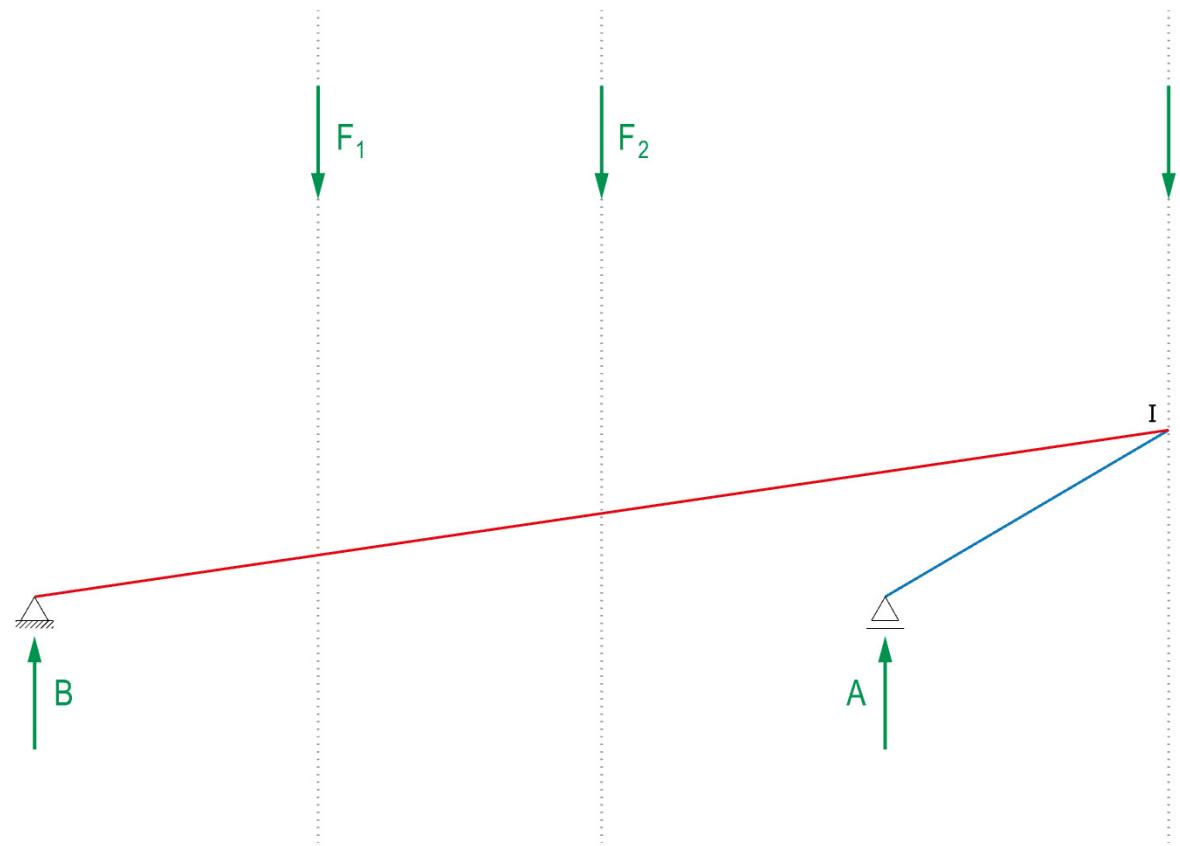
Kräfteplan 1 cm \triangleq 1 kN

Force diagram 1 cm \triangleq 1 kN

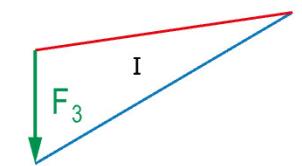


Lageplan 1:100
Form diagram 1:100

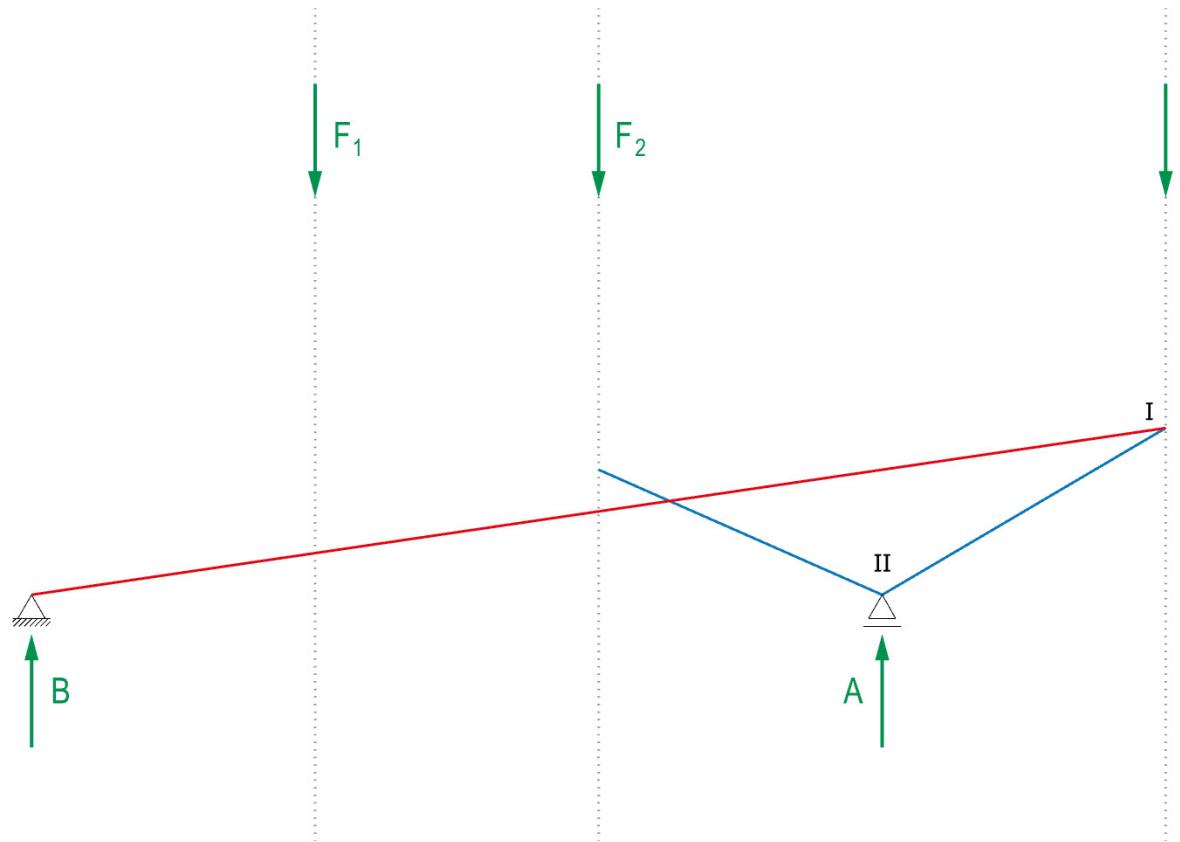
Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN



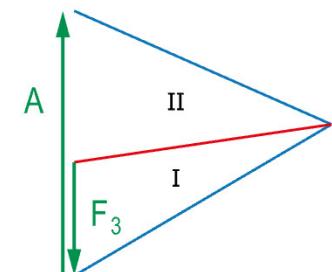
Lageplan 1:100
Form diagram 1:100



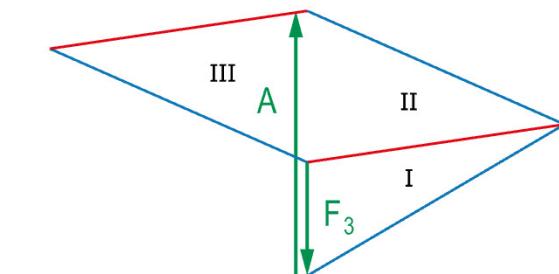
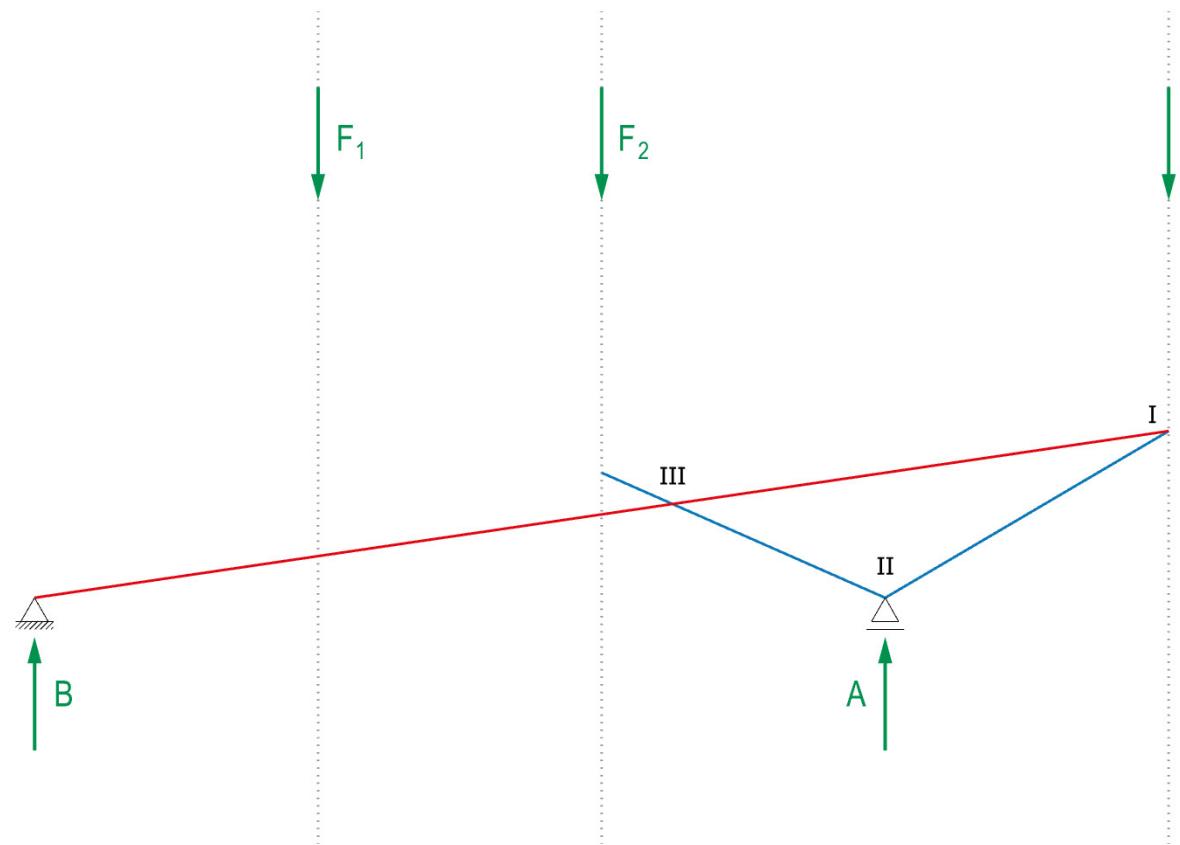
Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN

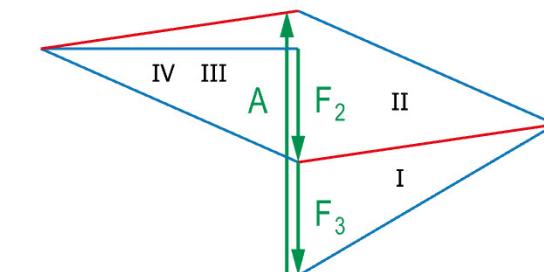
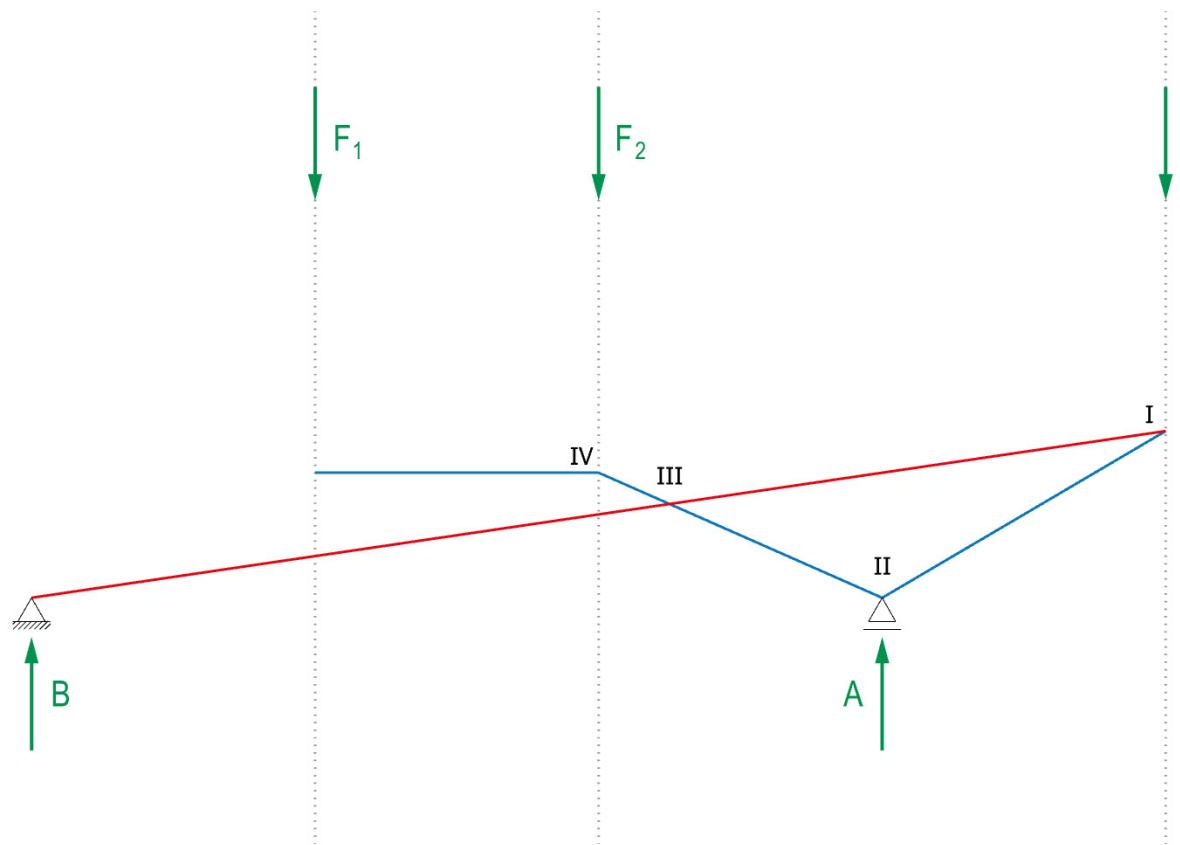


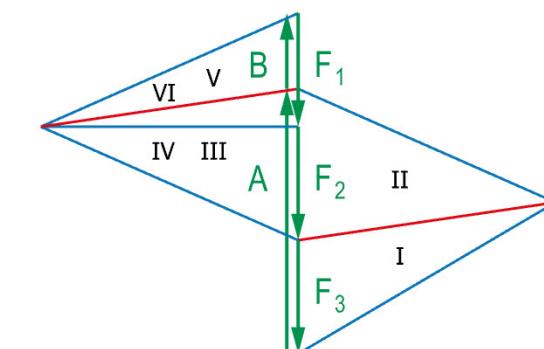
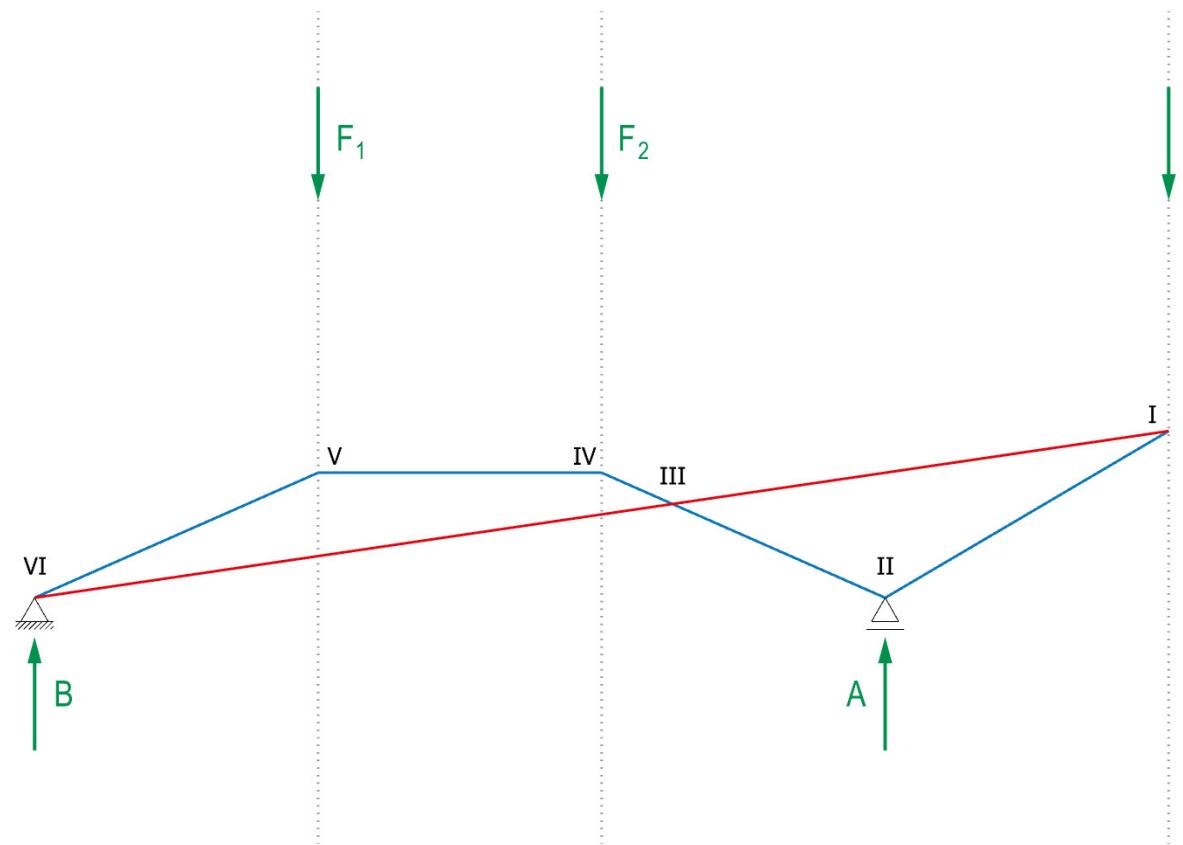
Lageplan 1:100
Form diagram 1:100

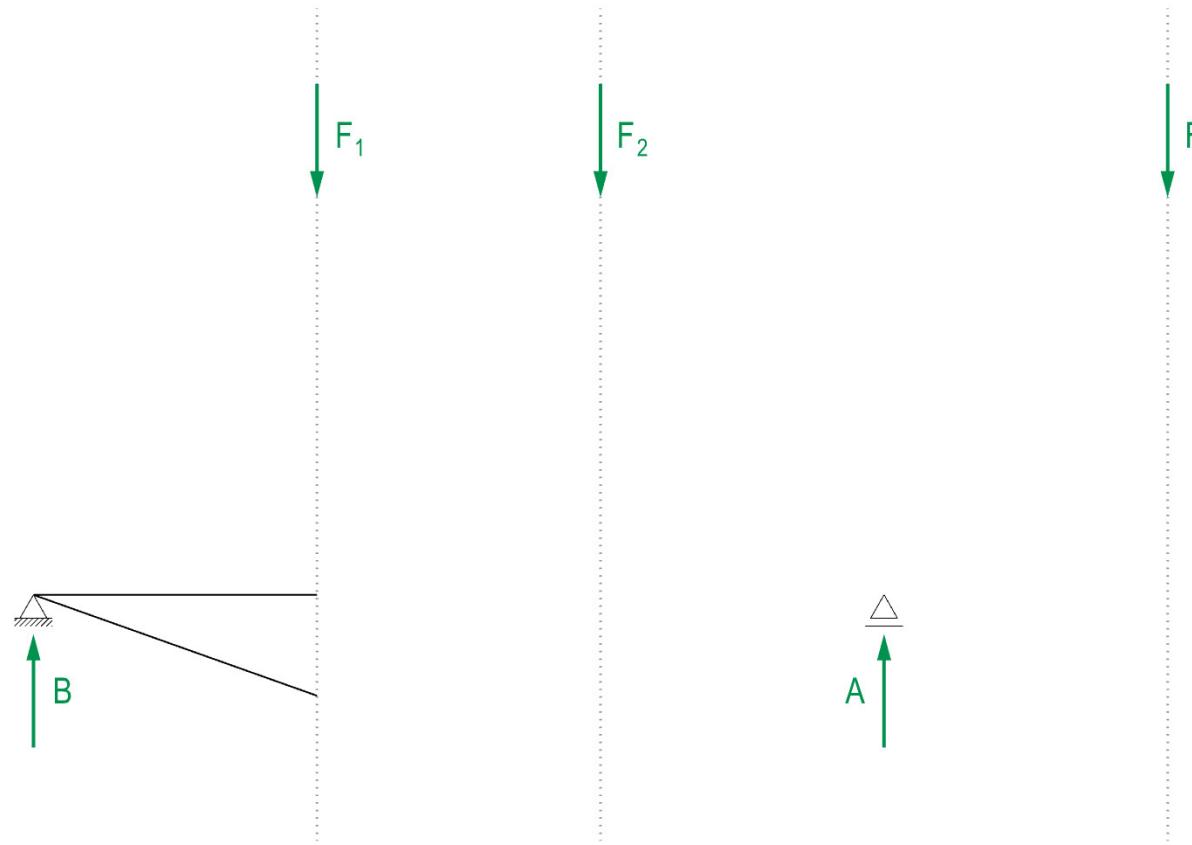


Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN







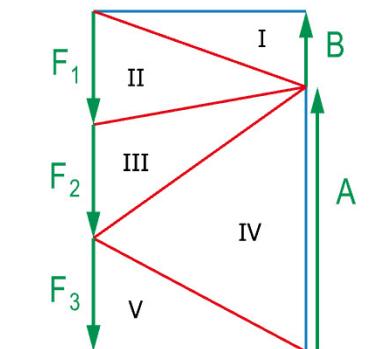
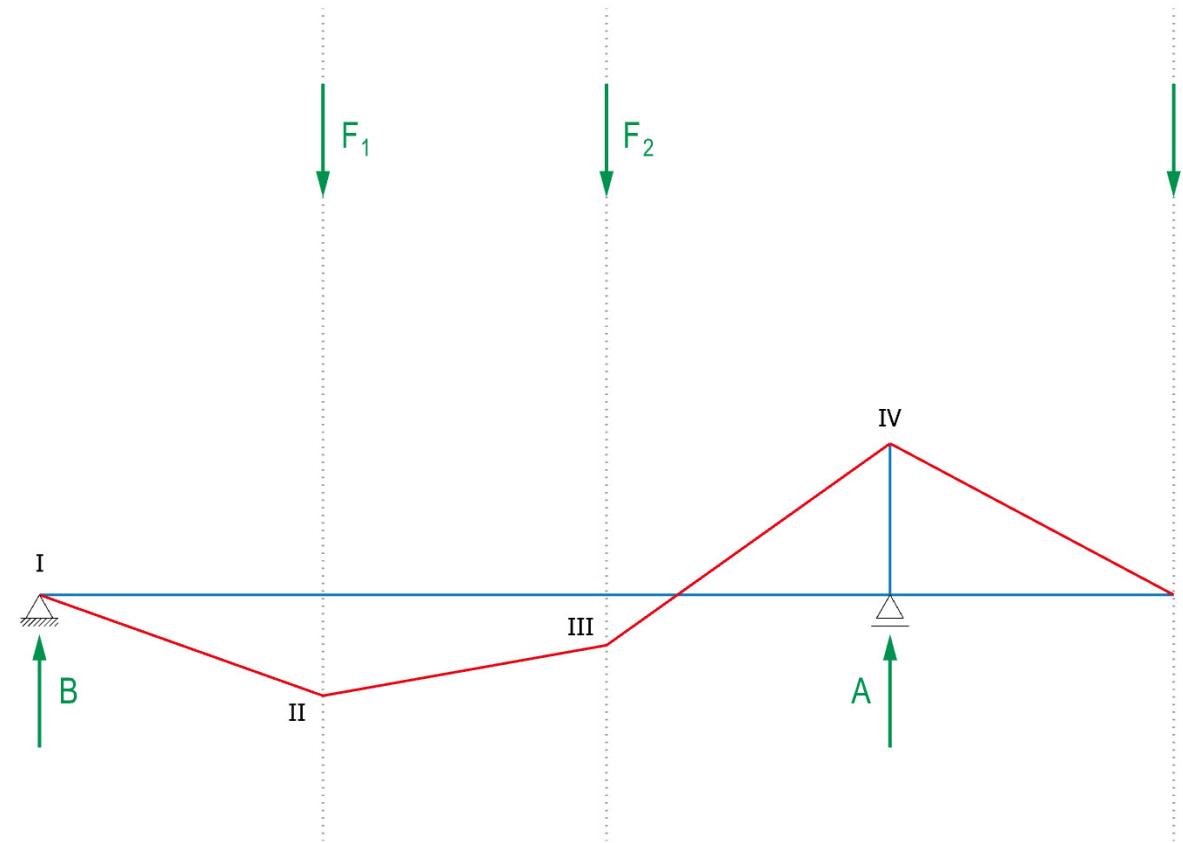


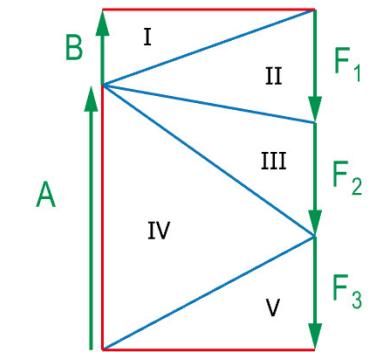
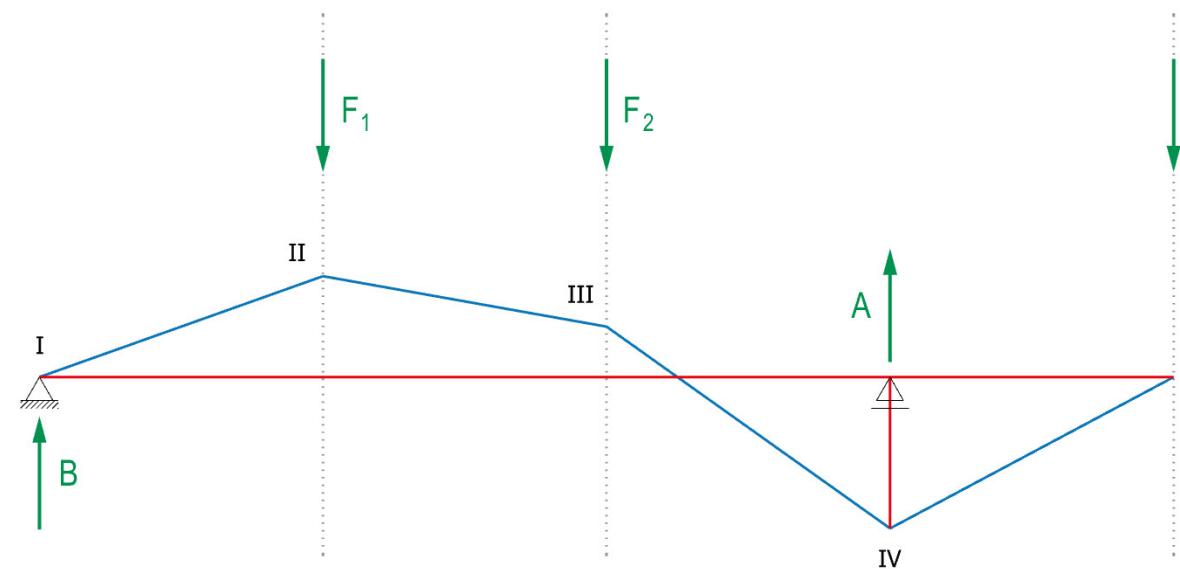
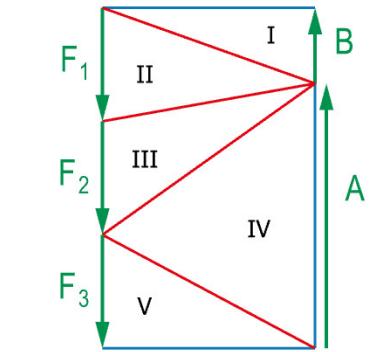
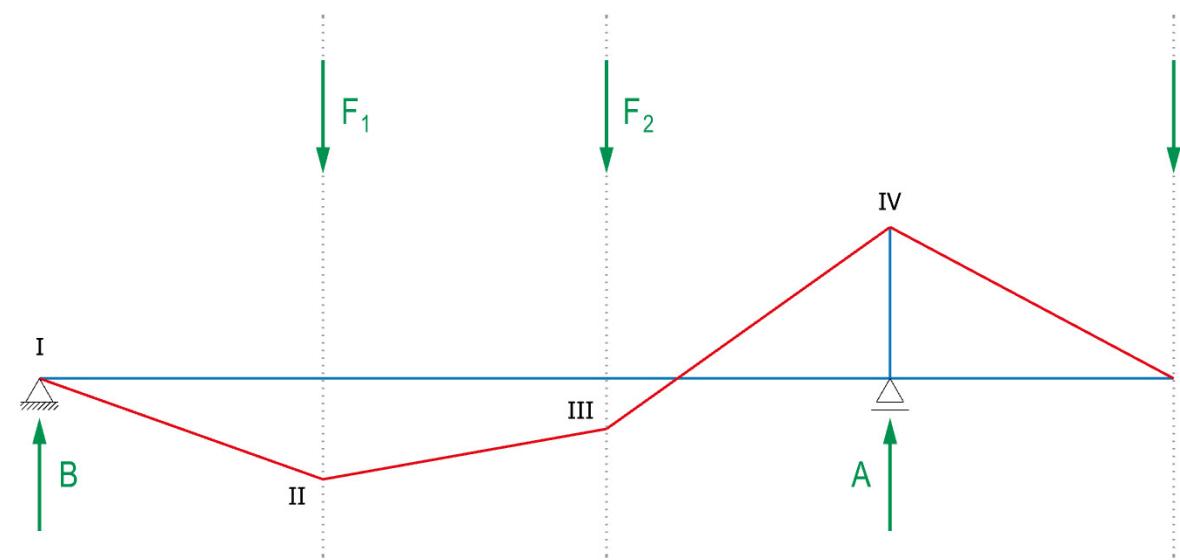
Lageplan 1:100

Form diagram 1:100

Kräfteplan 1 cm \triangleq 1 kN

Force diagram 1 cm \triangleq 1 kN



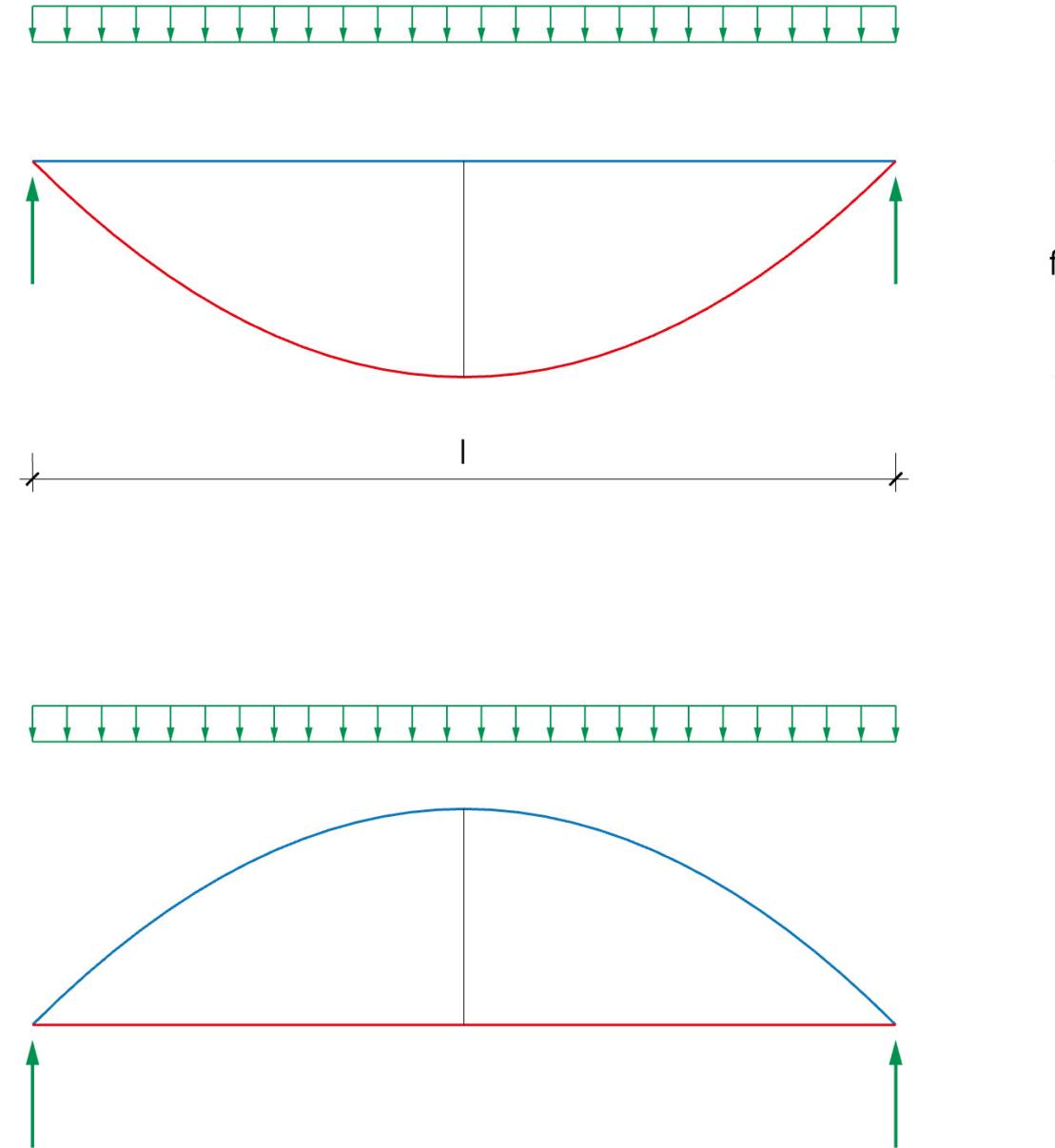


Lageplan 1:100

Form diagram 1:100

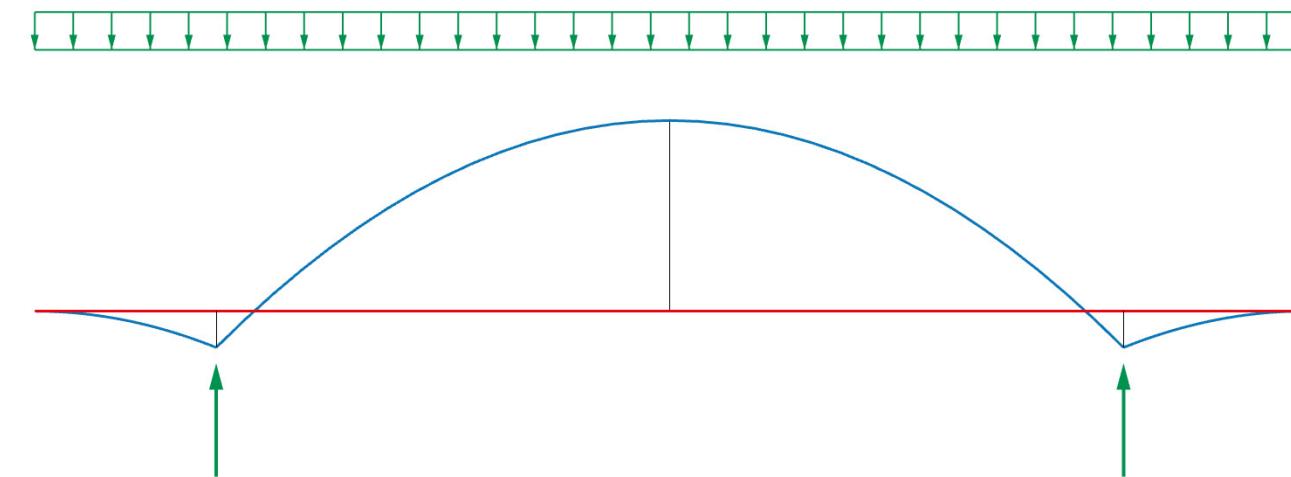
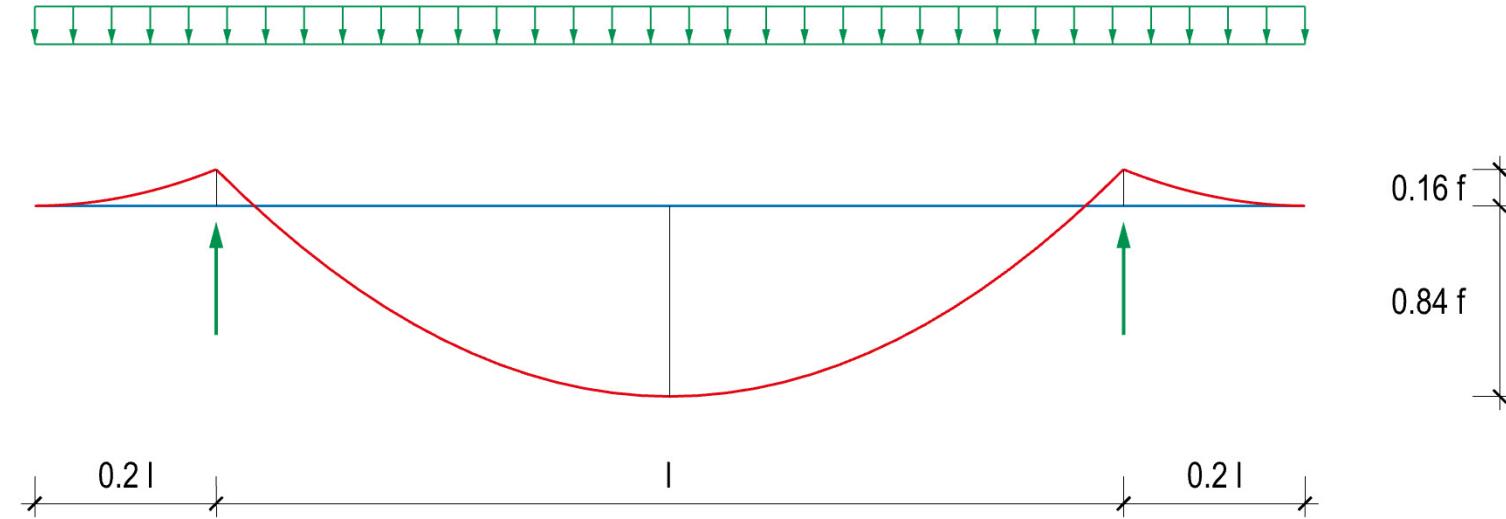
Kräfteplan 1 cm \triangleq 1 kN

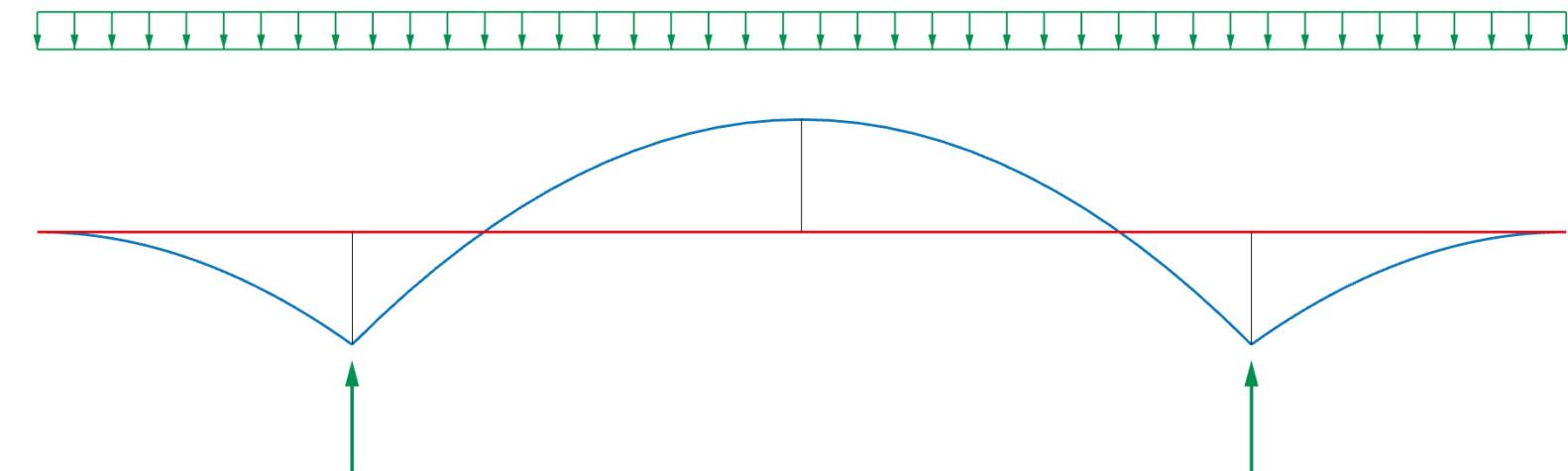
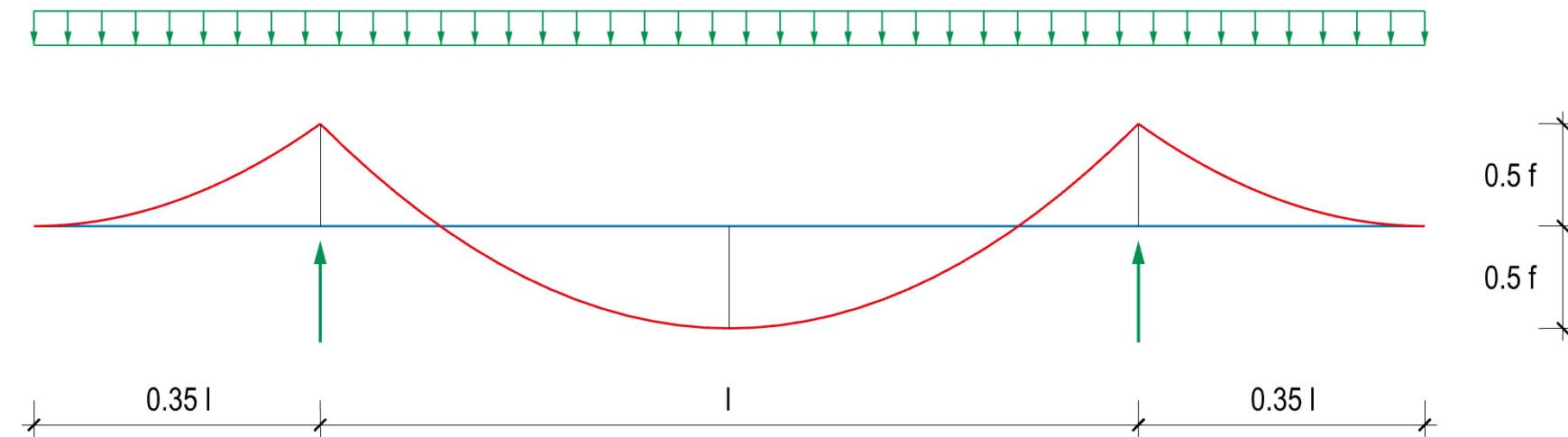
Force diagram 1 cm \triangleq 1 kN

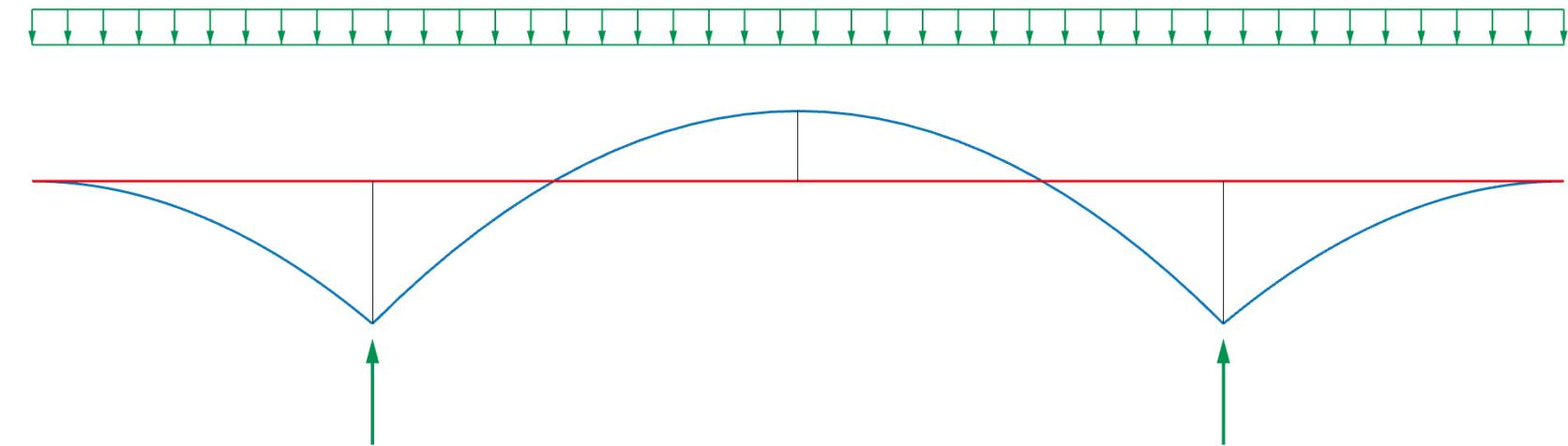
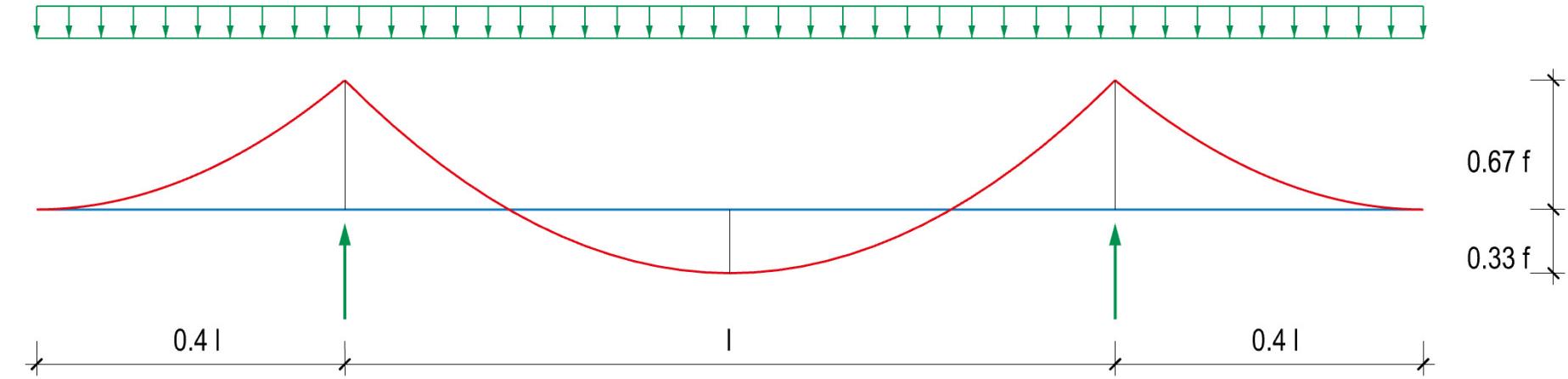


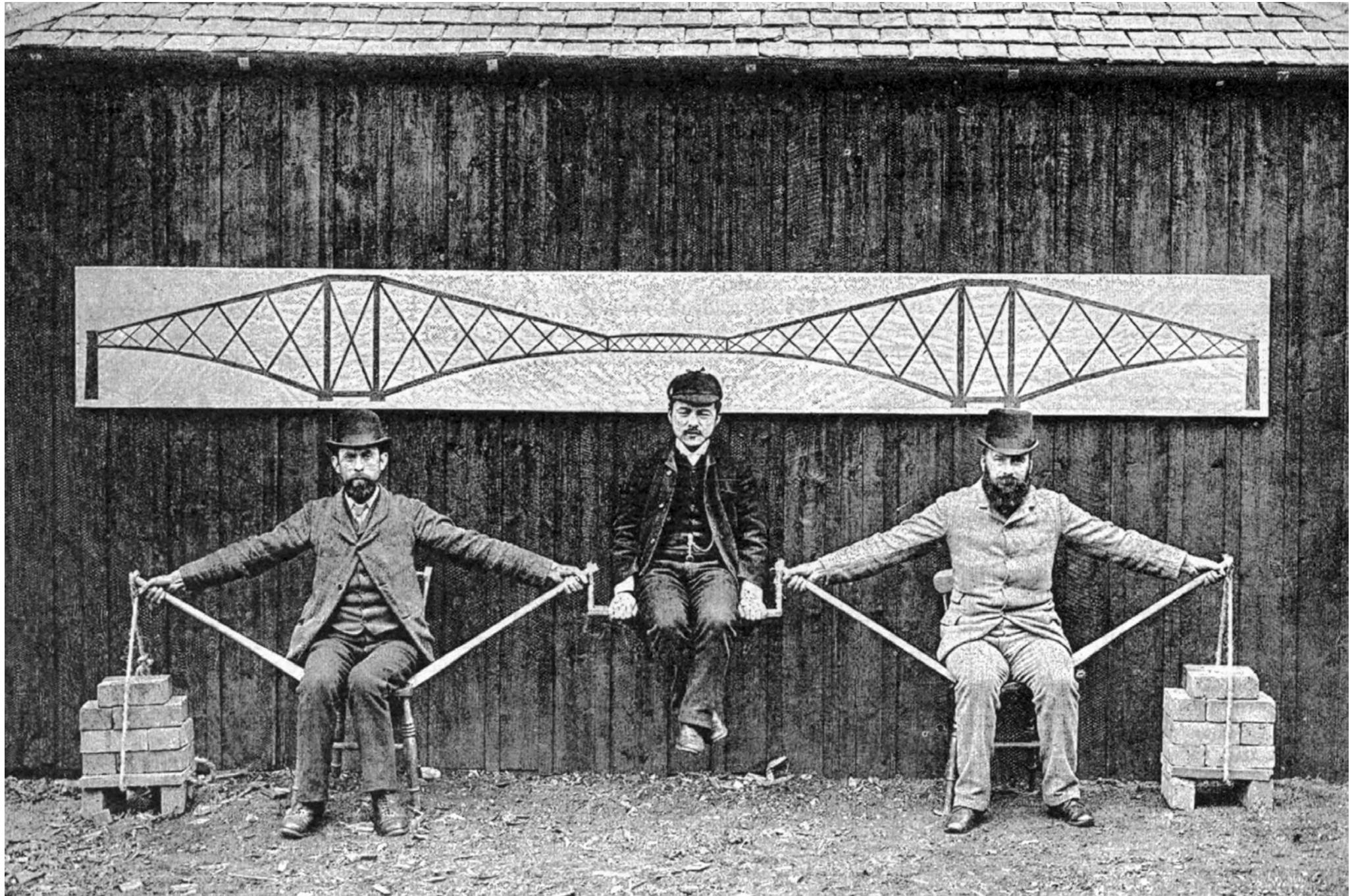
Lageplan 1:100
Form diagram 1:100

Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN

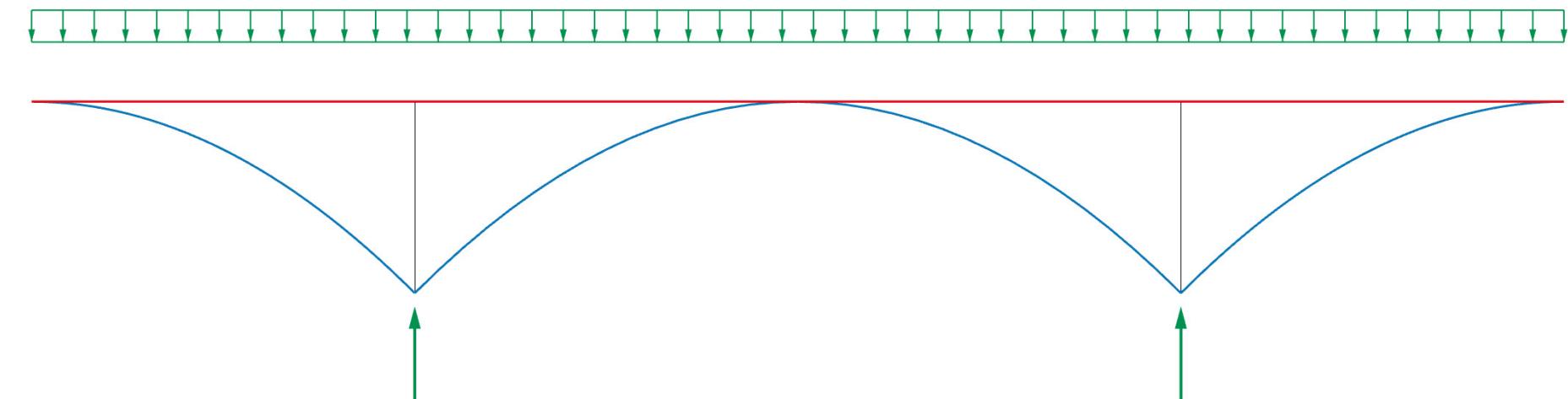
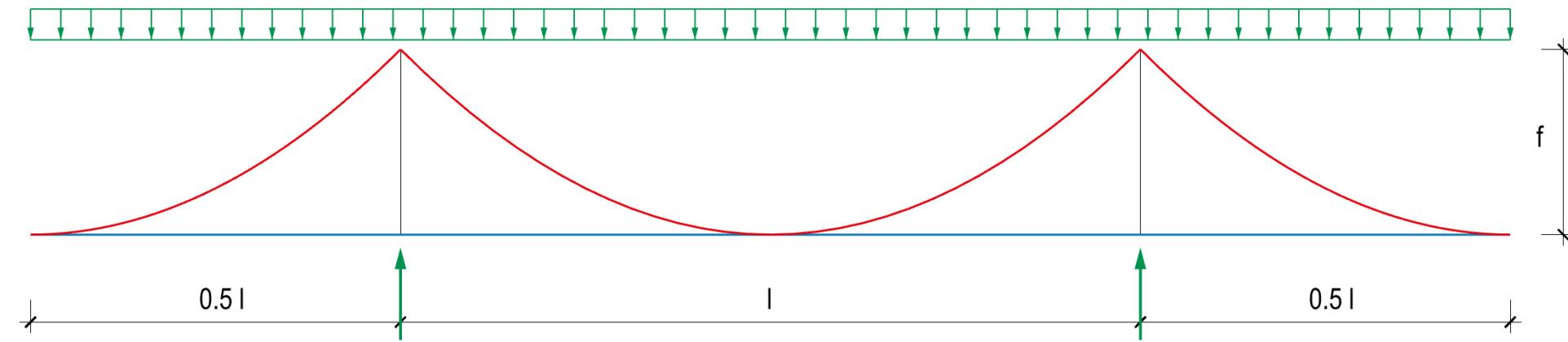






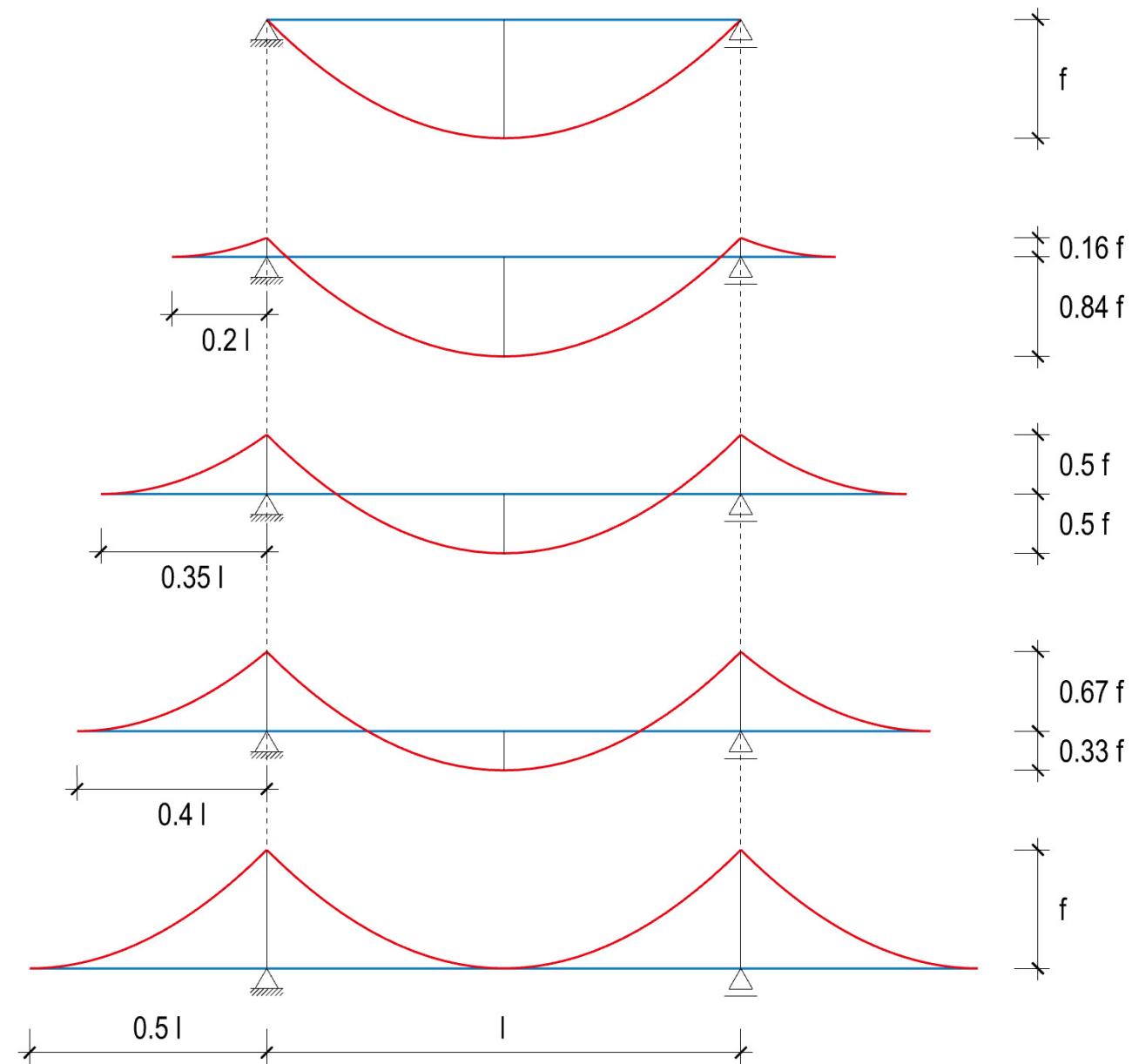


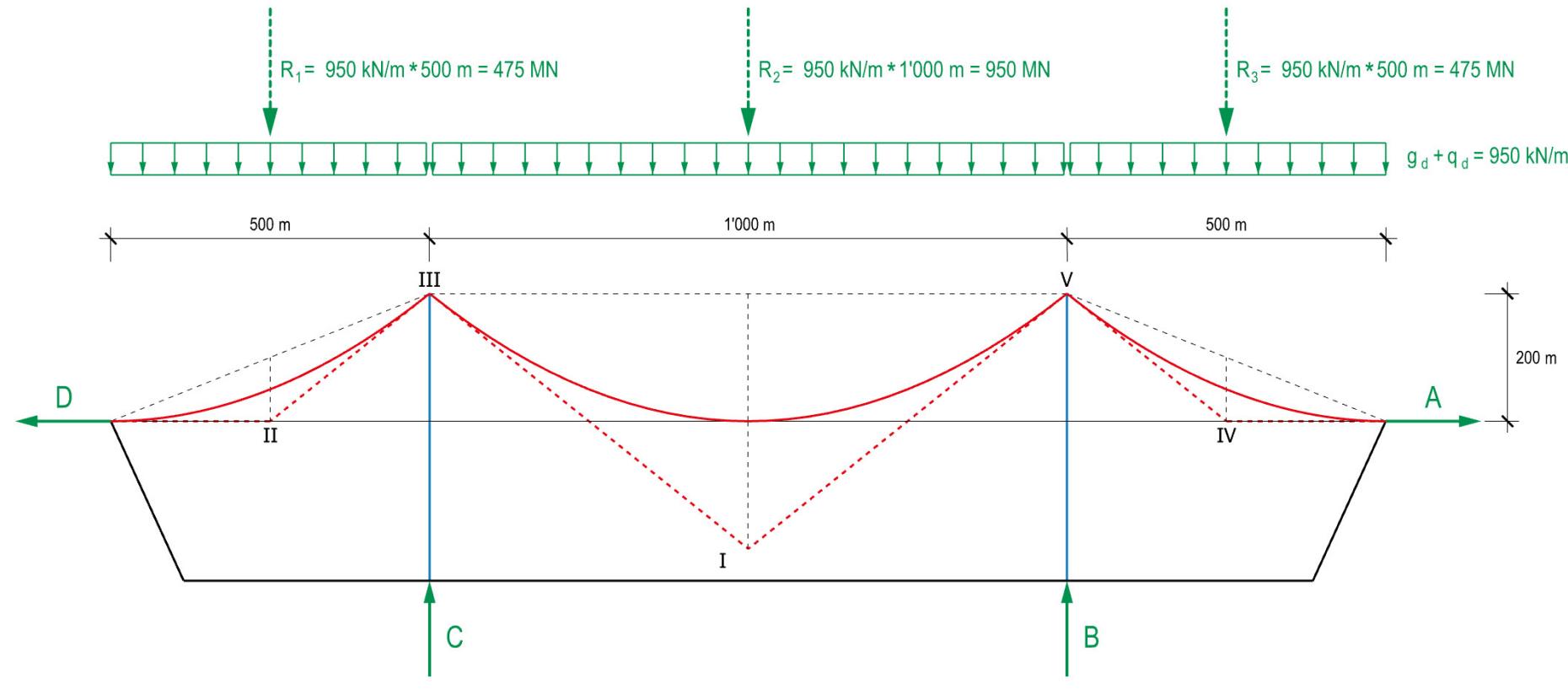
Sir John Fowler, Sir Benjamin Baker: Forth Bridge, South Quennsferry, 1890





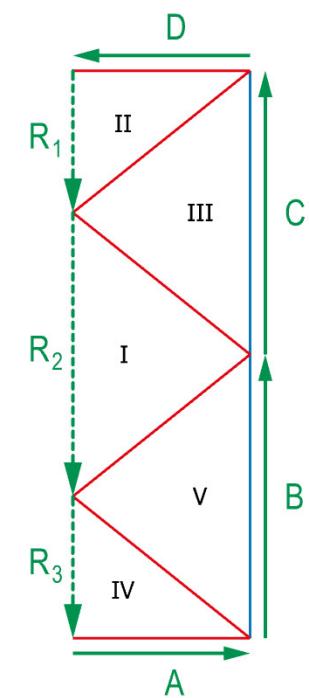
A. Fried: Rip-Bridge, Woy-Woy, Australien, 1971





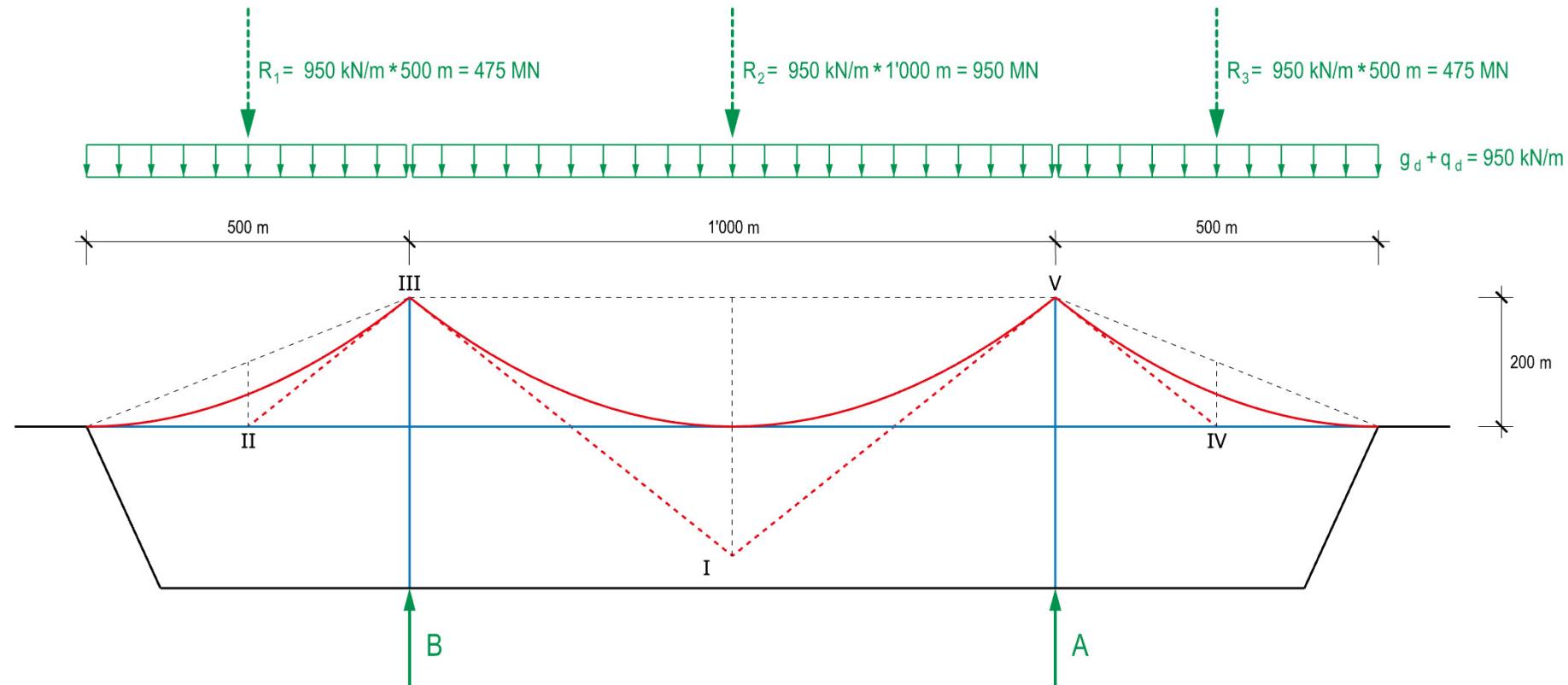
Lageplan

Form diagram

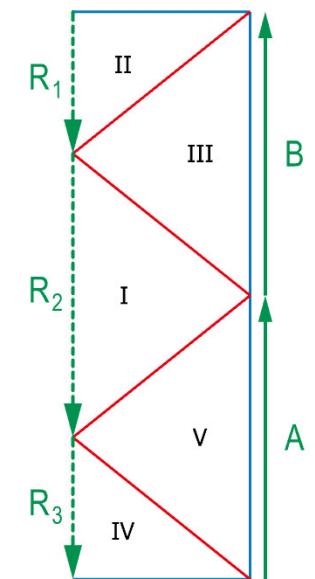


Kräfteplan

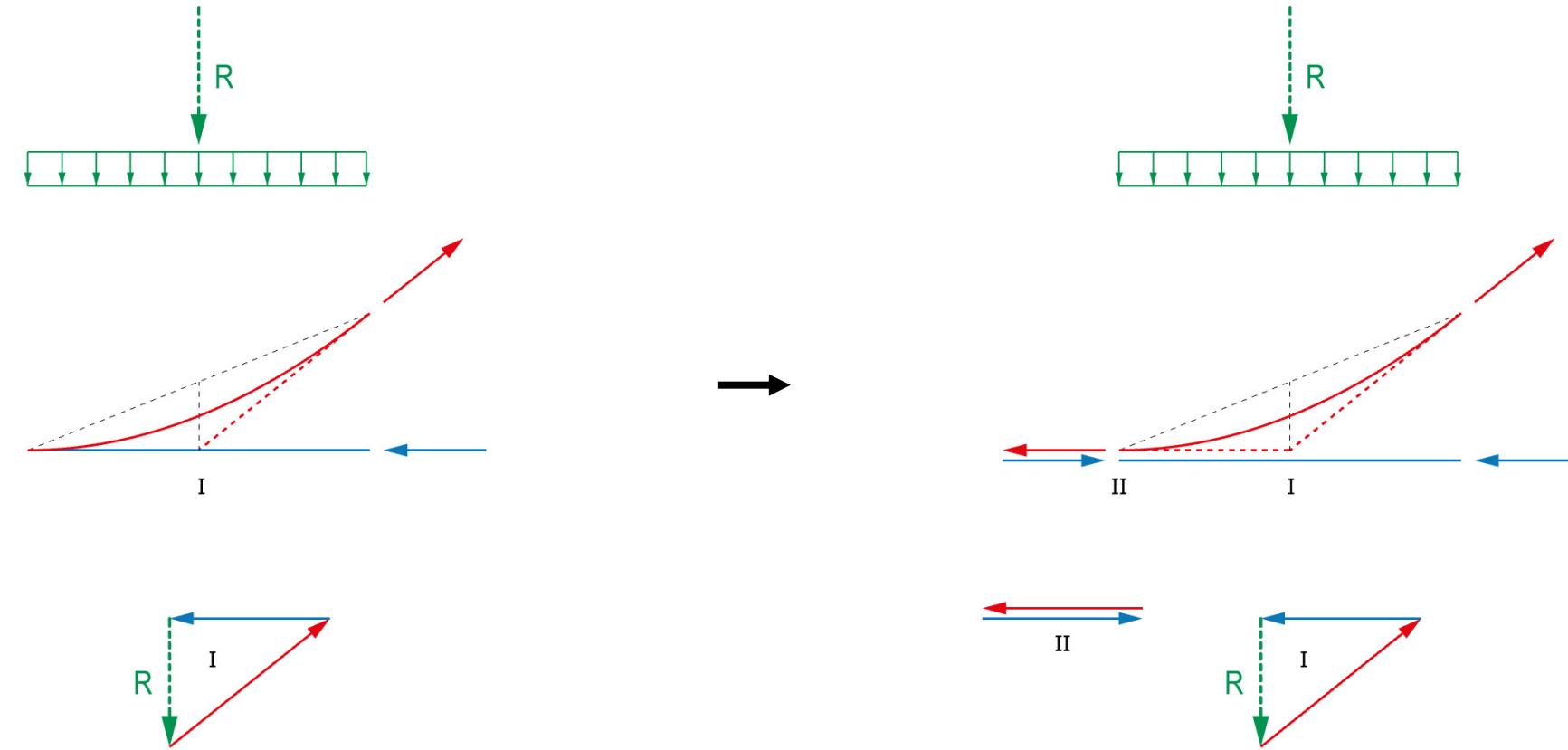
Force diagram

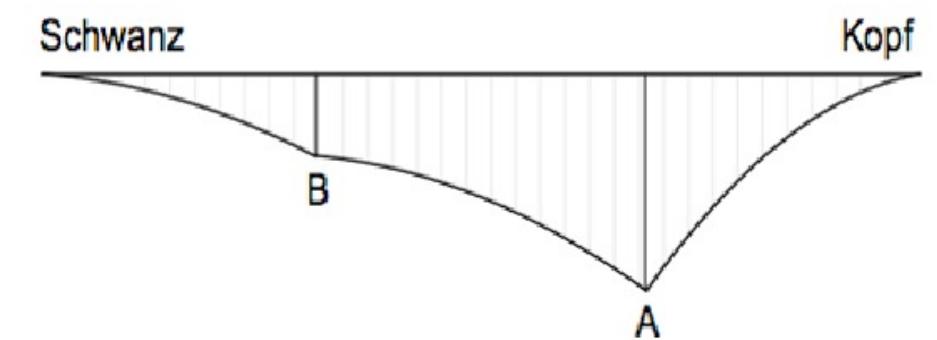
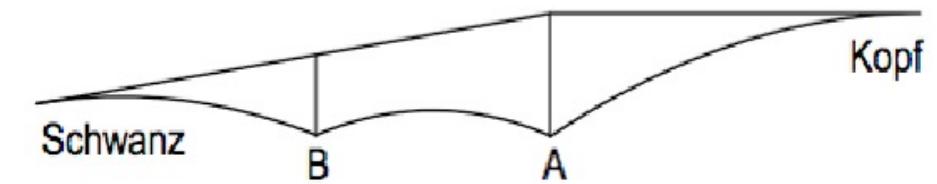
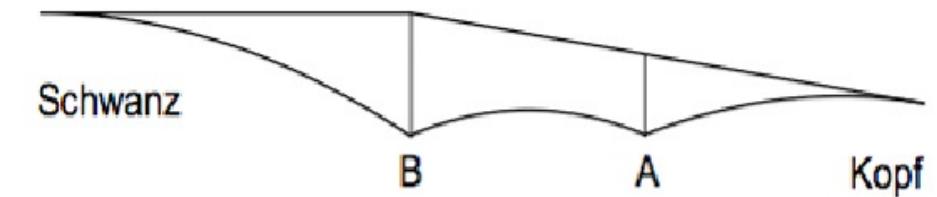
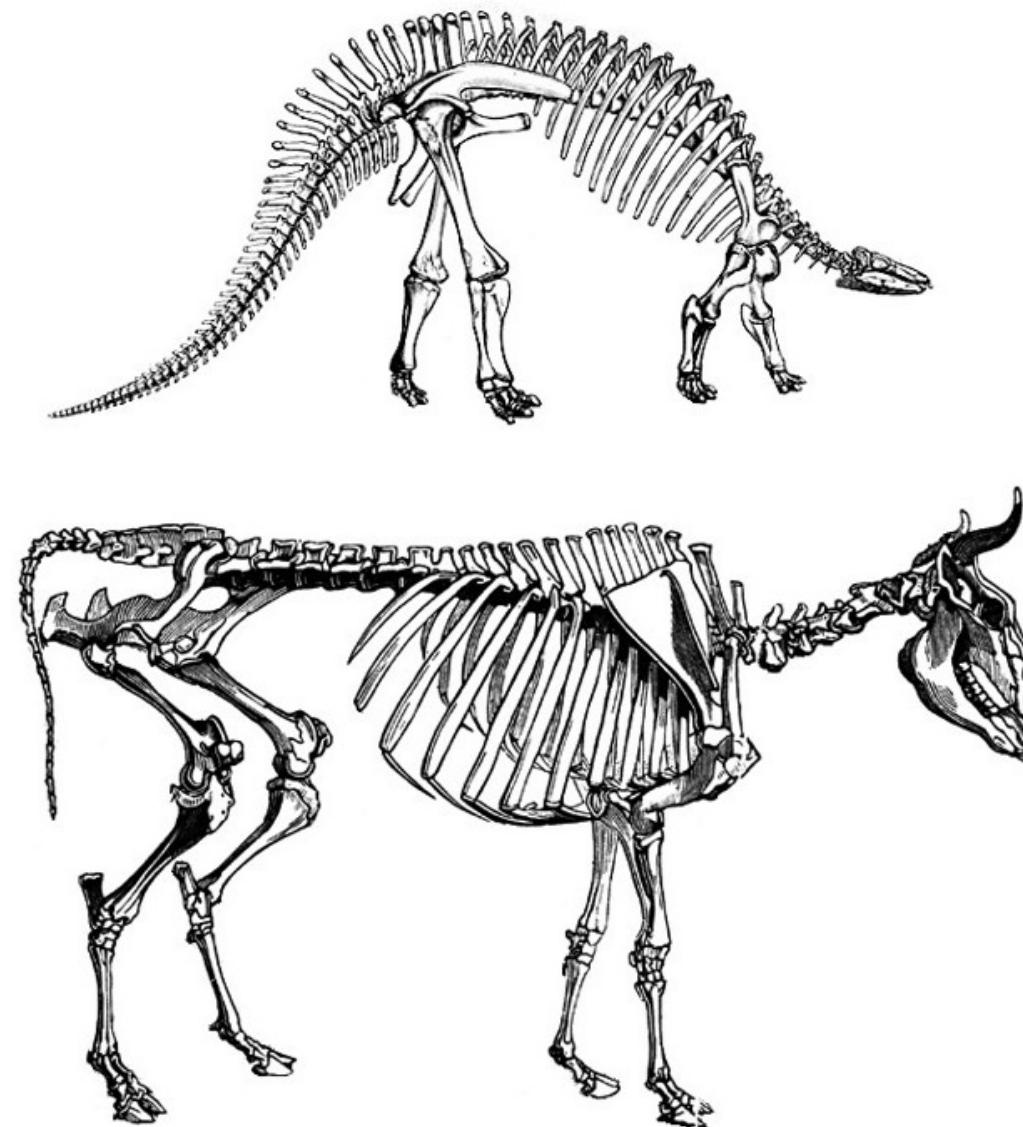


Lageplan
Form diagram

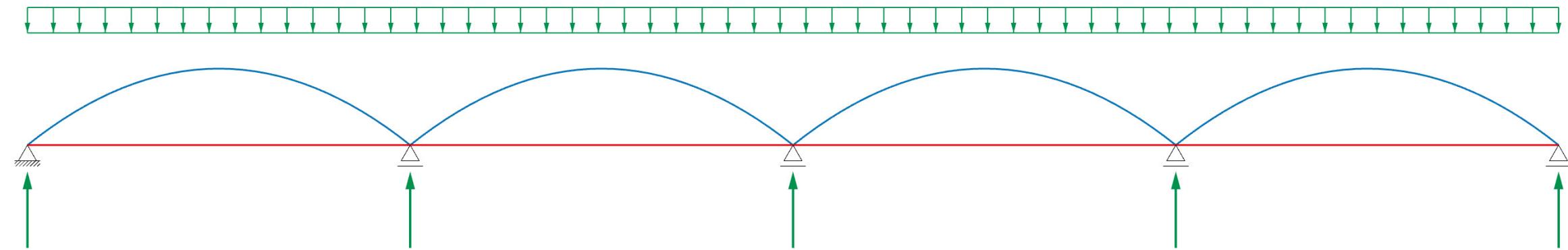


Kräfteplan
Force diagram





D'Arcy W. Thomson, „On growth and form“, 1917

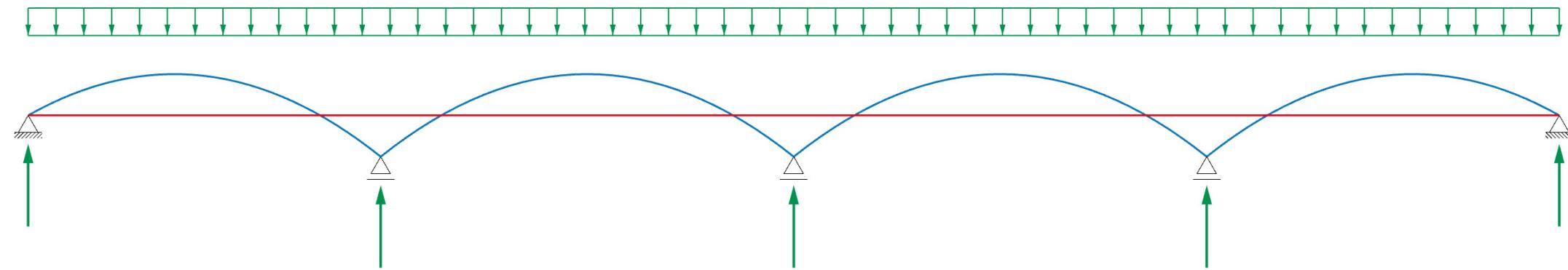


Durchlaufträger

Continuous beam

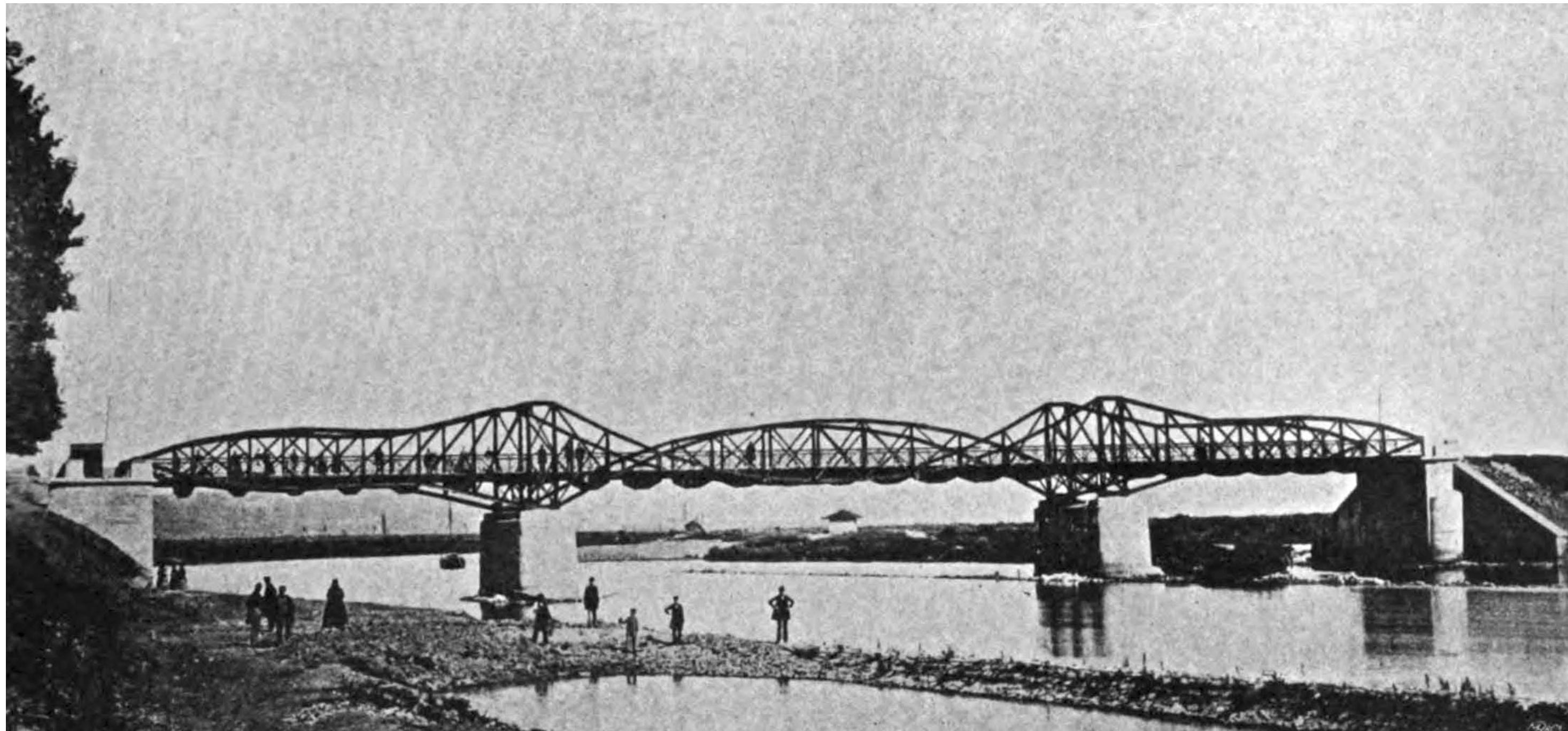


Eisenbahnbrücke, Riga, Lettland, 1914

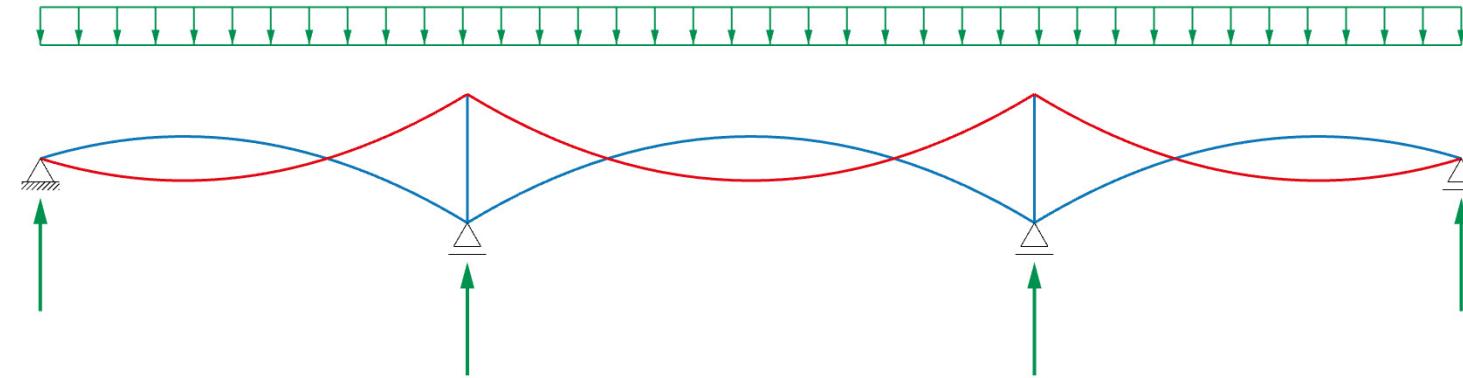


Durchlaufträger

Continuous beam



Heinrich Gerber: Hassfurt Brücke, Hassfurt, 1867



Durchlaufträger

Continuous beam

Bogen-Seil-Tragwerke

Arch-cable structures

Tragwirkung einfacher Bogen-Seil-Tragwerke

Structural behaviour of simple arch-cable structures

Auflagerbedingungen

Support conditions

Aufteilung der äusseren Lasten

Distribution of external loads

Formfindung eines überspannenden Bogen-Seils

Form-finding of a spanning arch-cable

Konsolenartige Bogen-Seil-Tragwerke

Cantilevering arch-cable structures

Geometrische Variation

Geometric variation

Zusammengesetzte Bogen-Seil-Tragwerke

Combined arch-cables

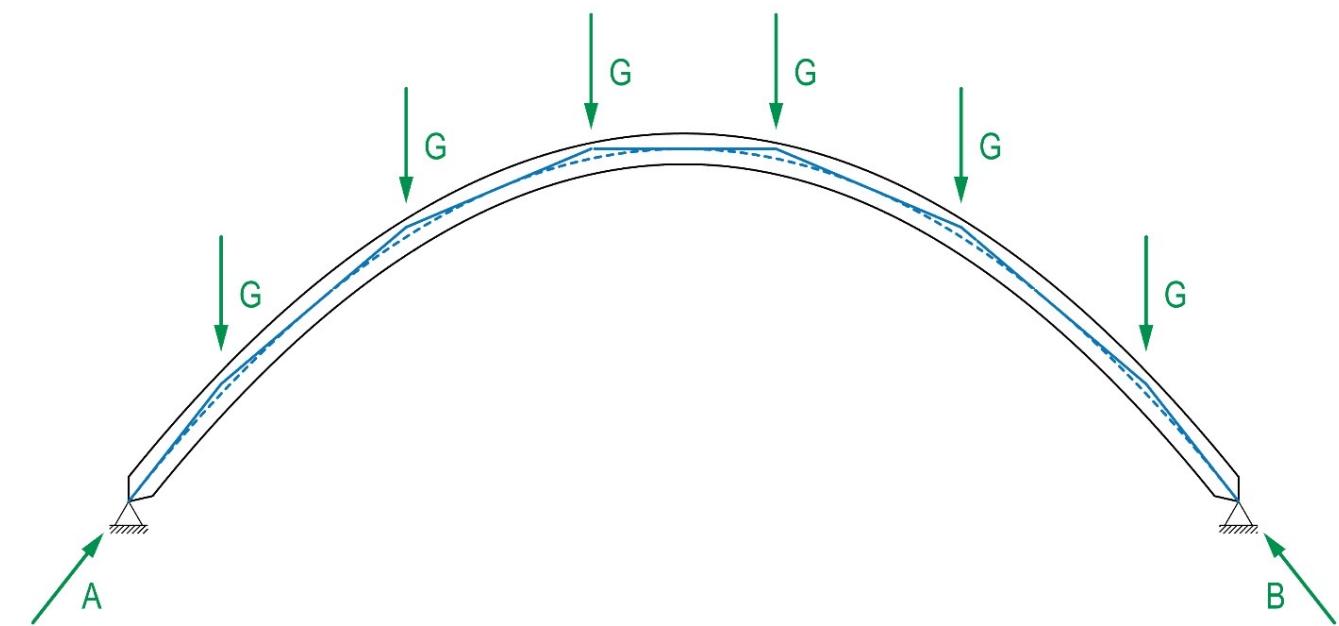
>>

Fallbeispiele

Case studies

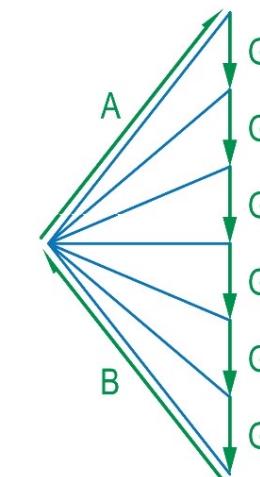


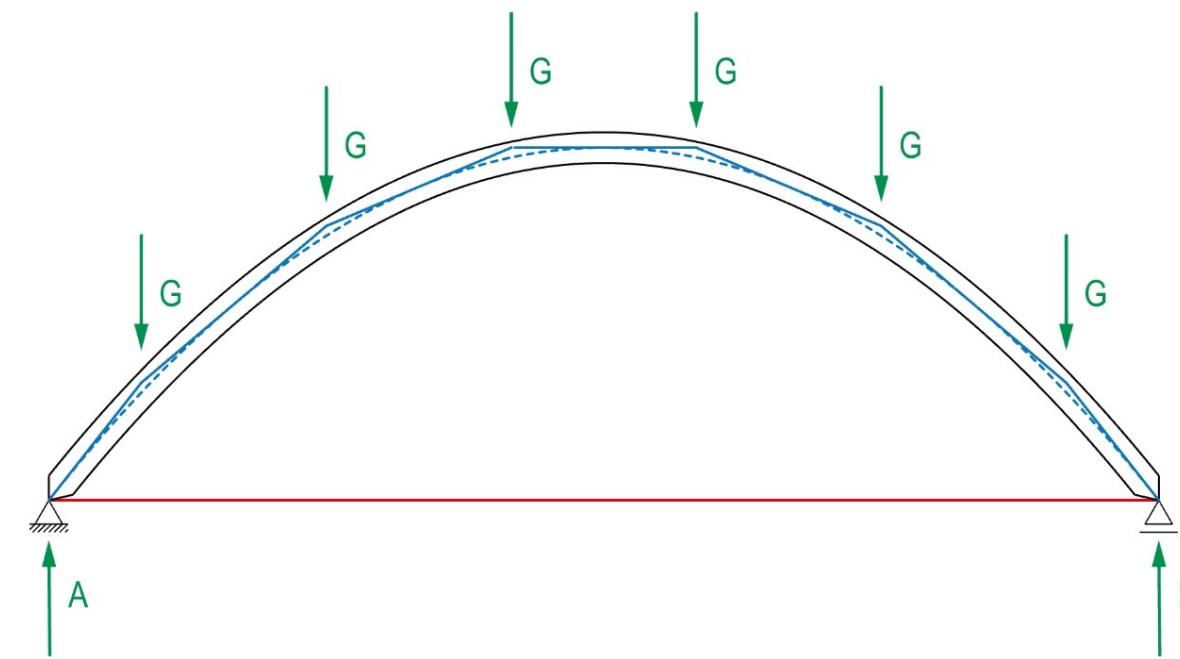
R. Brosi & Obrist and Partner, Peter Rice: Bus station Chur, 1992



Lageplan 1:100

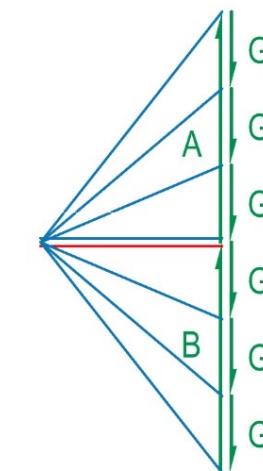
Form diagram 1:100

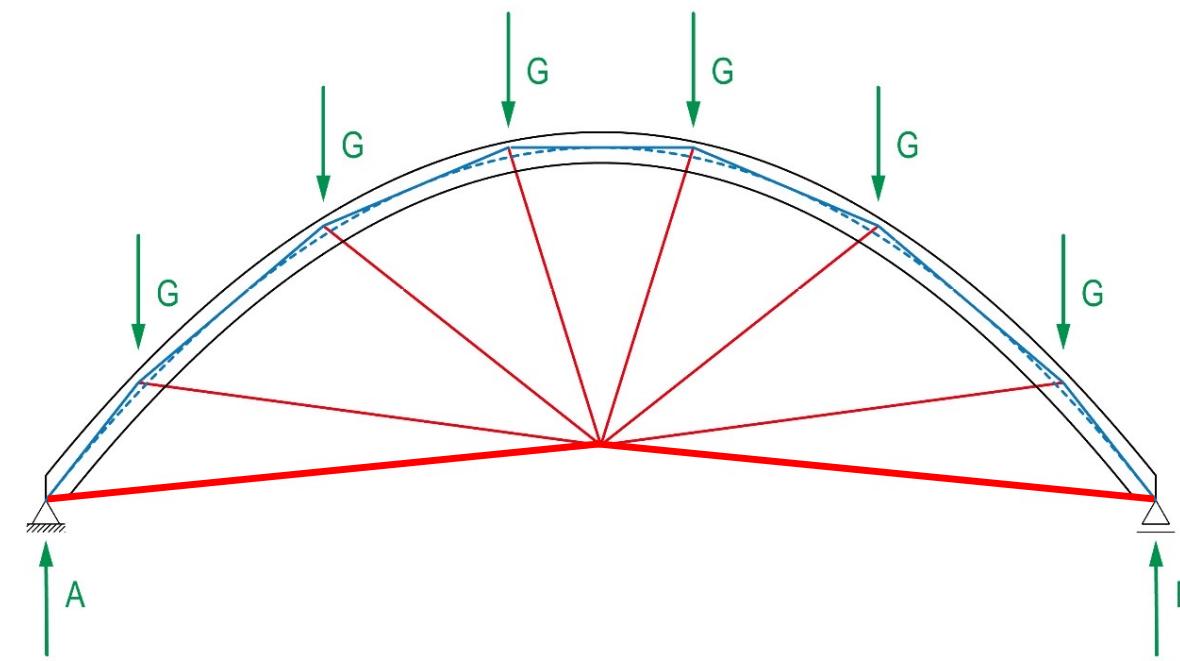
Kräfteplan 1 cm \triangleq 1 kNForce diagram 1 cm \triangleq 1 kN



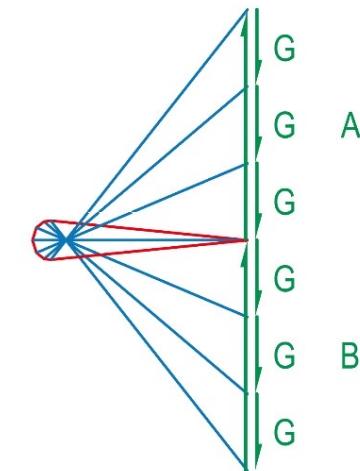
Lageplan 1:100

Form diagram 1:100

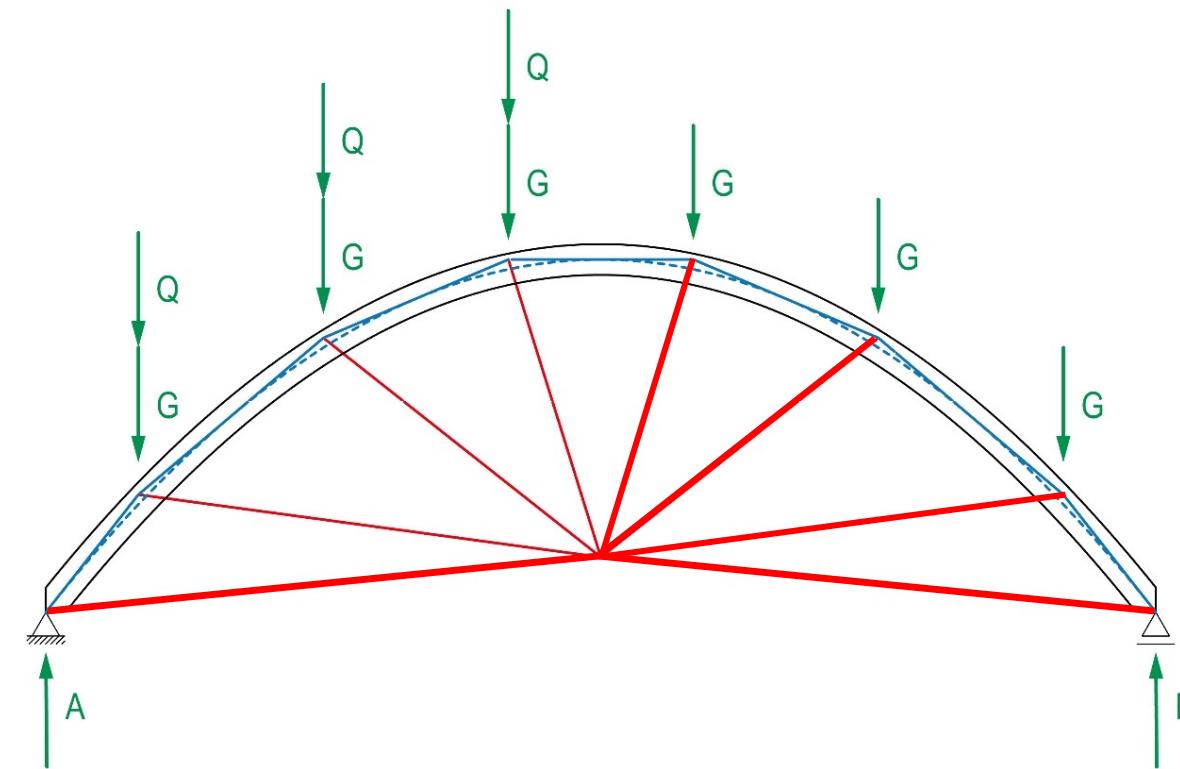
Kräfteplan 1 cm \triangleq 1 kNForce diagram 1 cm \triangleq 1 kN



Lageplan 1:100
Form diagram 1:100

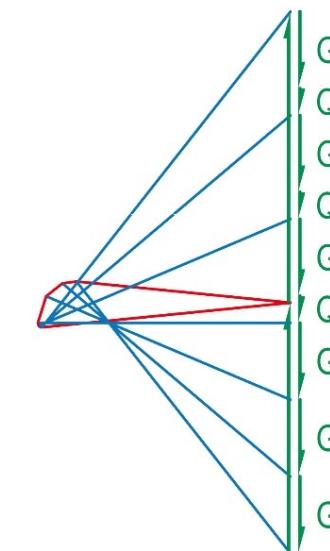


Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN



Lageplan 1:100

Form diagram 1:100

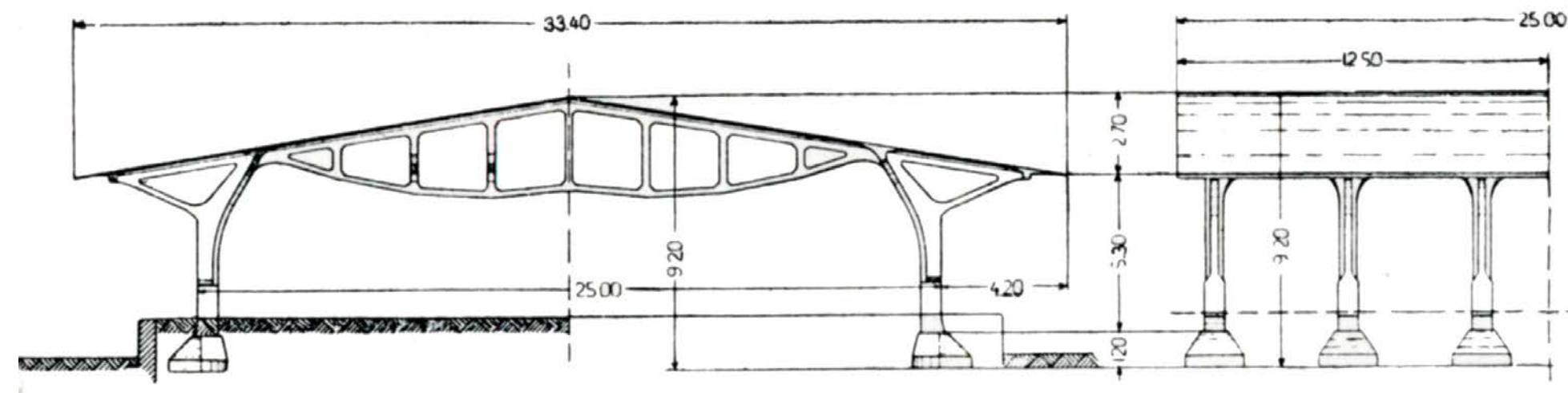
Kräfteplan 1 cm \triangleq 1 kNForce diagram 1 cm \triangleq 1 kN



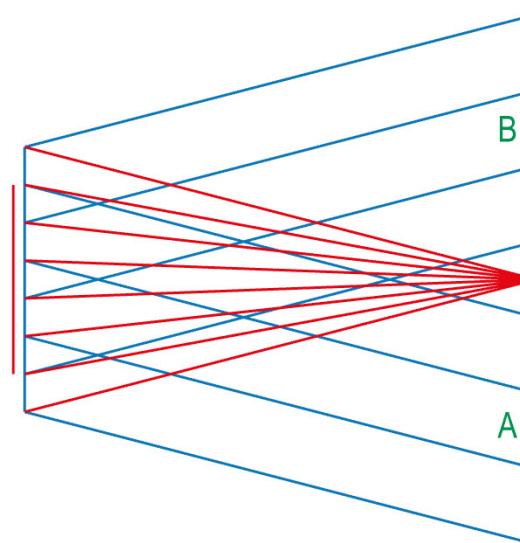
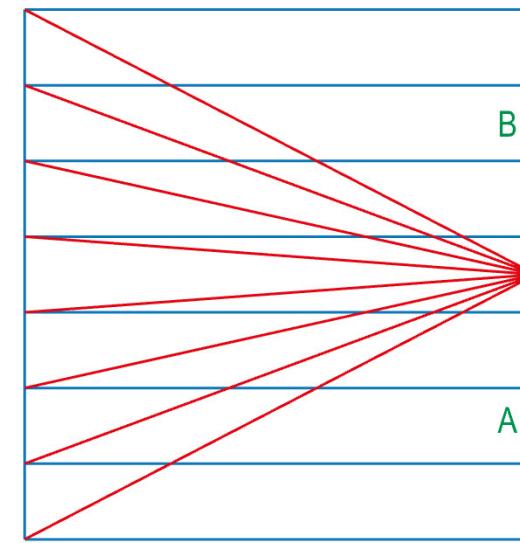
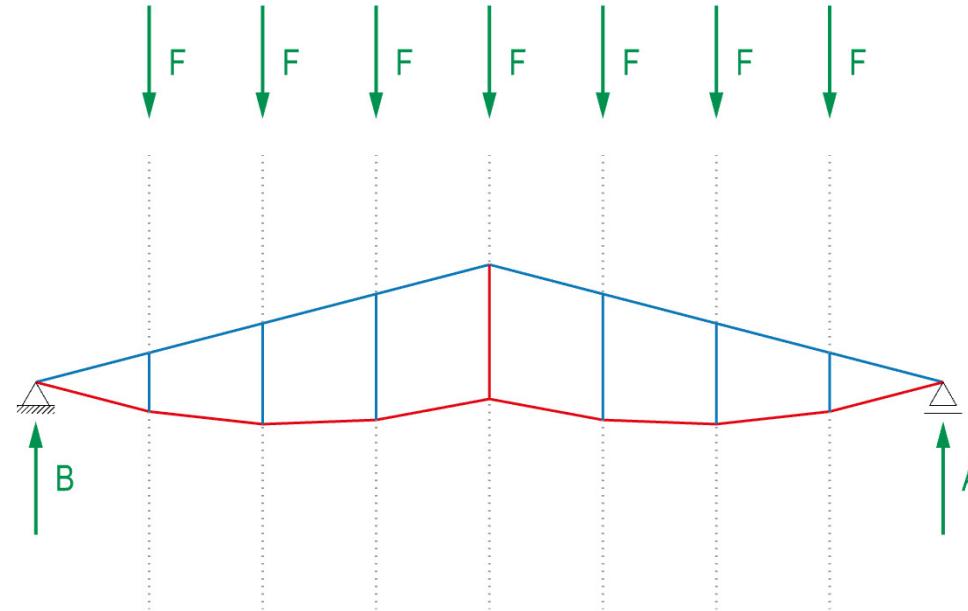
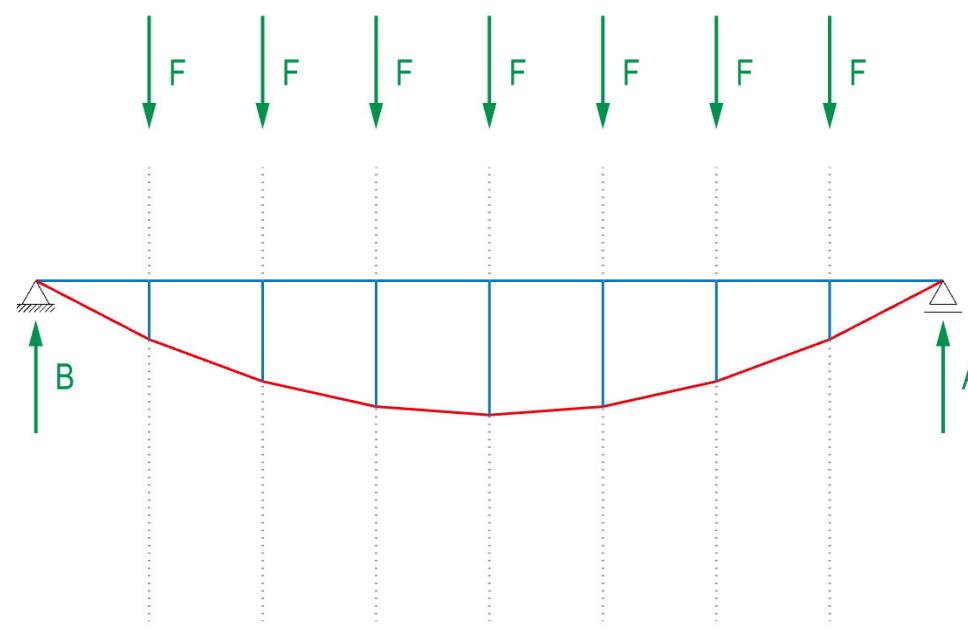
R. Brosi & Obrist and Partner, Peter Rice: Bus station Chur, 1992

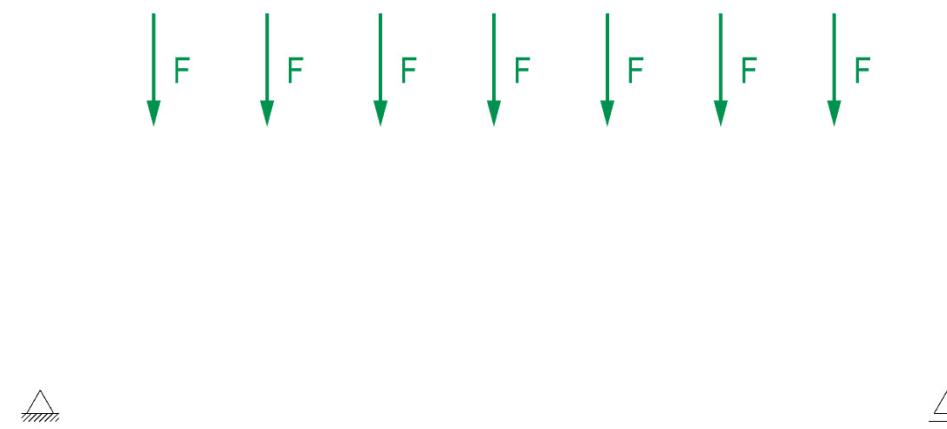


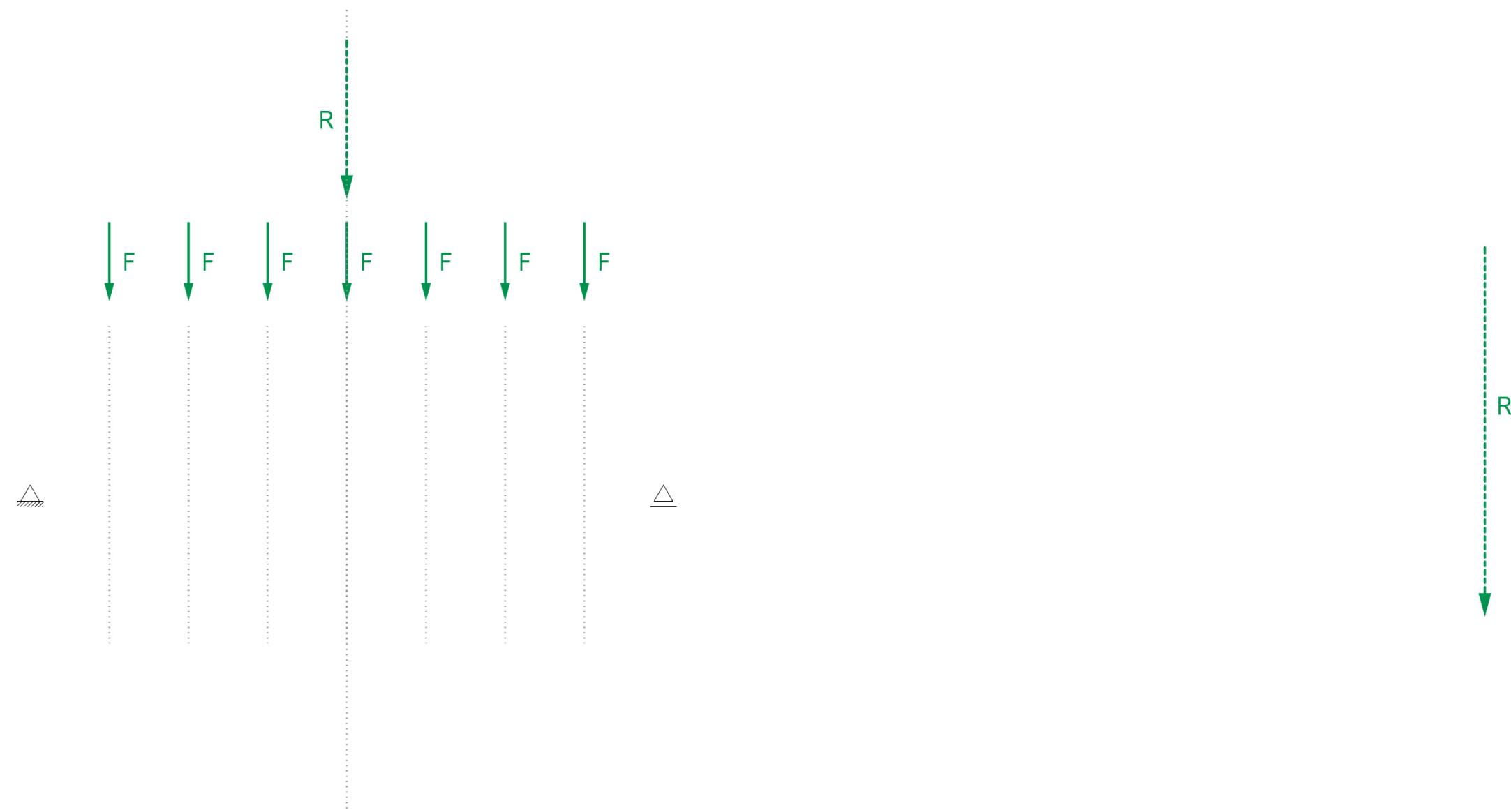
Robert Maillart: Magazzini Generali, Chiasso, 1924

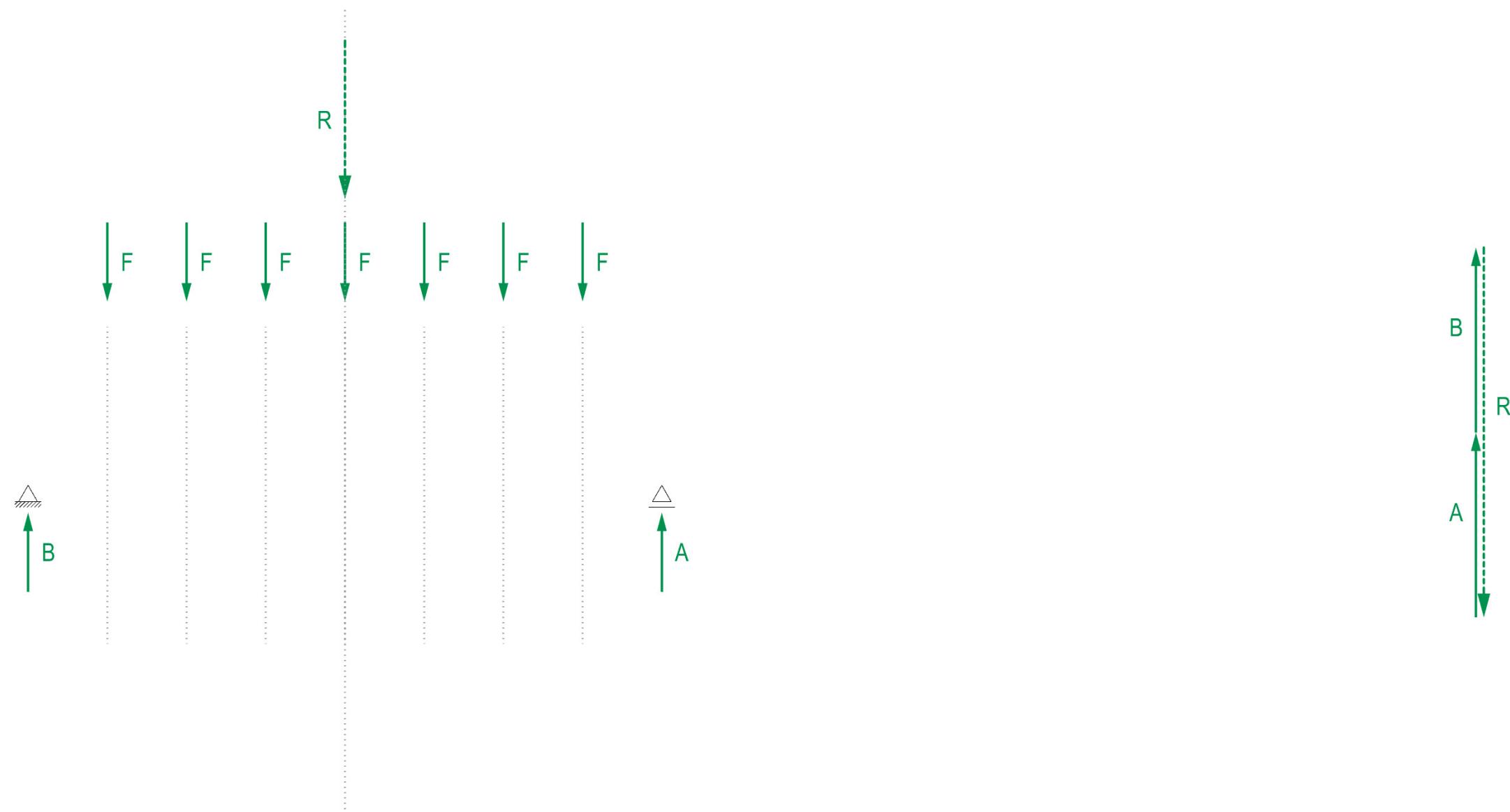


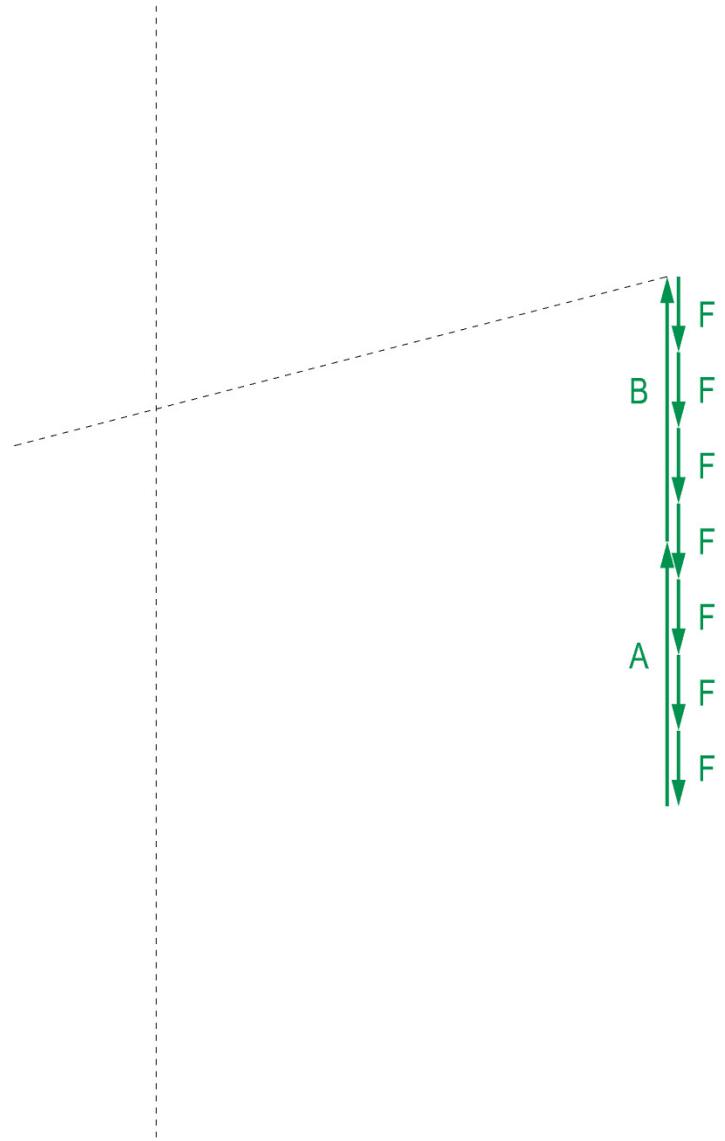
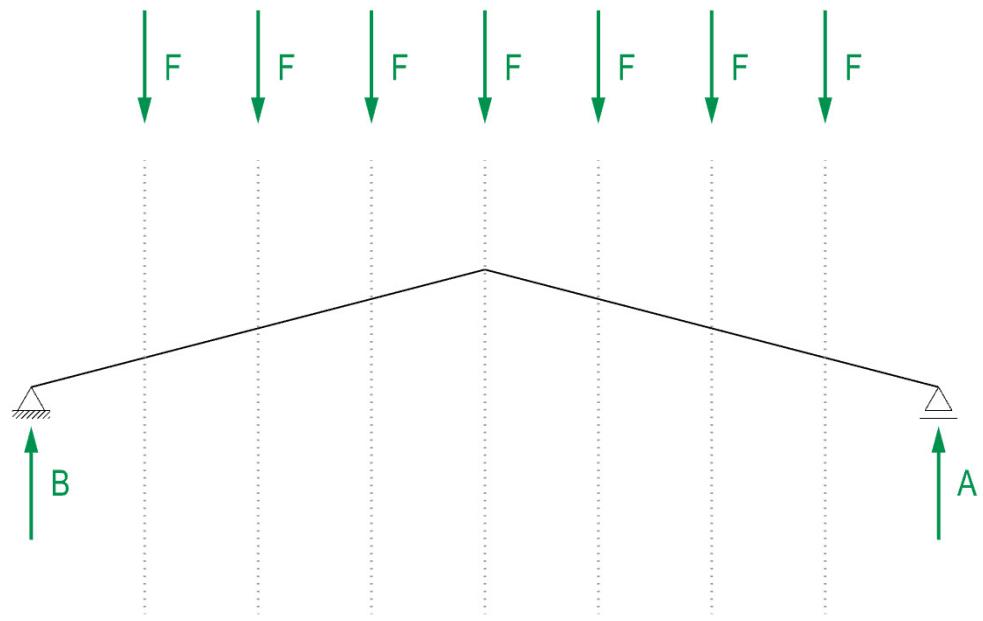
Robert Maillart: Lagerhaus Magazzini Generali, Chiasso, 1925

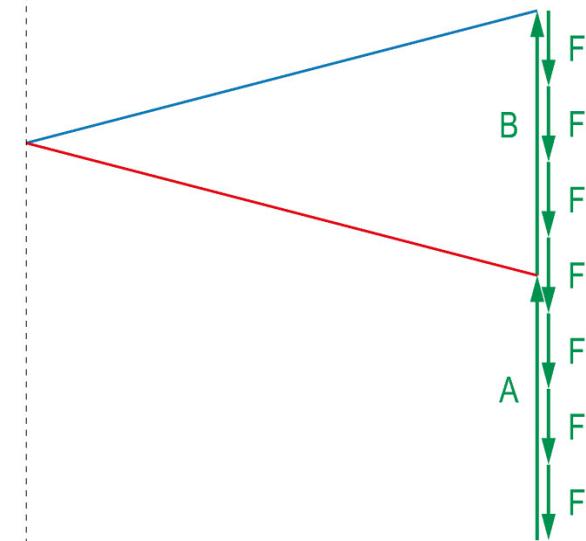
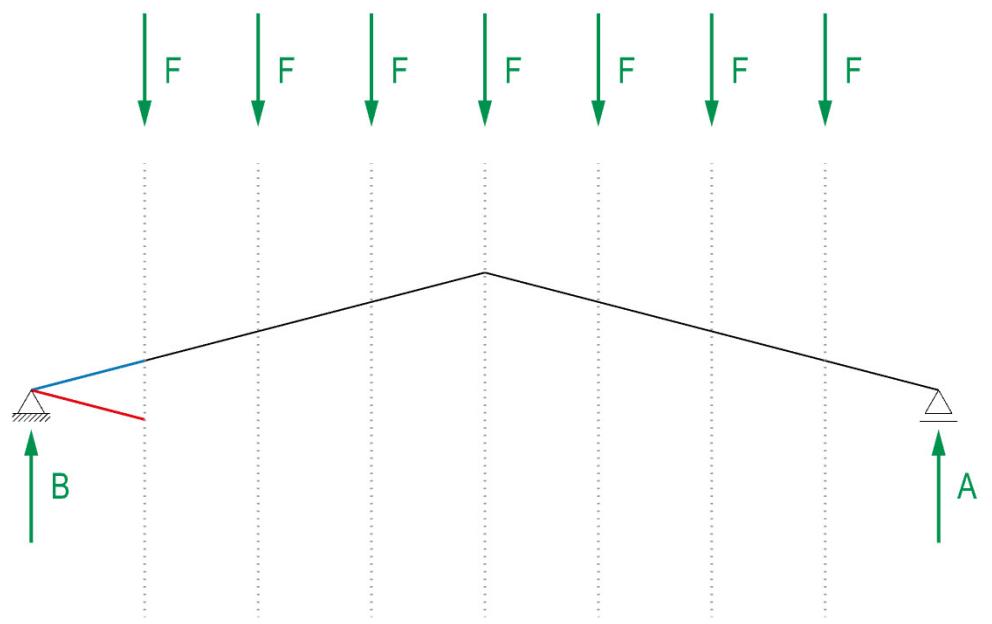


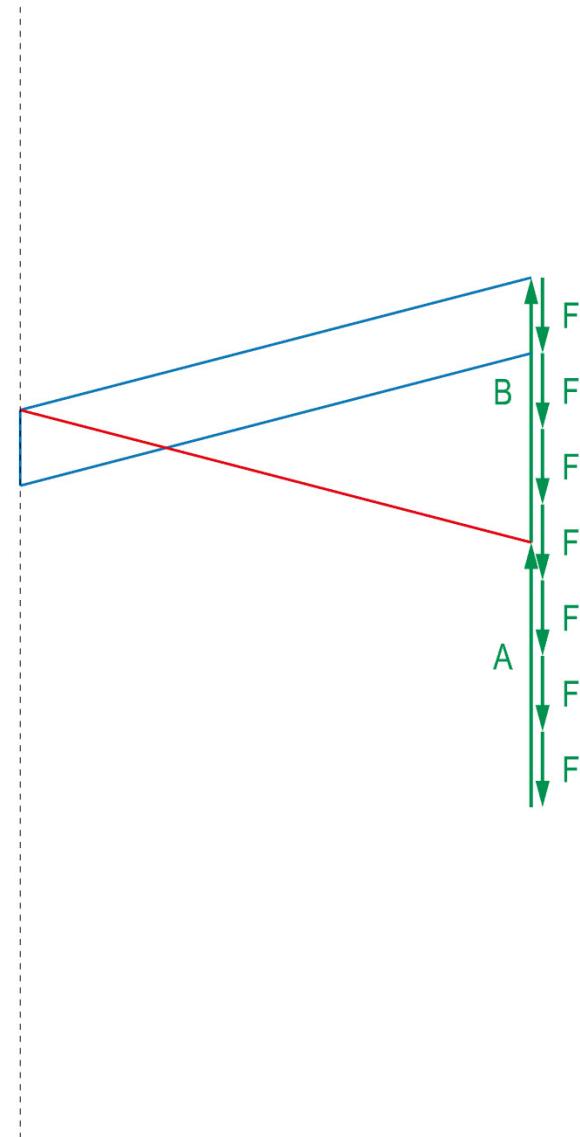
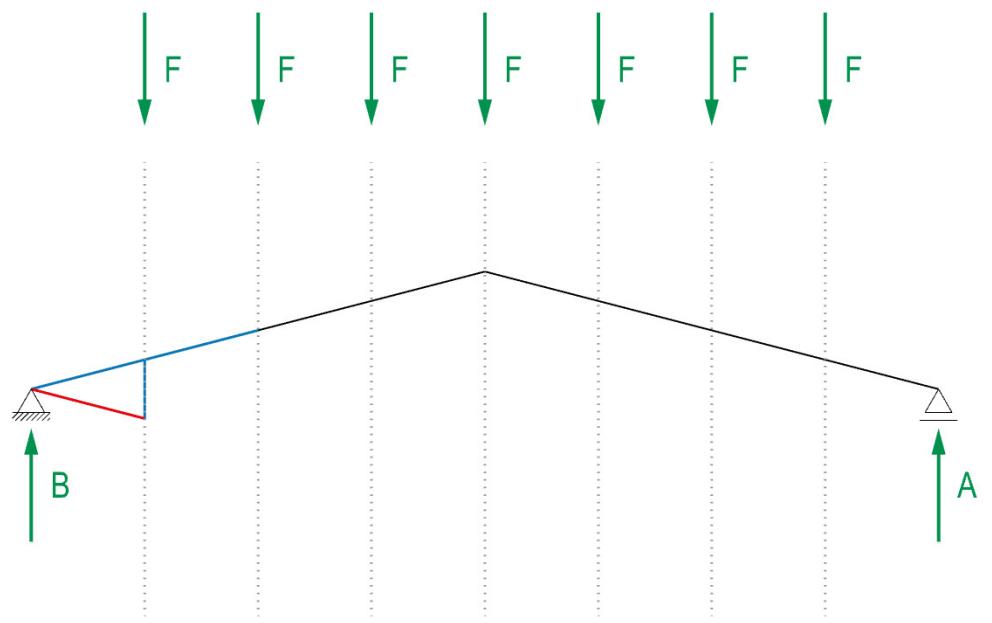


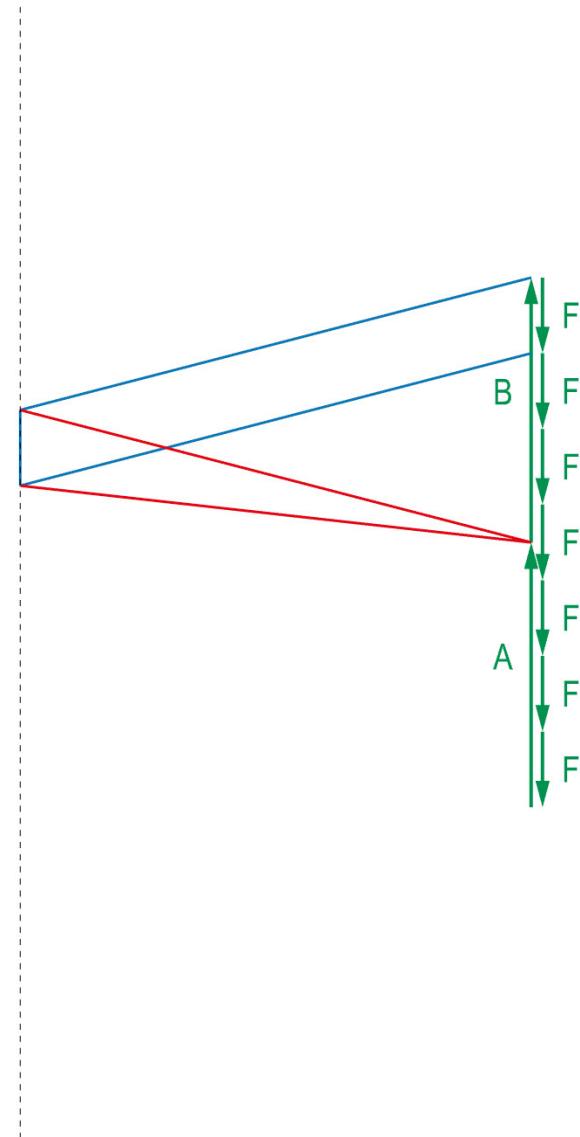
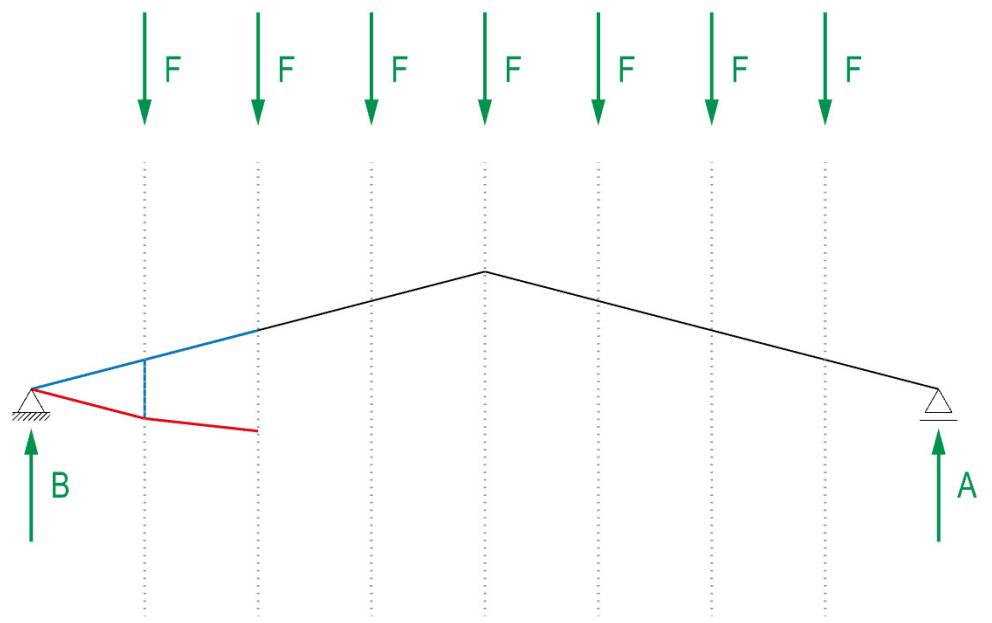


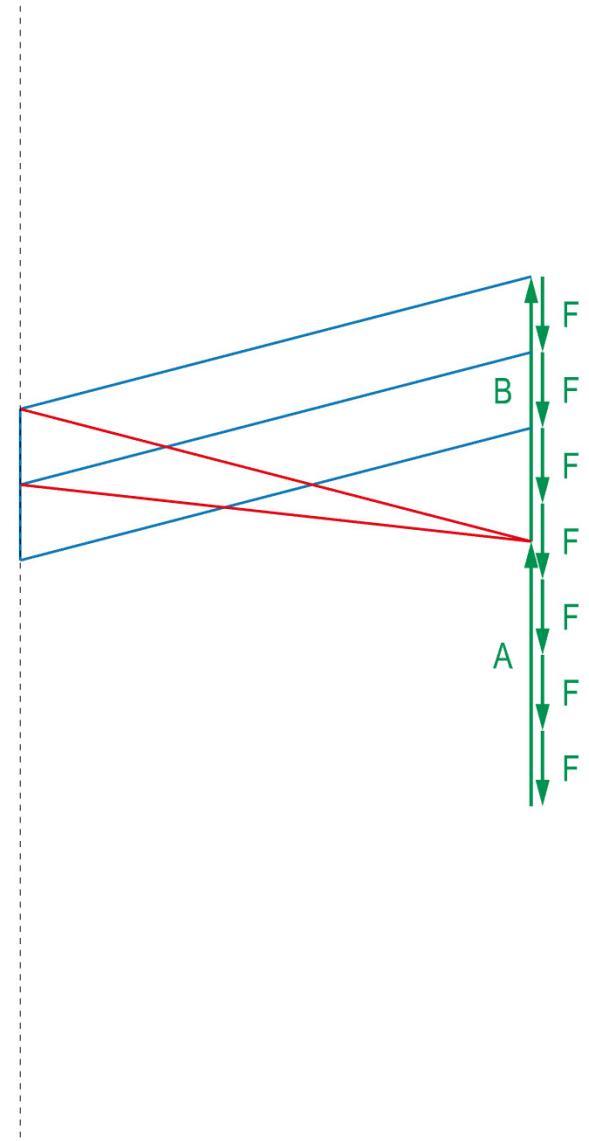
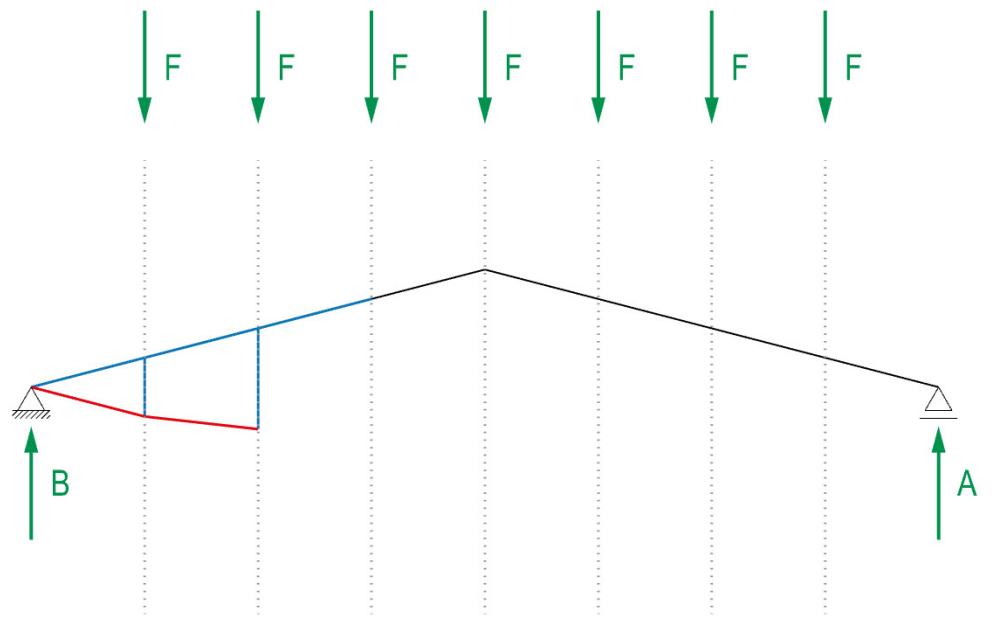


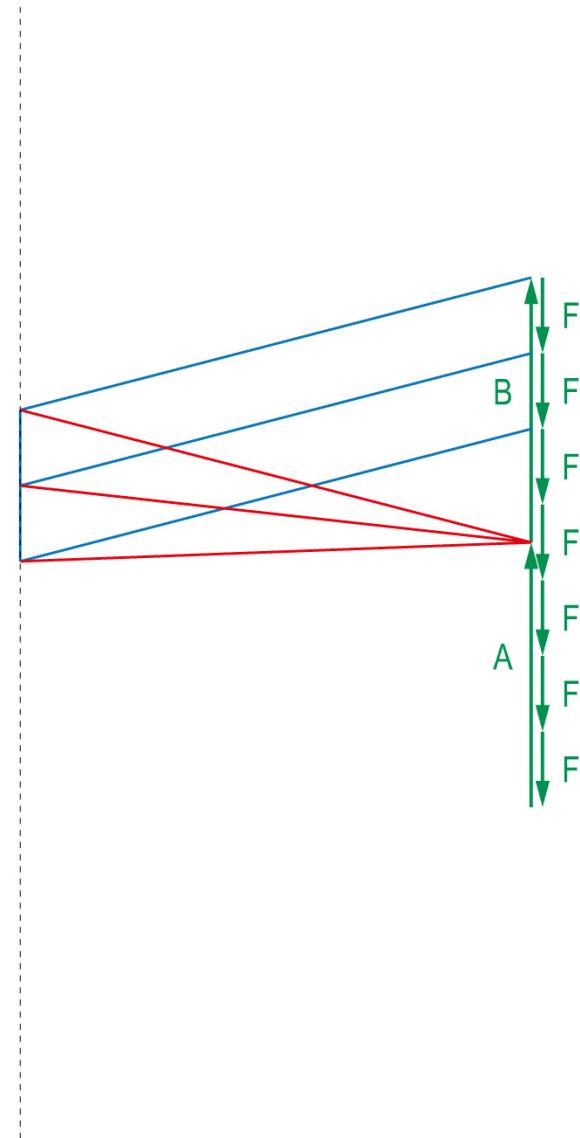
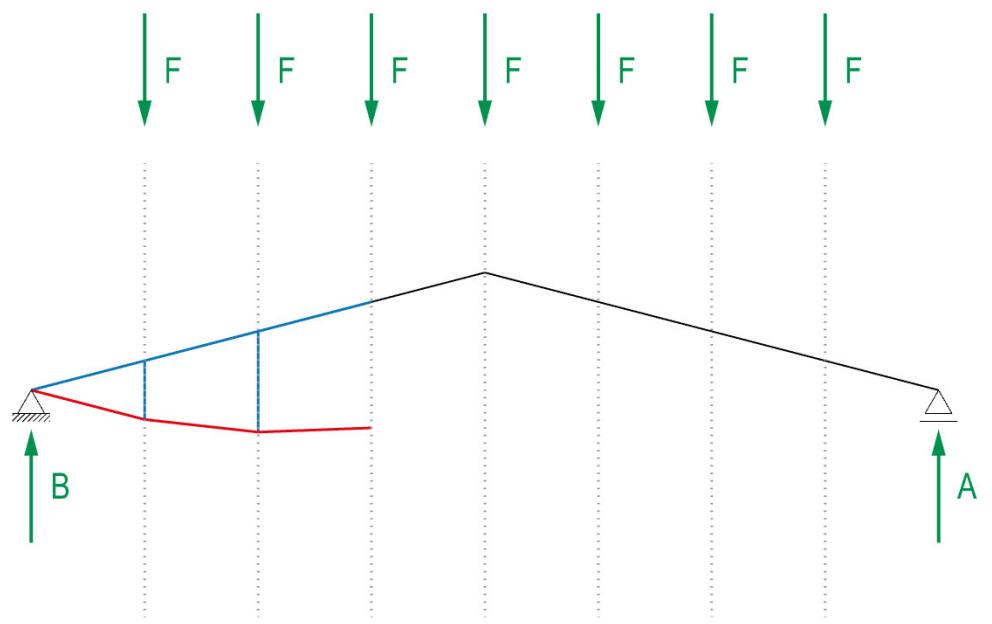


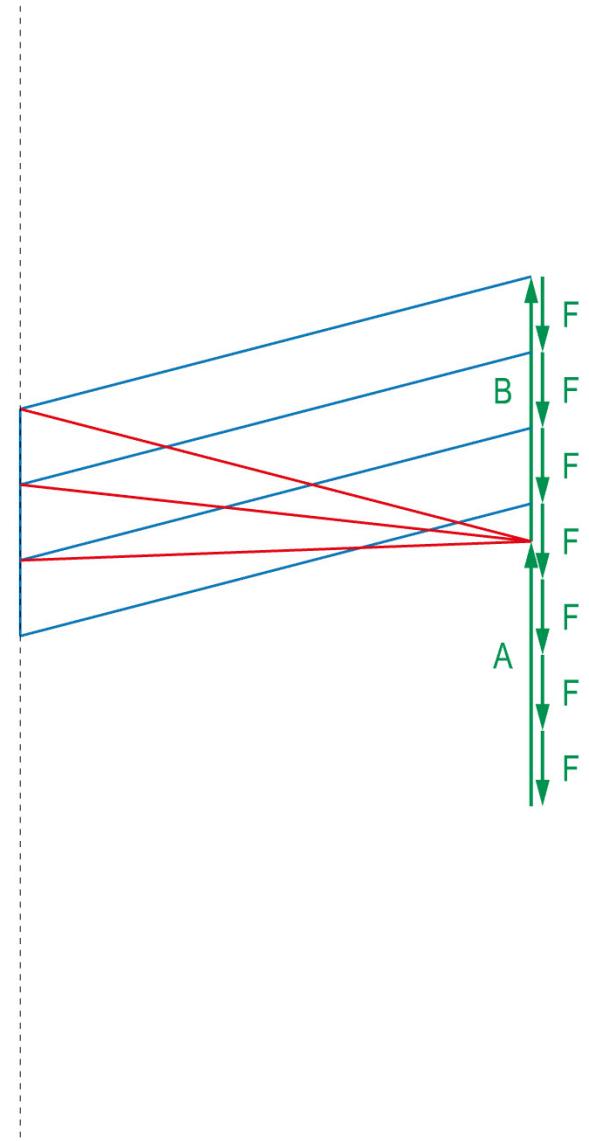
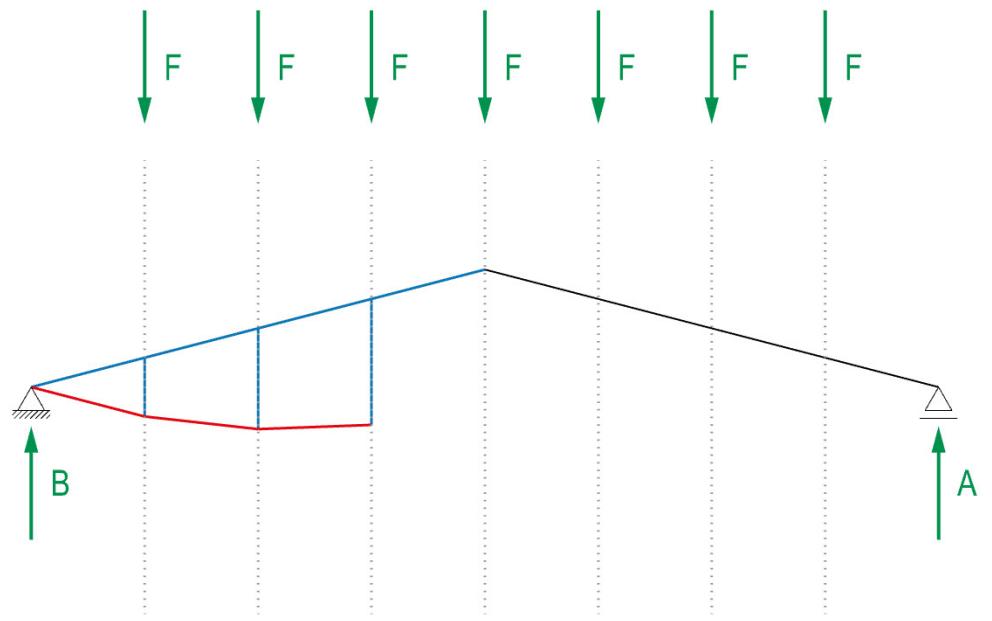


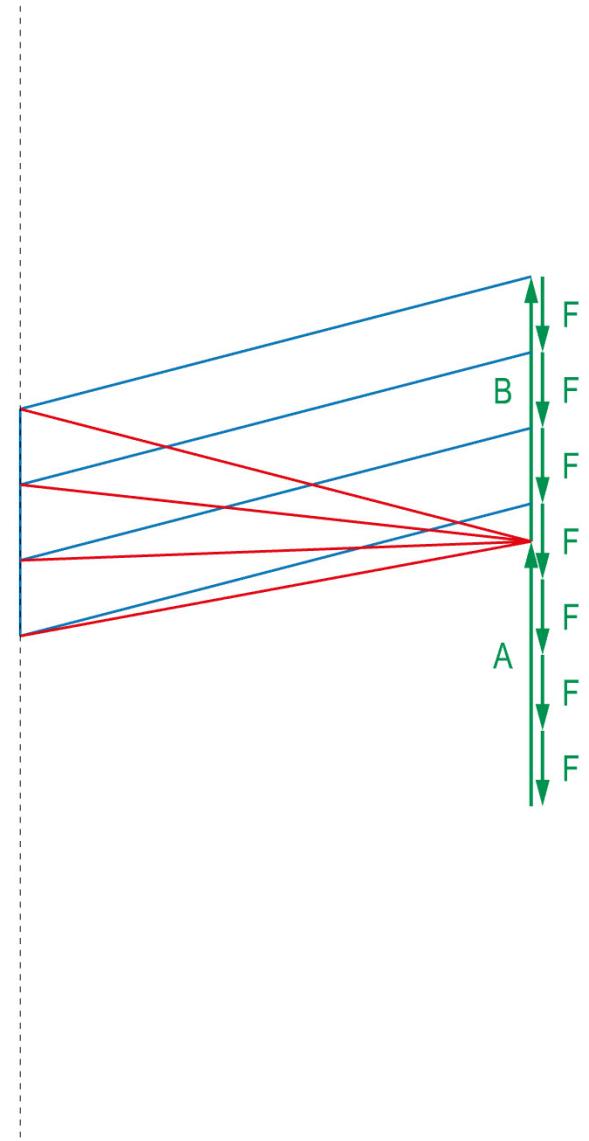
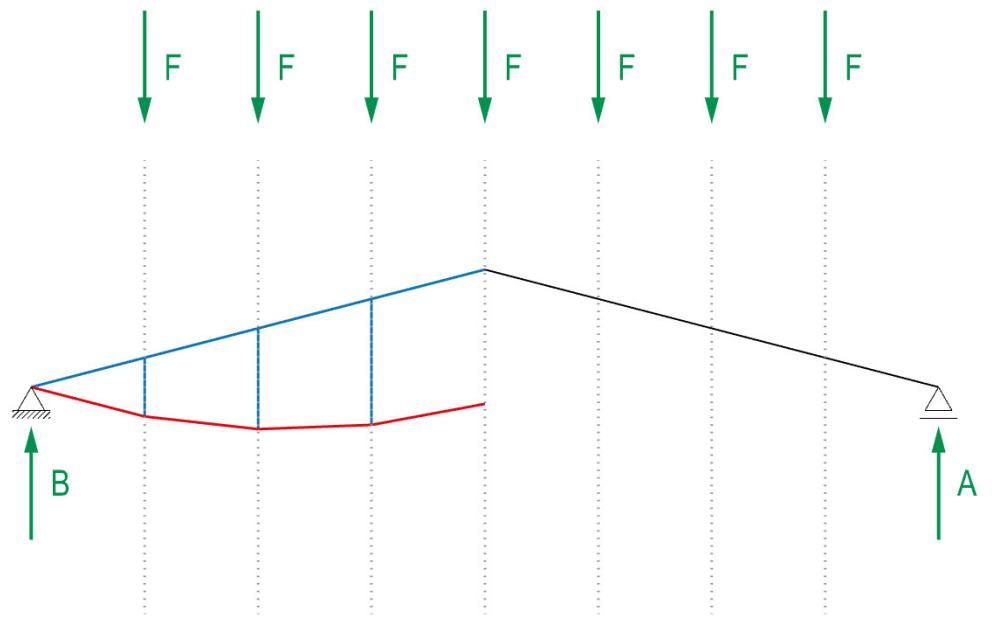


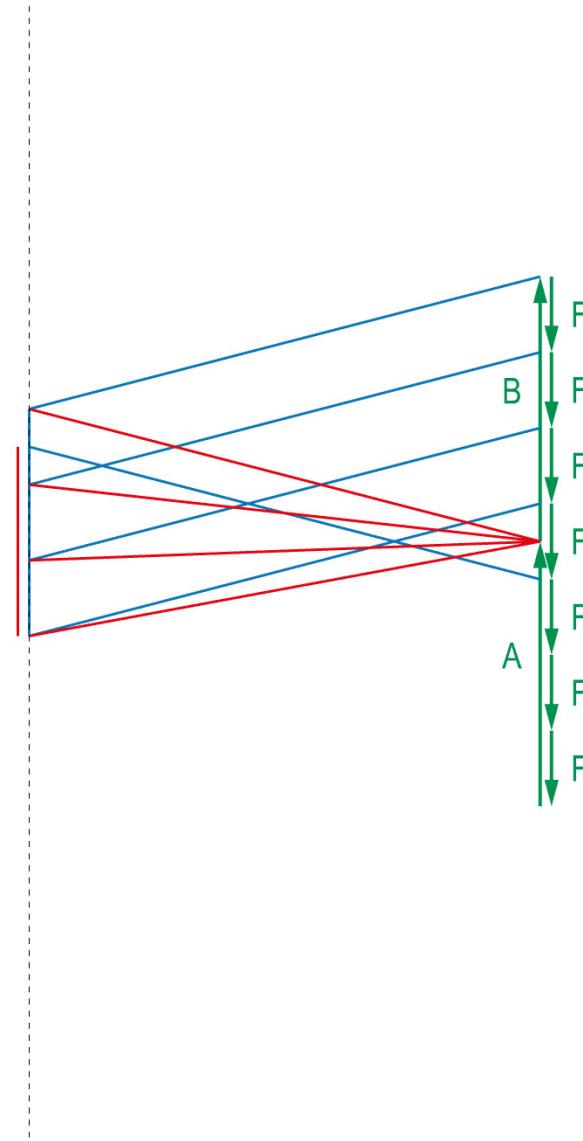
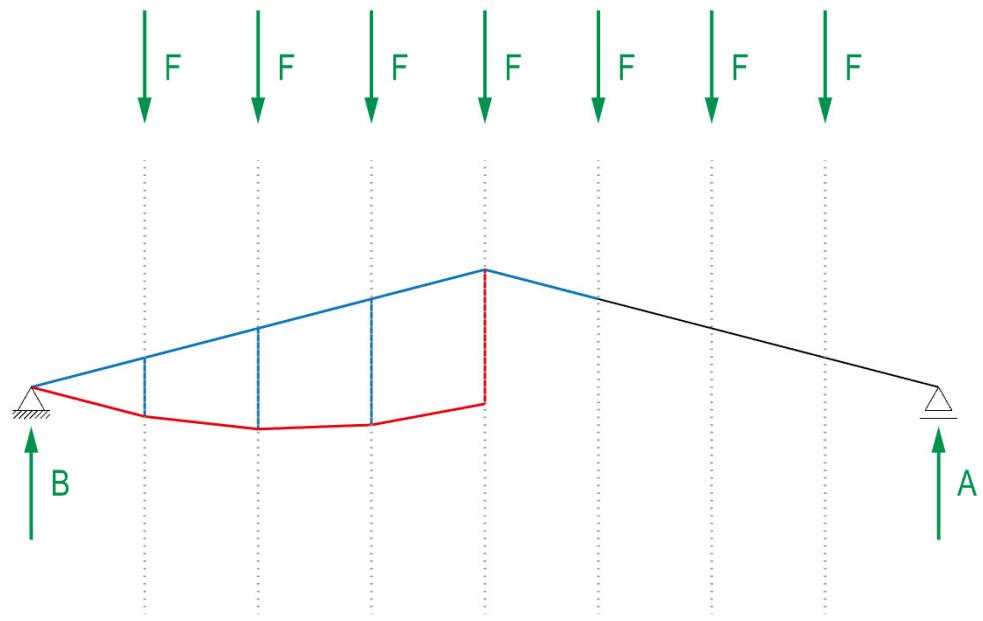


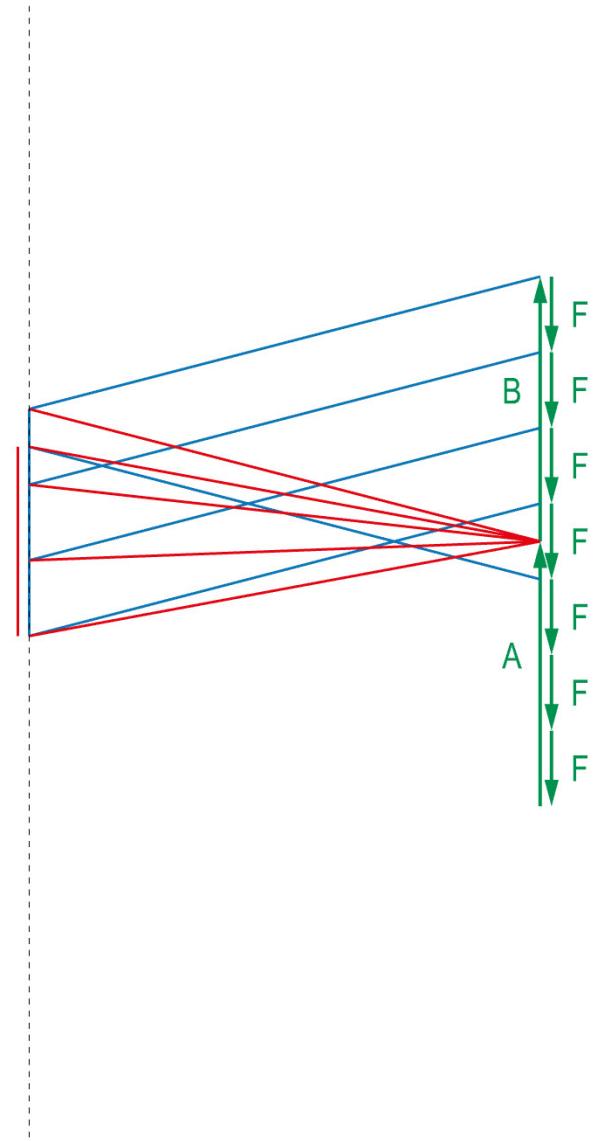
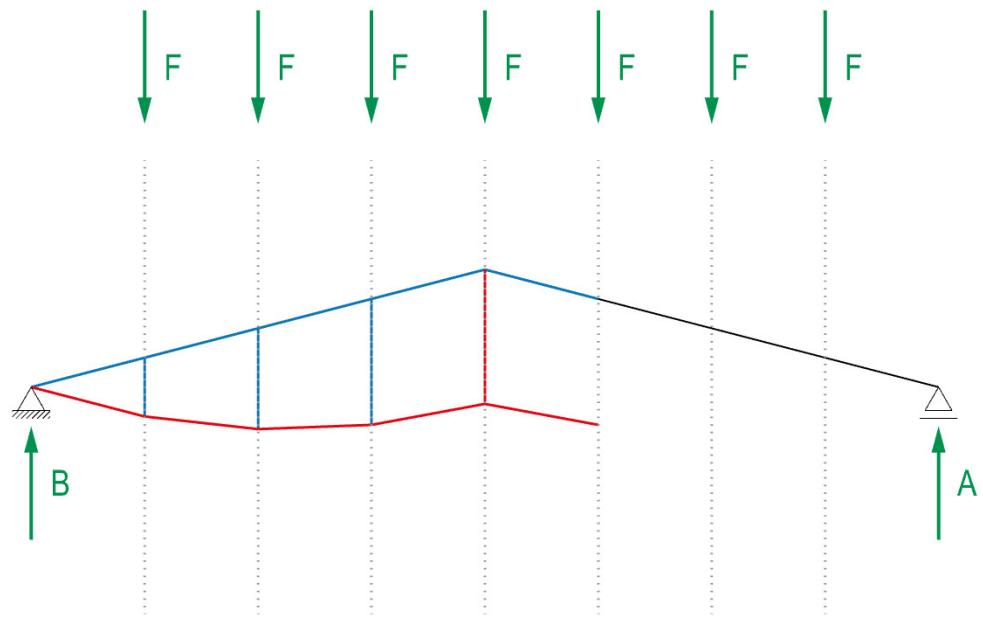


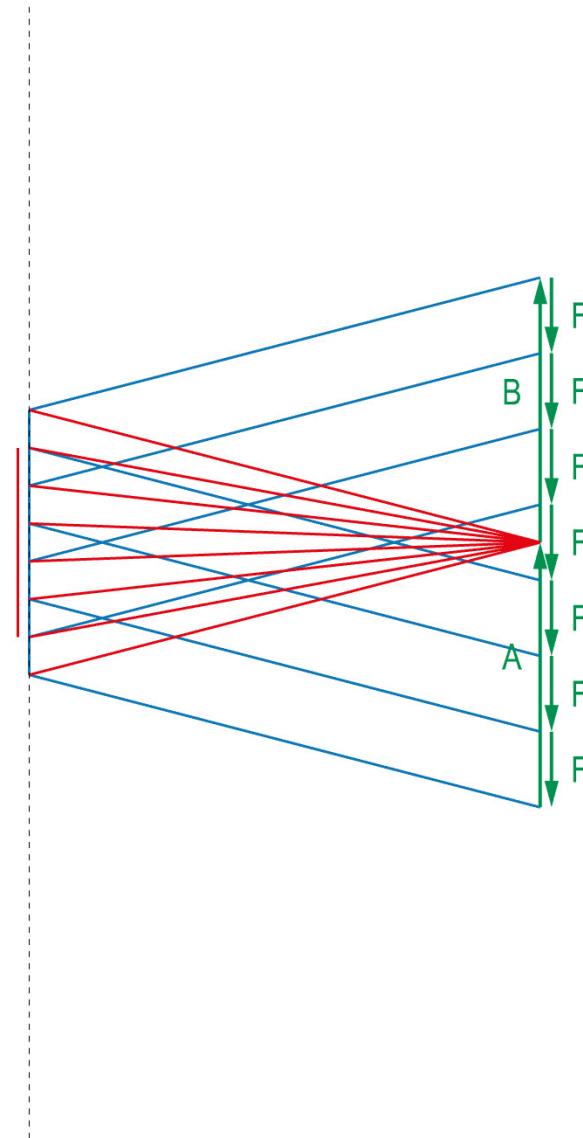
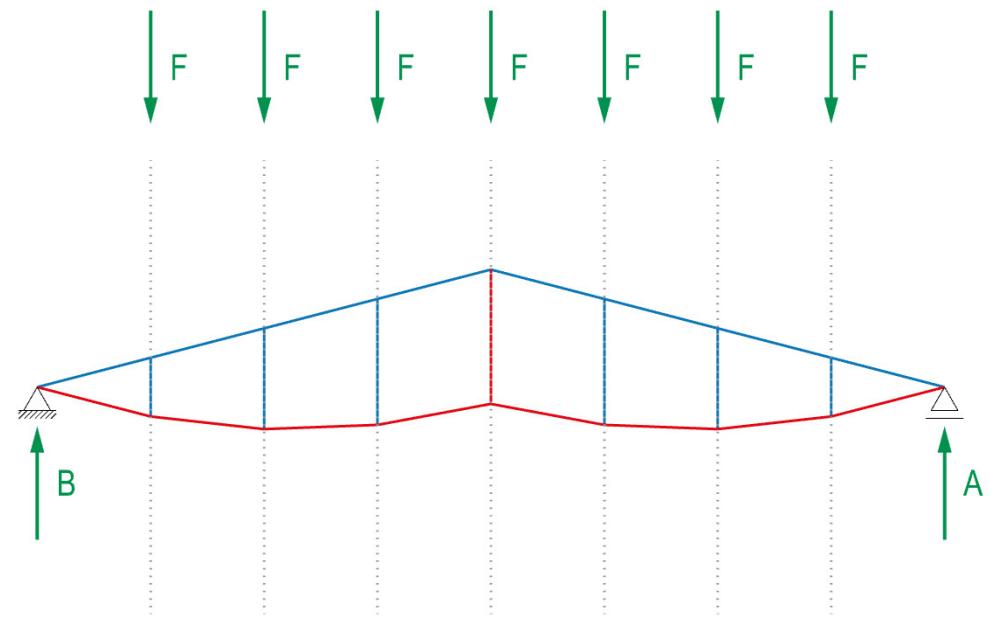


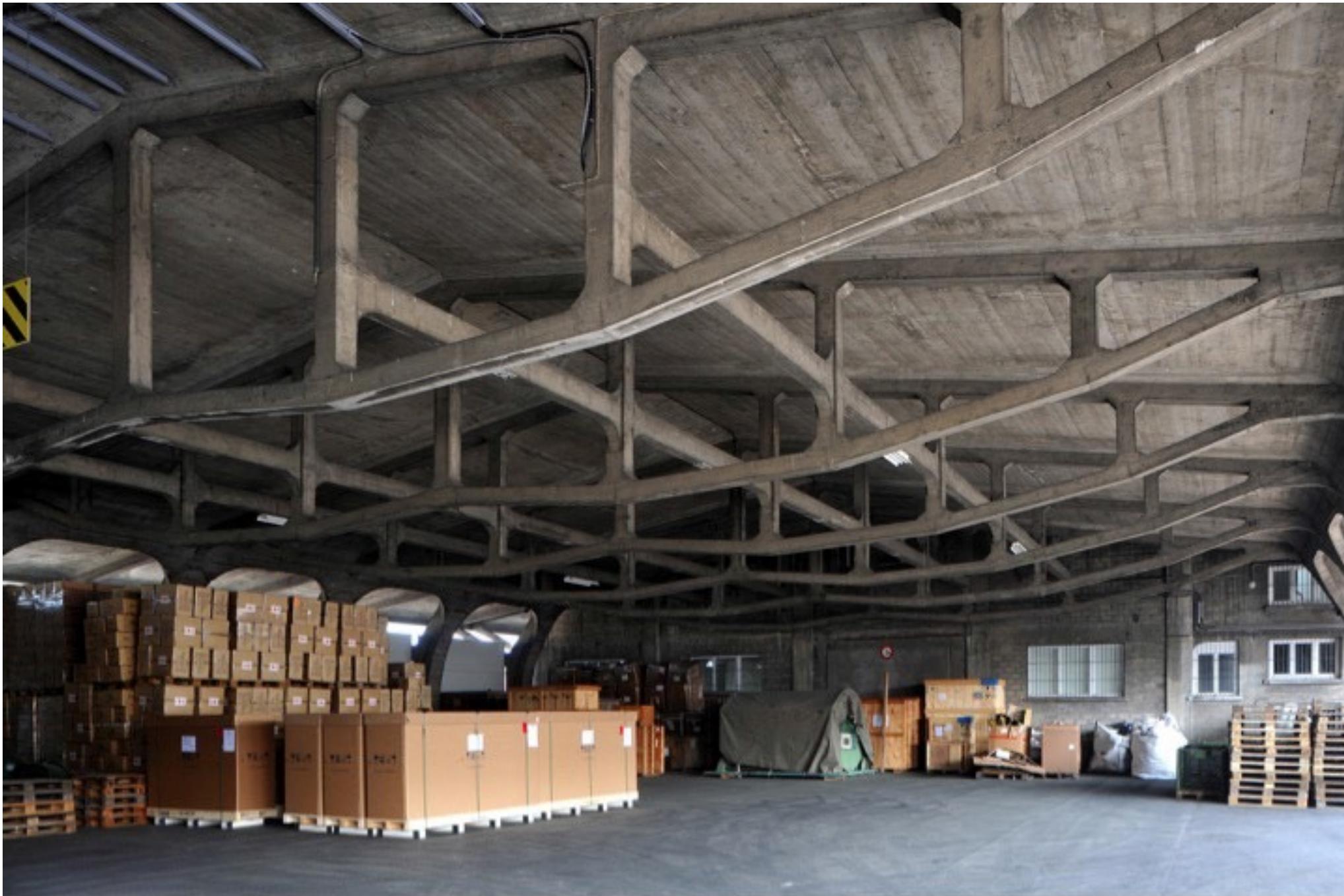








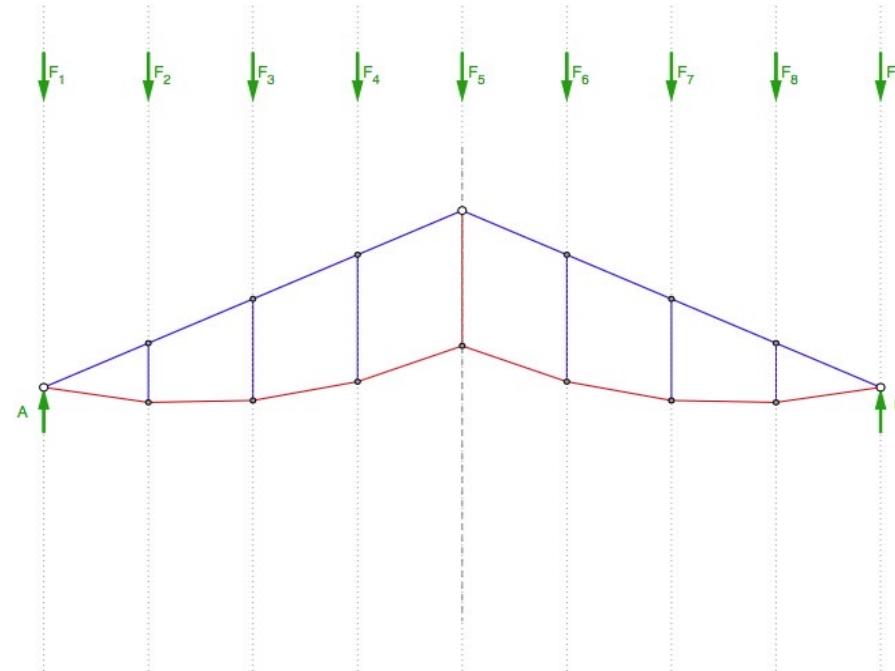




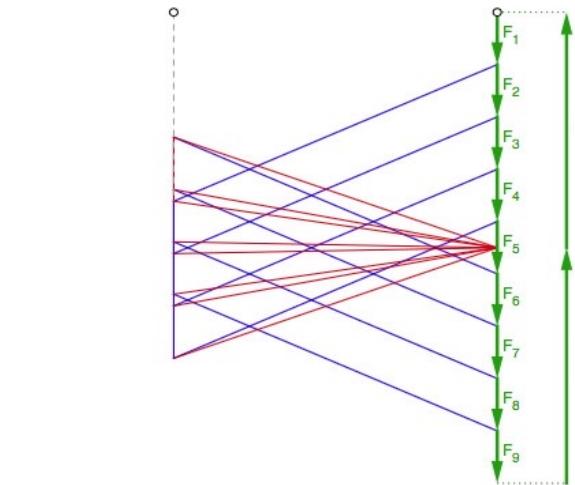
Robert Maillart: Lagerhaus Magazzini Generali, Chiasso, 1925

eQ: Constant-force gable truss

Form Diagram



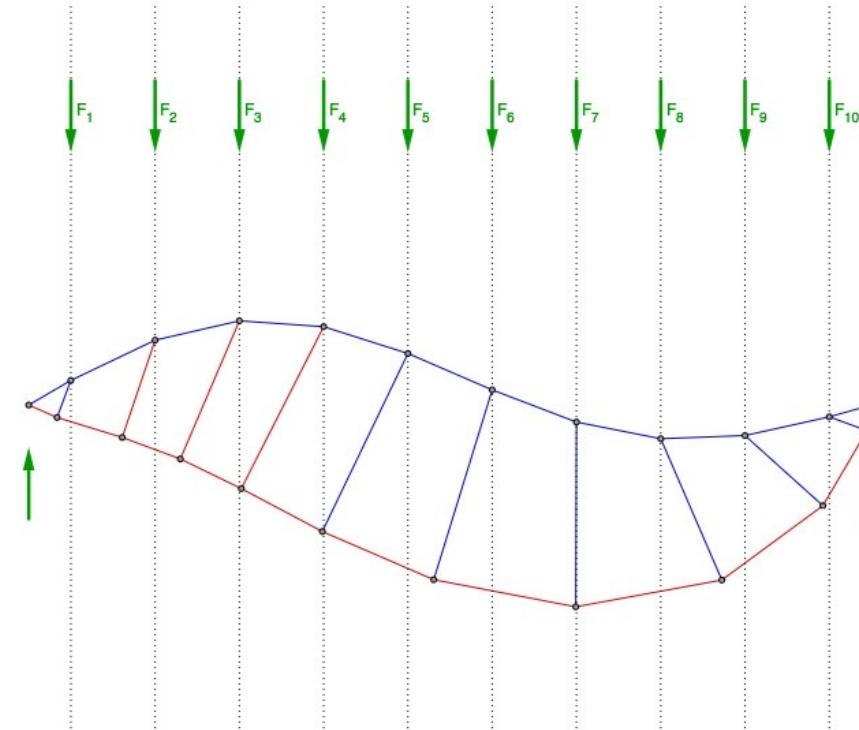
Force Diagram



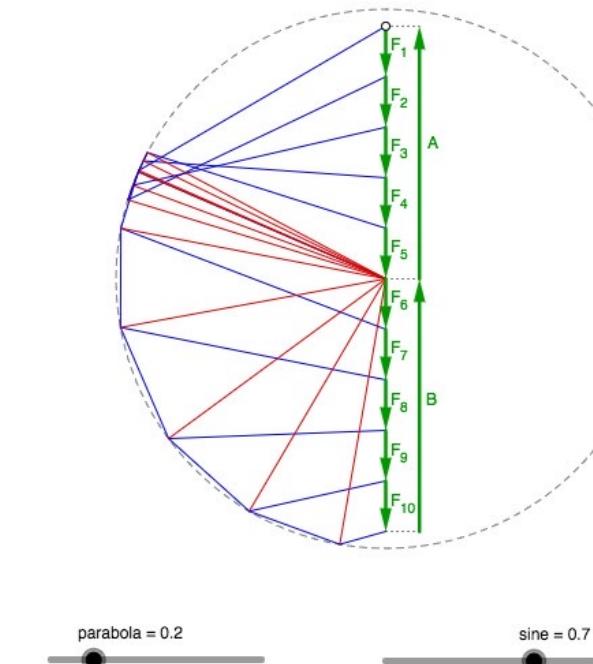
<http://www.block.arch.ethz.ch/eq/drawing/view/26>

eQ: Freeform truss

Form Diagram



Force Diagram



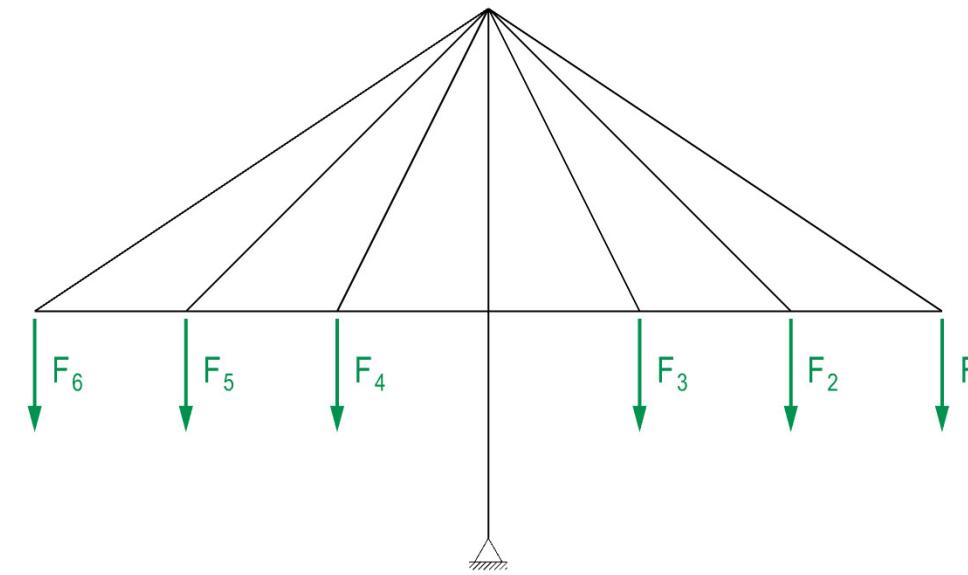
<http://www.block.arch.ethz.ch/eq/drawing/view/52>



Norman Foster, Michel Virlogeux: Viaduct de Millau, Aveyron, 2004

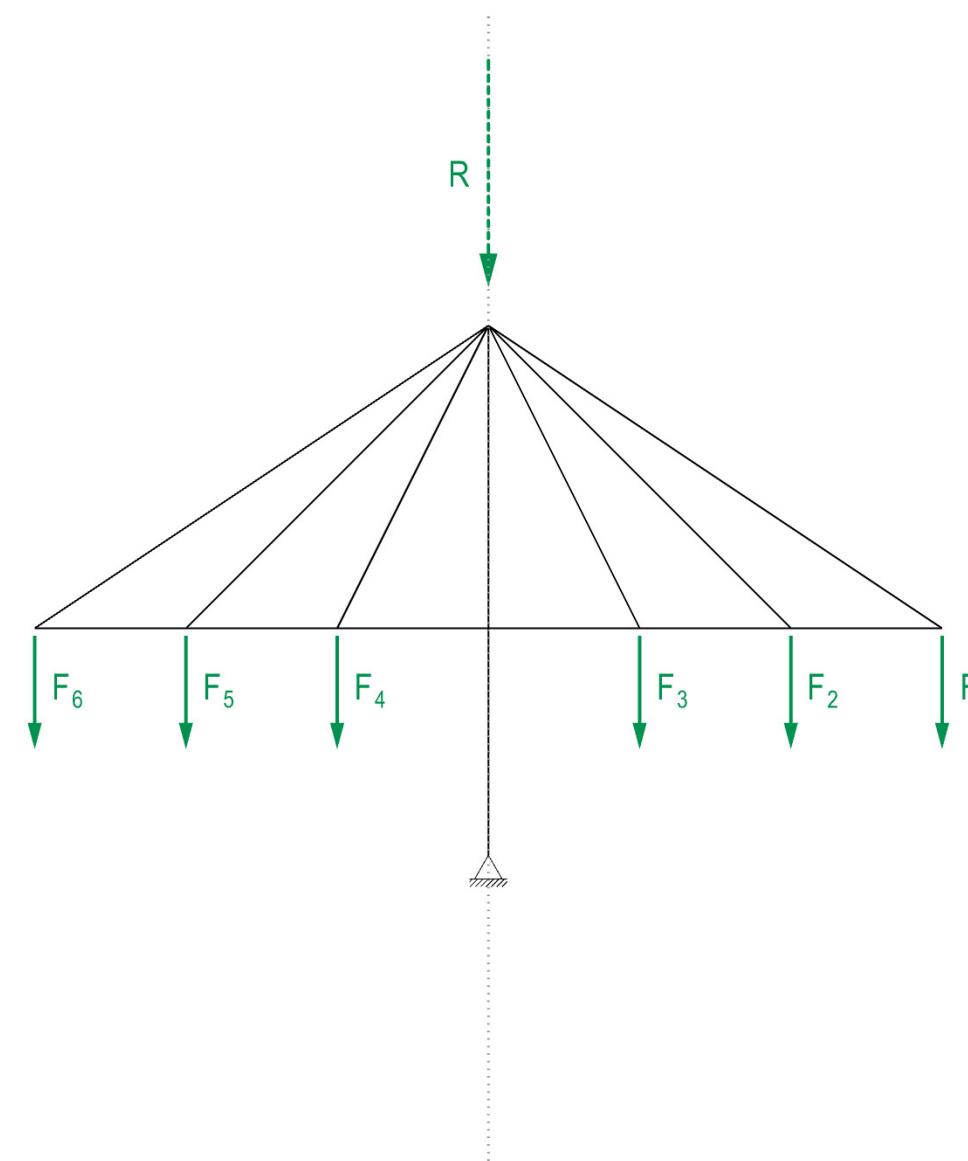


Foster+Partners, Michel Virlogeux: Millau Viaduct, nahe Montpellier, France, 2004



Lageplan 1:100
Form diagram 1:100

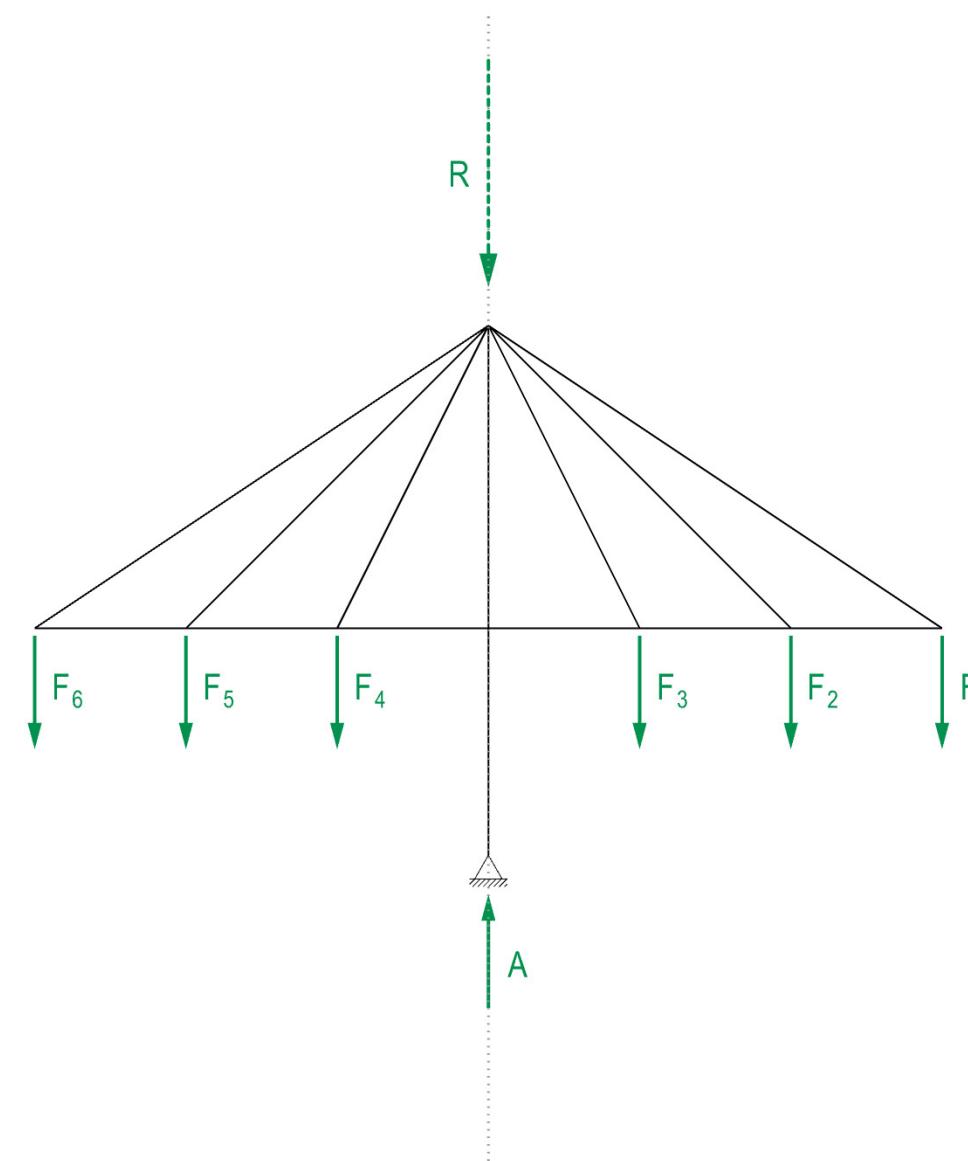
Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN



Lageplan 1:100
Form diagram 1:100

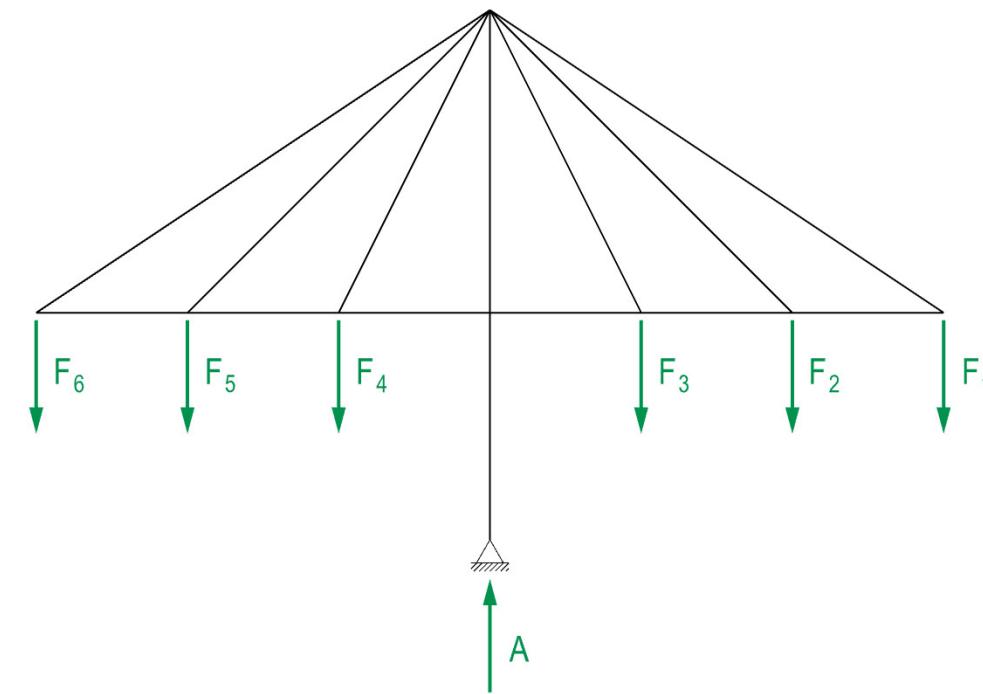


Kräfteplan 1 cm \triangleq 1 kN
Force diagram 1 cm \triangleq 1 kN



Lageplan 1:100

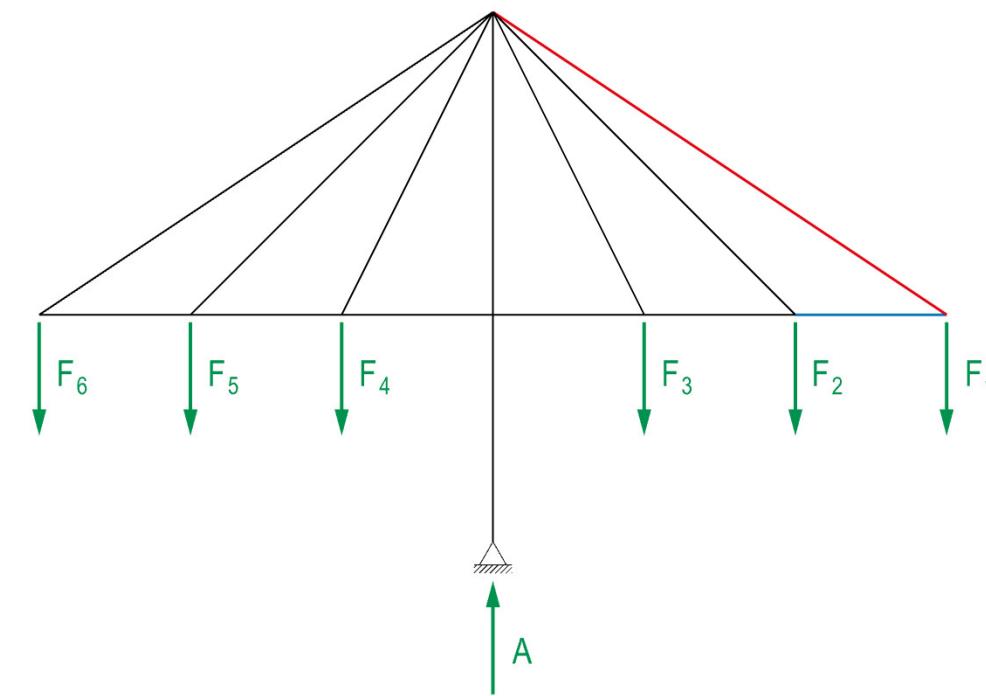
Form diagram 1:100Kräfteplan 1 cm \triangleq 1 kN*Force diagram 1 cm \triangleq 1 kN*



Lageplan 1:100

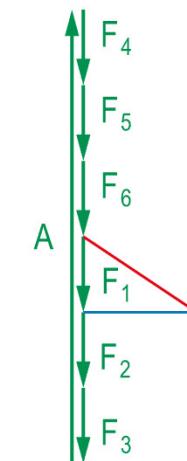
Form diagram 1:100

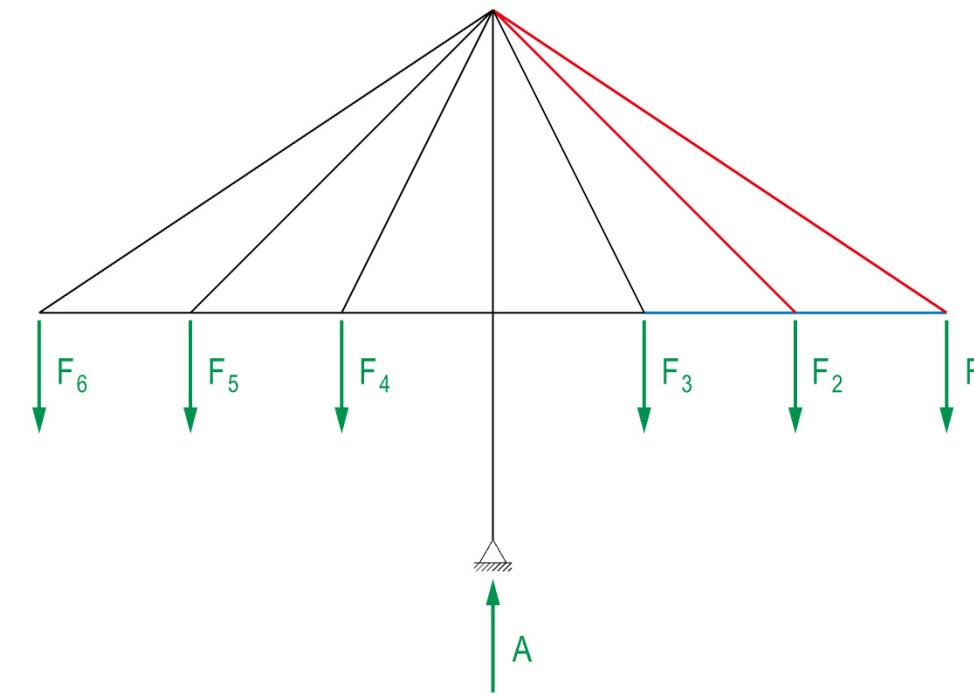
Kräfteplan 1 cm \triangleq 1 kNForce diagram 1 cm \triangleq 1 kN



Lageplan 1:100

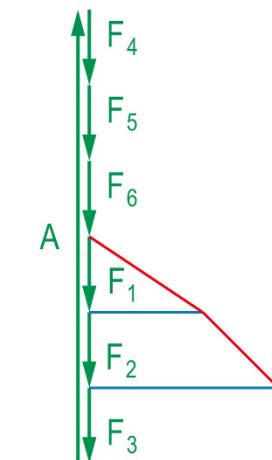
Form diagram 1:100

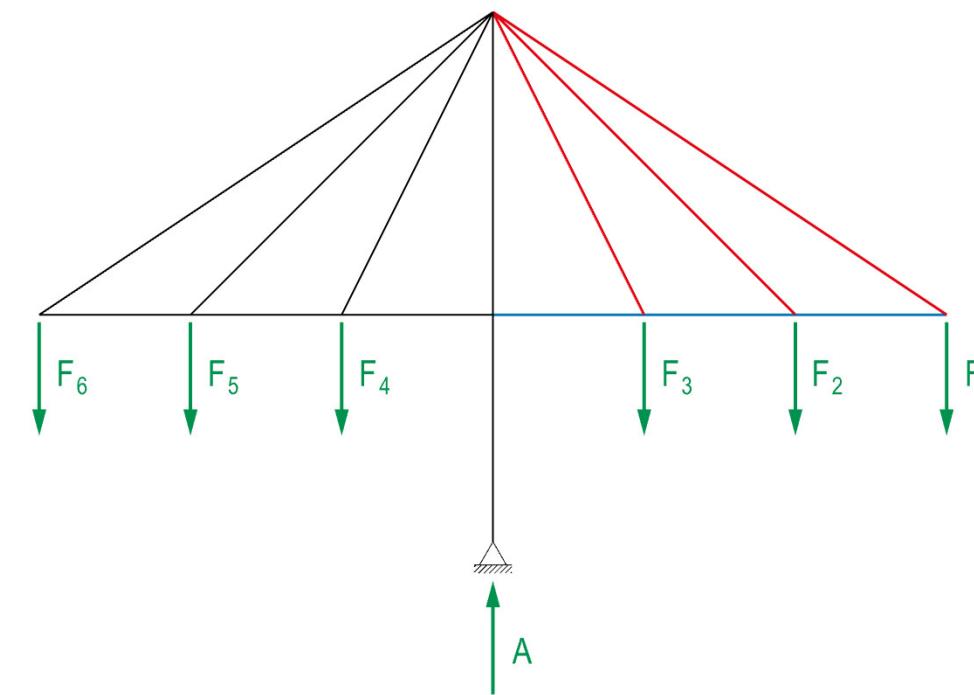
Kräfteplan 1 cm \triangleq 1 kNForce diagram 1 cm \triangleq 1 kN



Lageplan 1:100

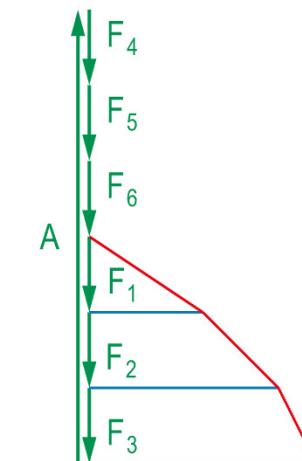
Form diagram 1:100

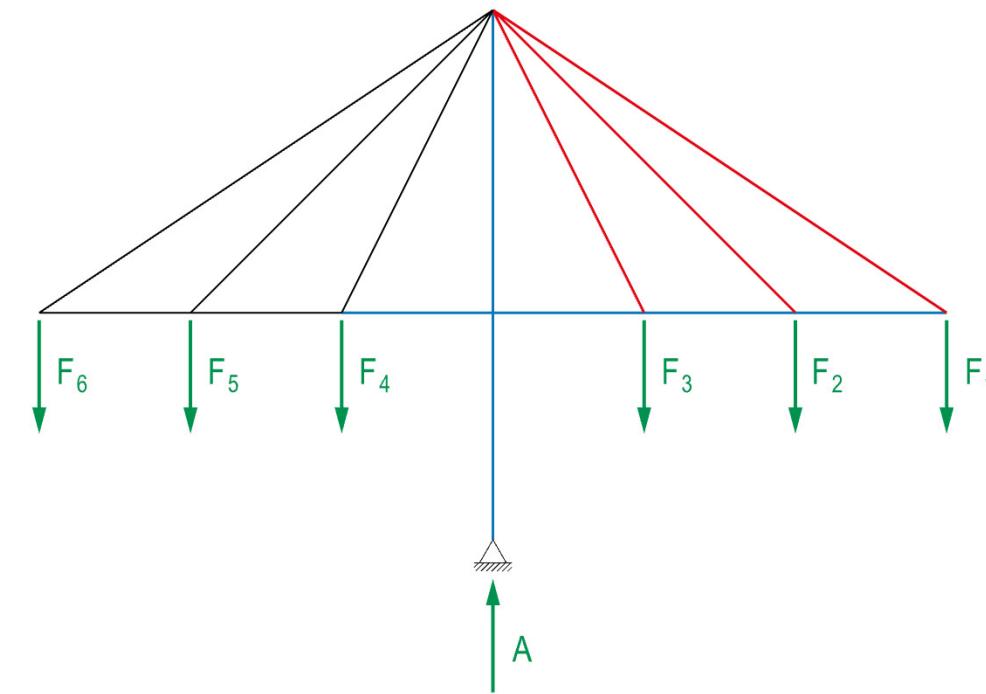
Kräfteplan 1 cm \triangleq 1 kNForce diagram 1 cm \triangleq 1 kN



Lageplan 1:100

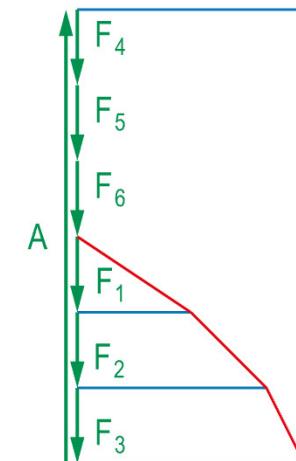
Form diagram 1:100

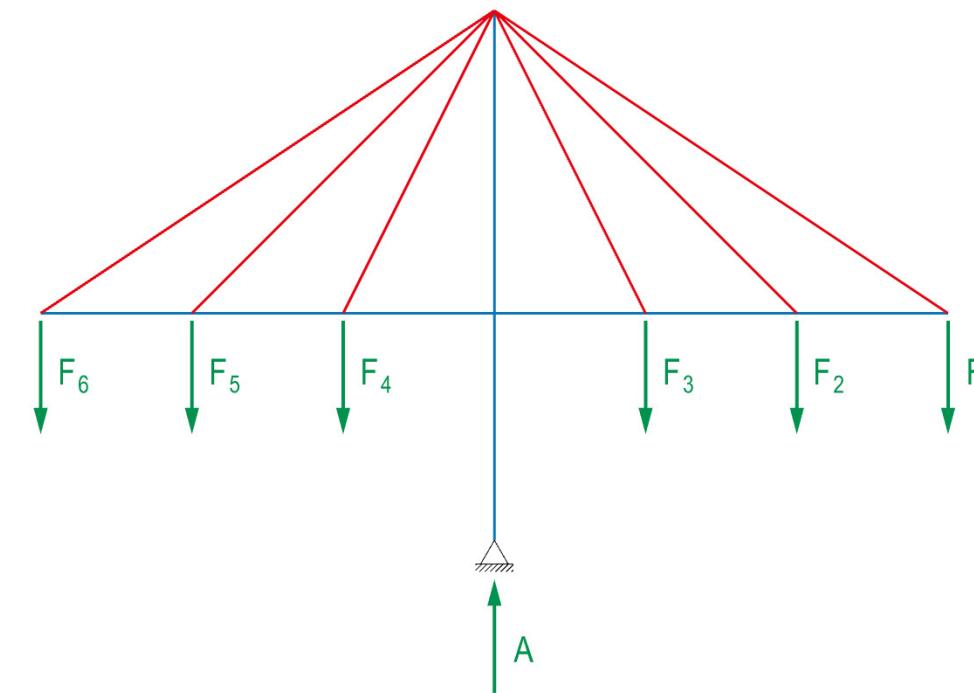
Kräfteplan 1 cm \triangleq 1 kNForce diagram 1 cm \triangleq 1 kN



Lageplan 1:100

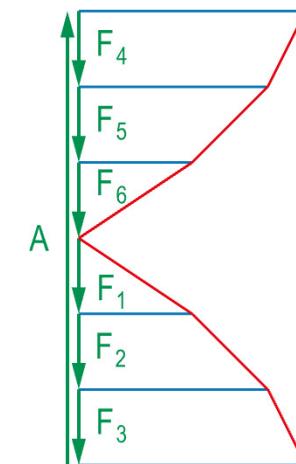
Form diagram 1:100

Kräfteplan 1 cm \triangleq 1 kNForce diagram 1 cm \triangleq 1 kN



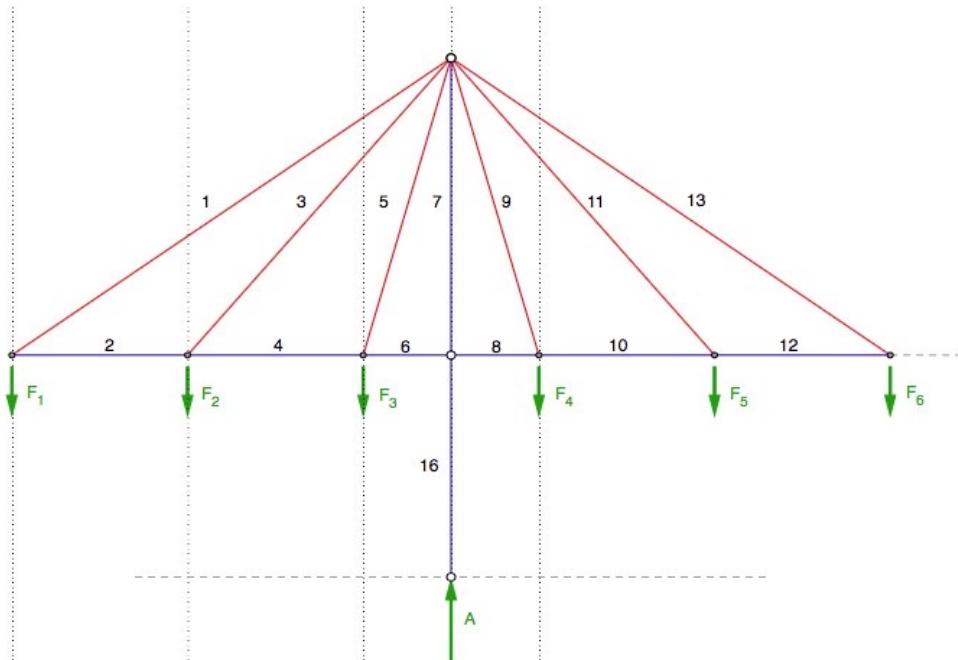
Lageplan 1:100

Form diagram 1:100

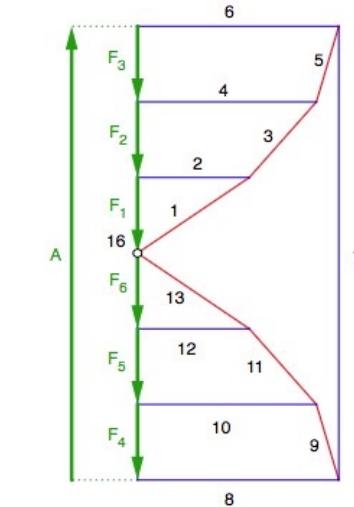
Kräfteplan 1 cm \triangleq 1 kNForce diagram 1 cm \triangleq 1 kN

eQ: Fan-harp bridge

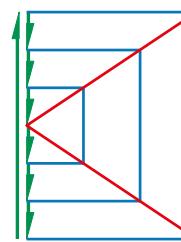
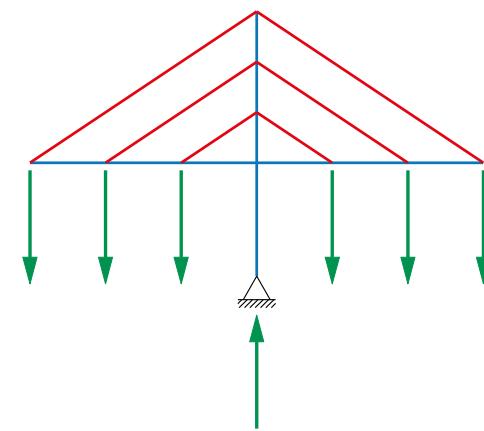
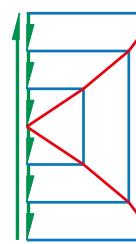
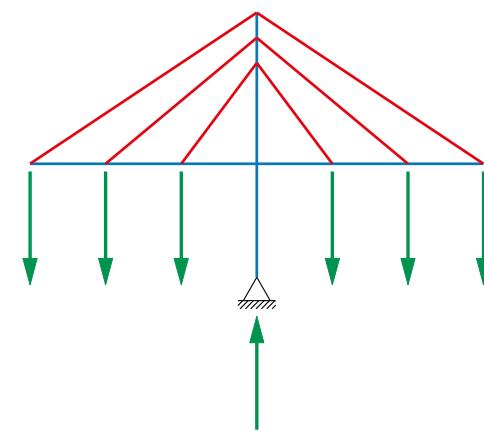
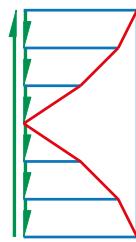
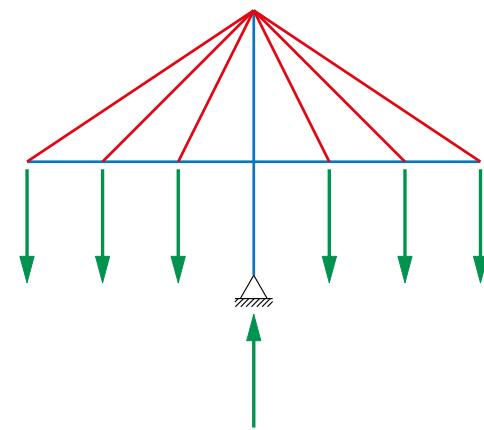
Form Diagram



Force Diagram



<http://www.block.arch.ethz.ch/eq/drawing/view/21>

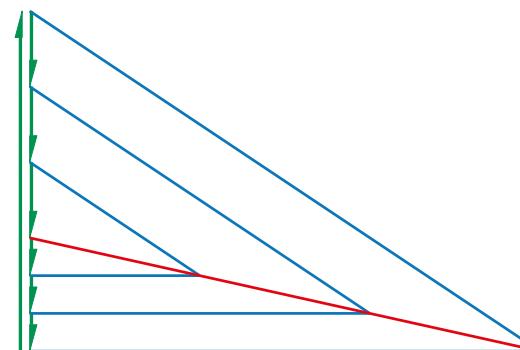
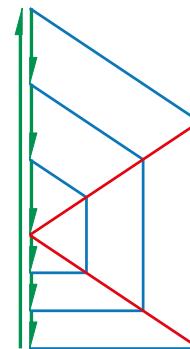
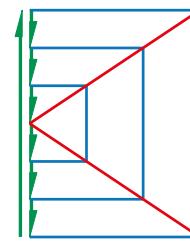
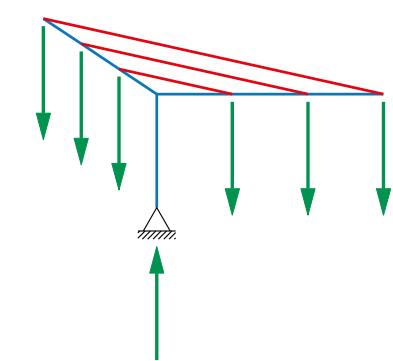
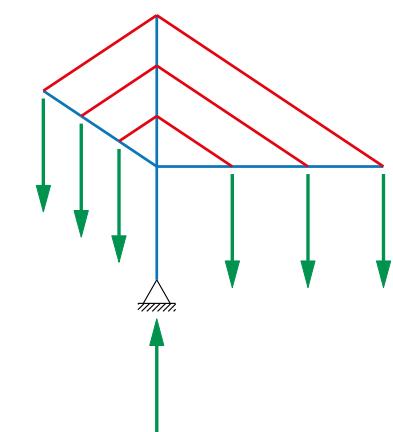
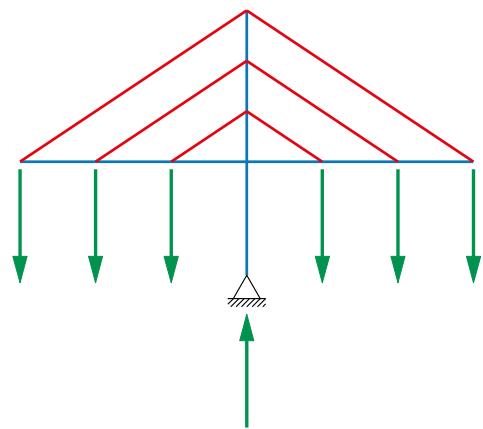




Christian Menn: Sunnibergbrücke, zwischen Klosters und Serneus, 2005



Christian Menn: Sunnibergbrücke, zwischen Klosters und Serneus, 2005

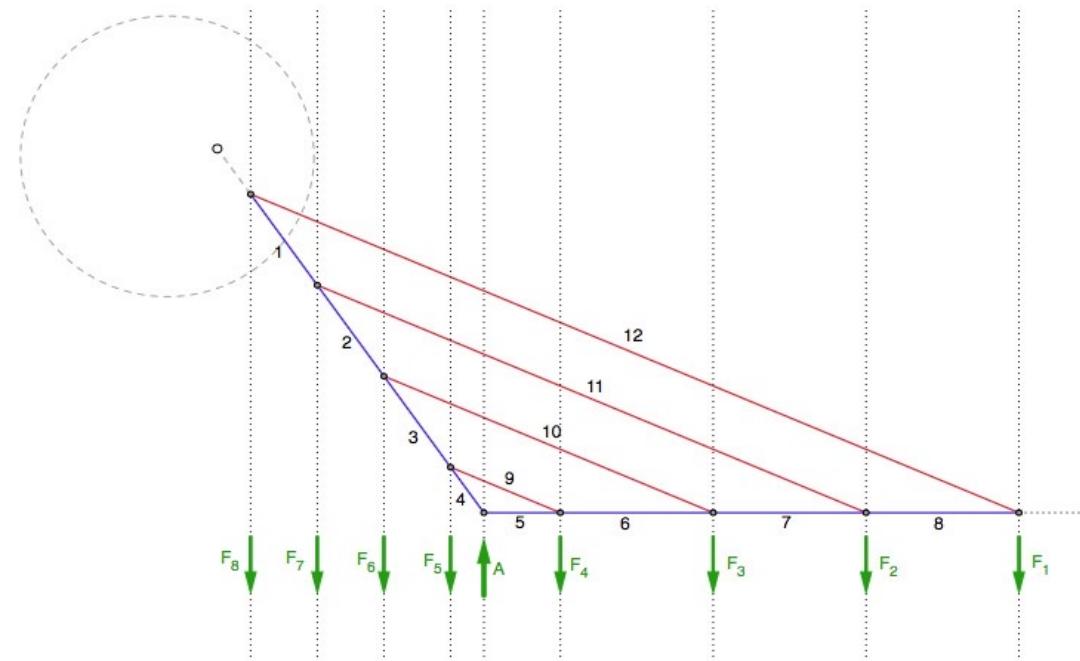




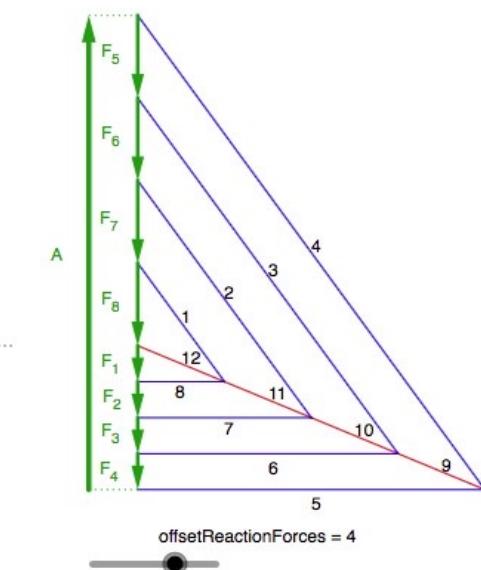
Santiago Calatrava: Alamillo Bridge, Sevilla, 1992

eQ: Cantilevered fan bridge

Form Diagram



Force Diagram



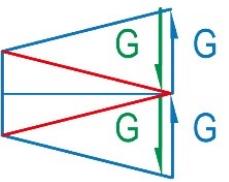
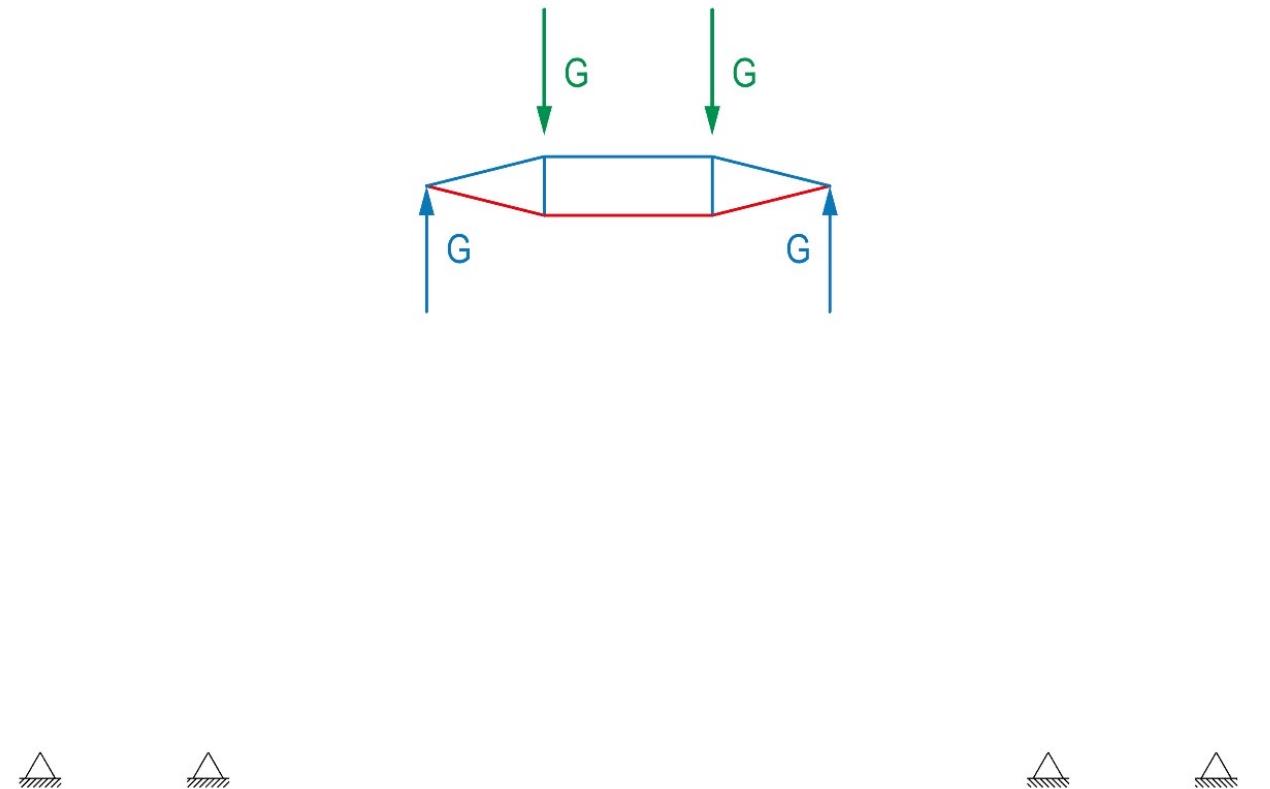
<http://www.block.arch.ethz.ch/eq/drawing/view/22>

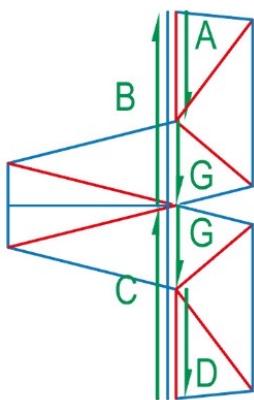
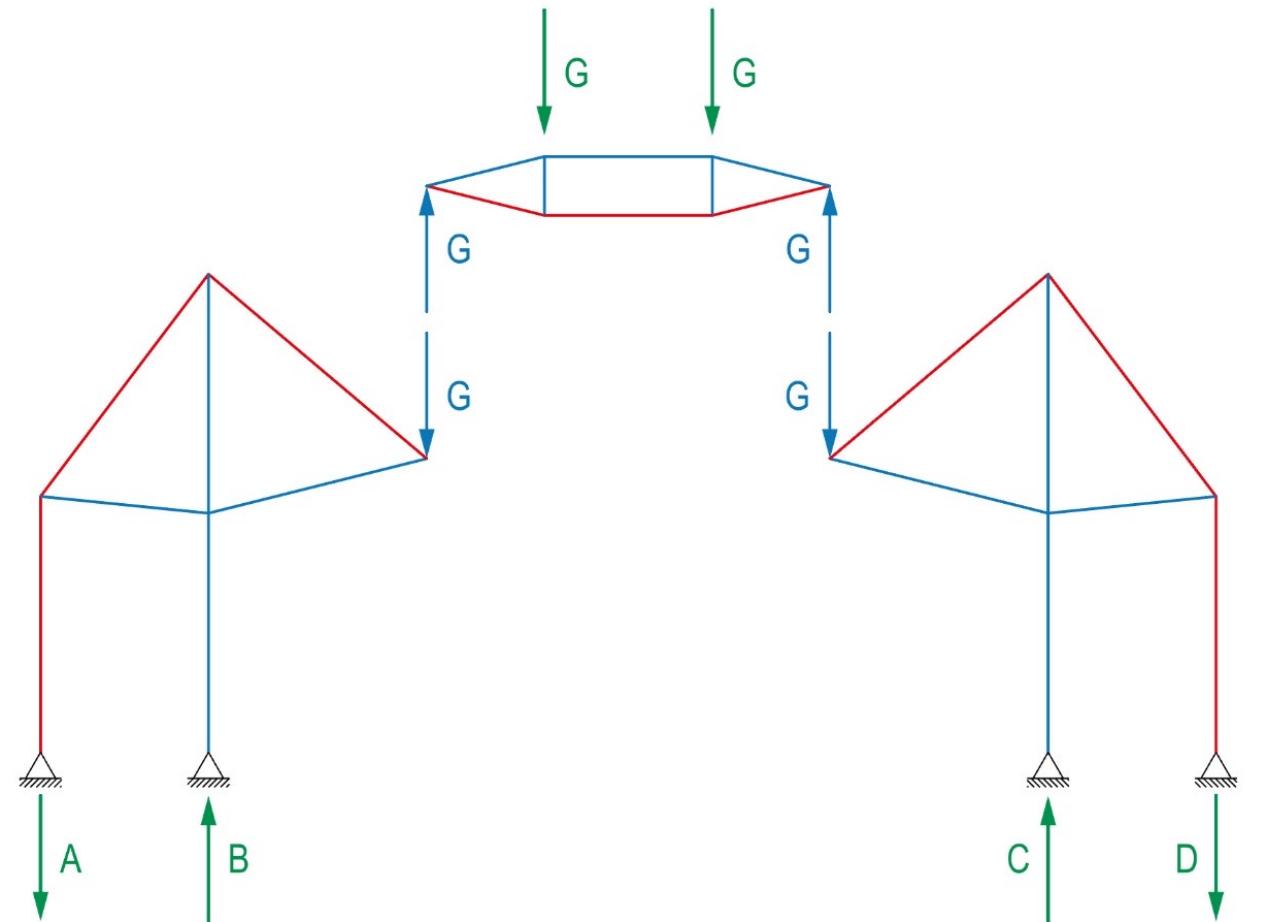


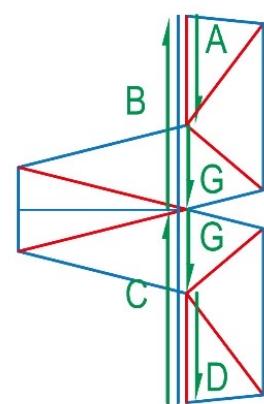
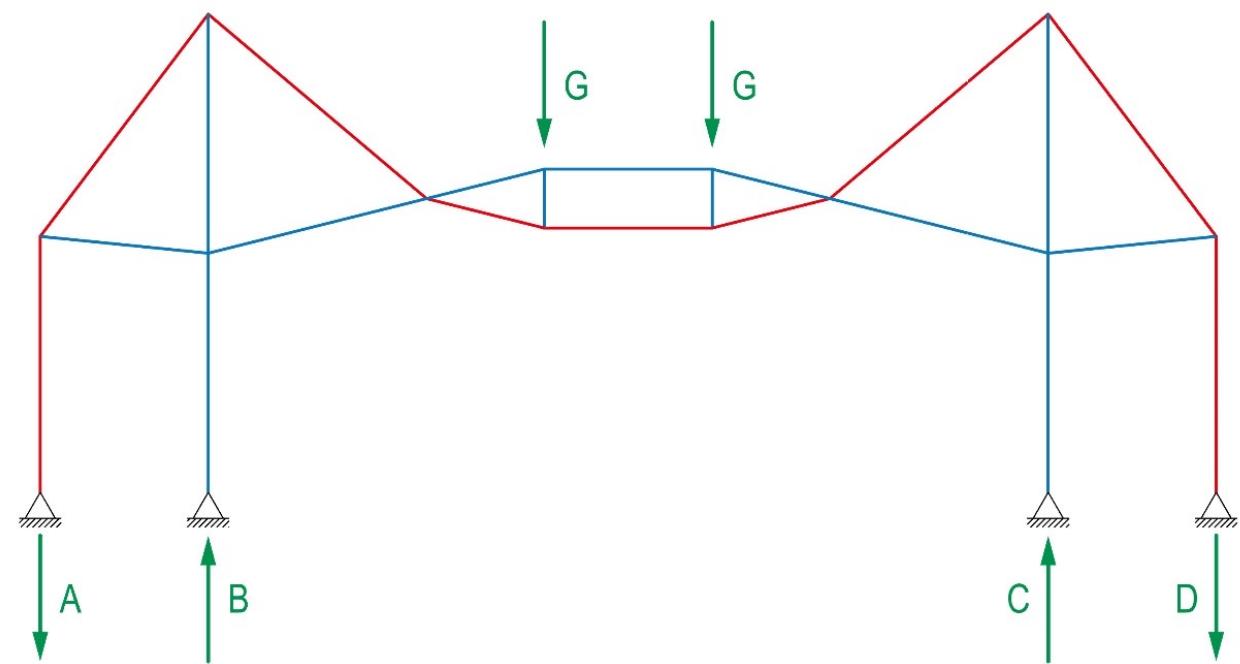
Foster+Partners: Renault Distribution Center, Swindon UK, 1983



Foster+Partners: Renault Distribution Center, Swindon UK, 1983

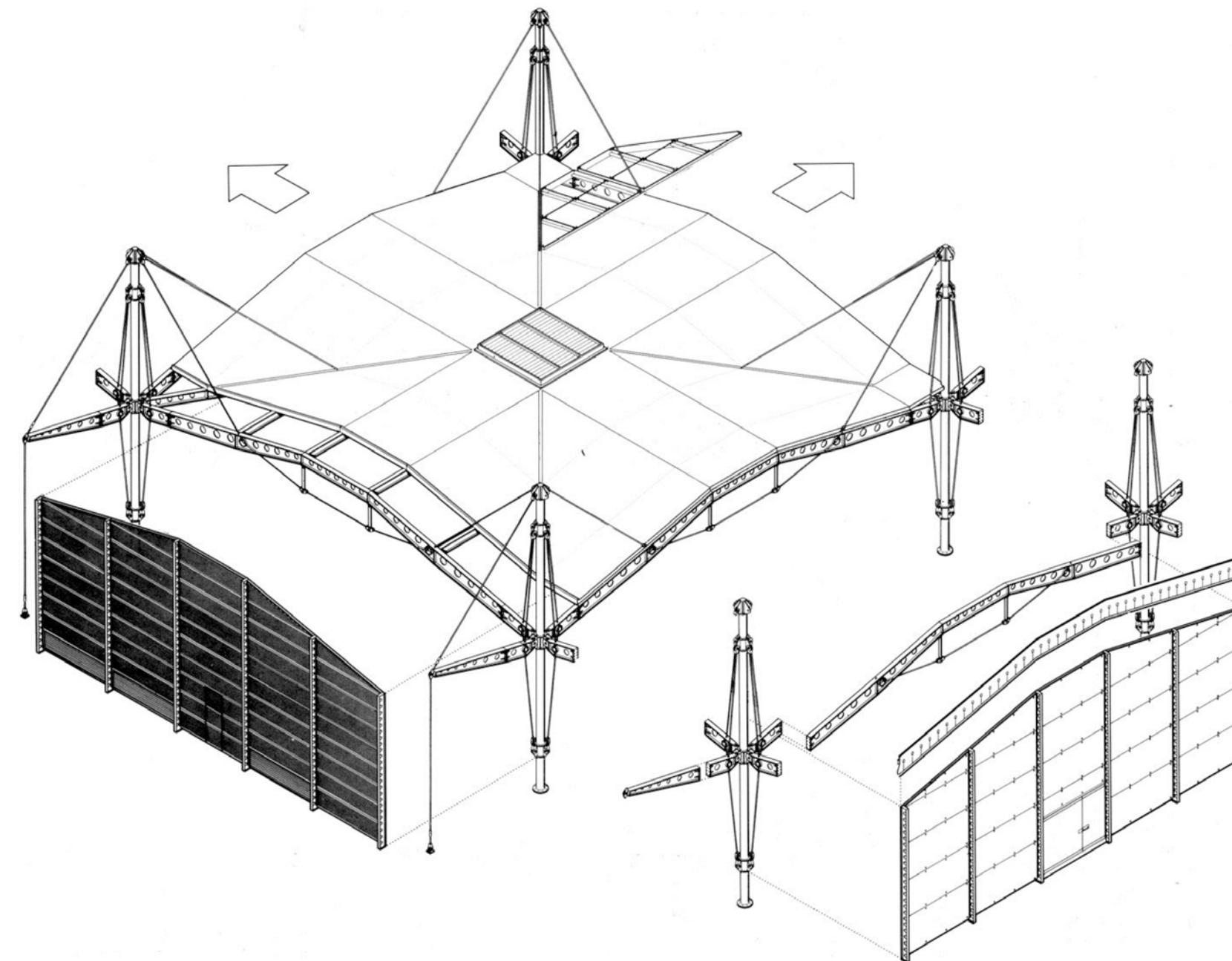




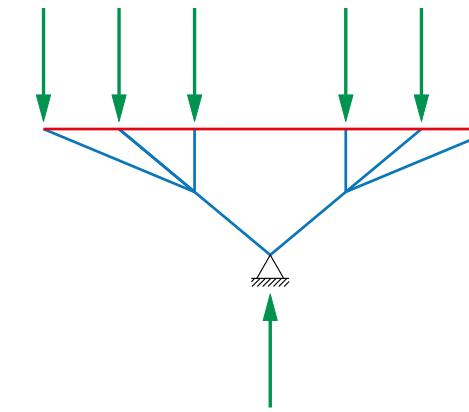
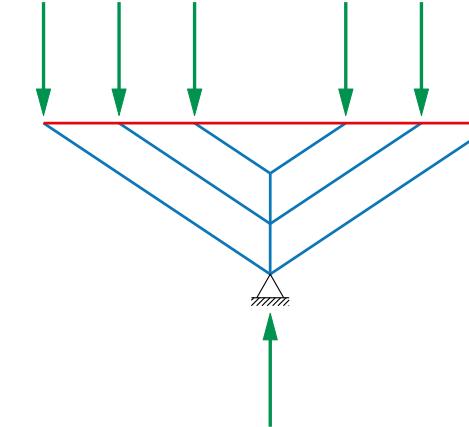
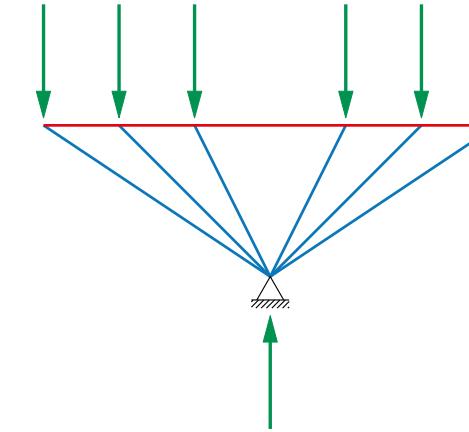
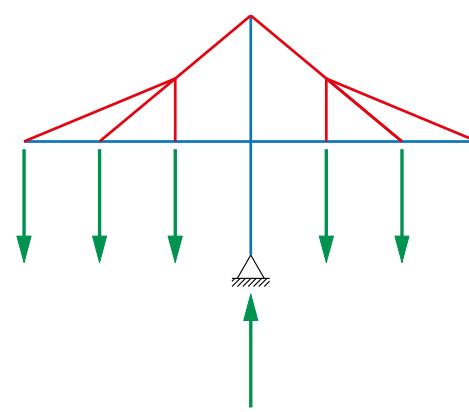
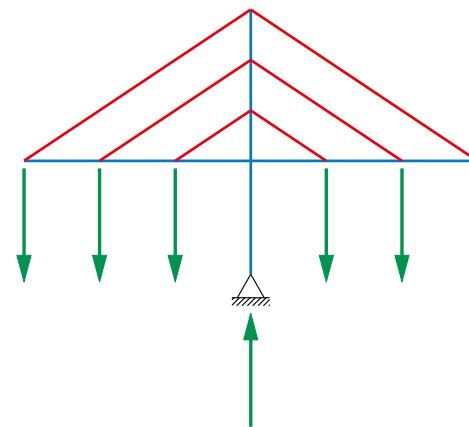
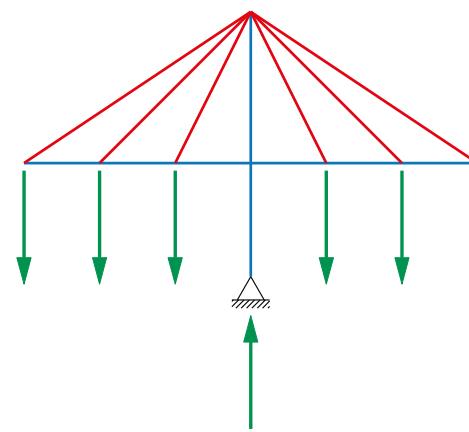




Foster+Partners: Renault Distribution Center, Swindon UK, 1983

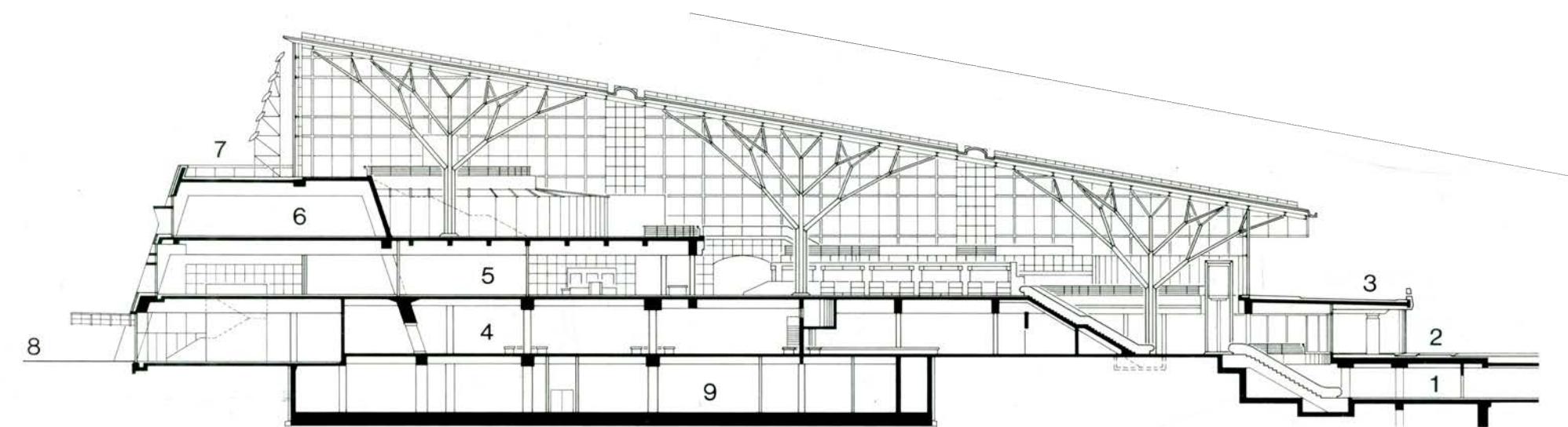


Foster+Partners: Renault Distribution Center, Swindon UK, 1983

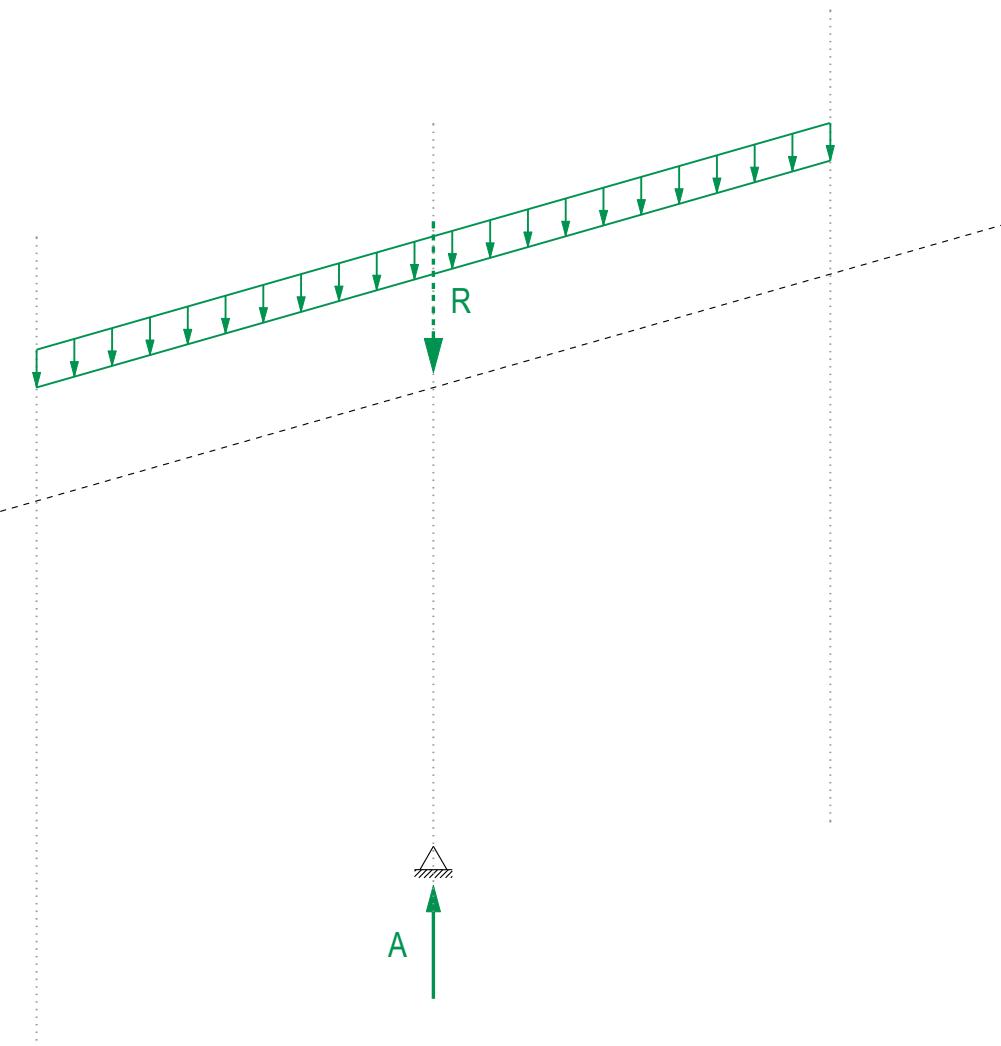




Gerkan, Mark & Partner, Schlaich Bergermann: Stuttgart Airport Terminal 3, 2004

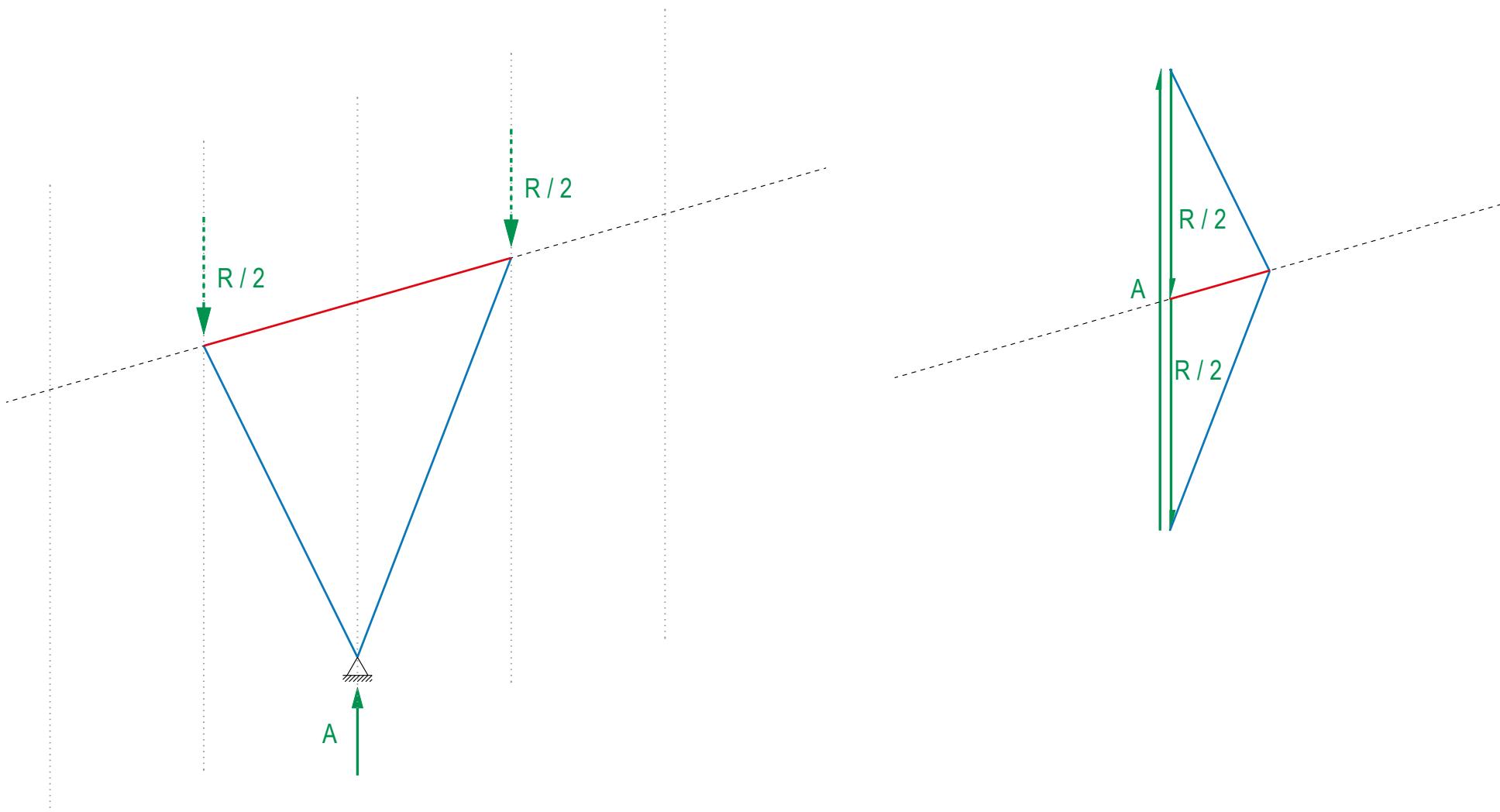


Gerkan, Mark & Partner, Schlaich Bergermann: Stuttgart Airport Terminal 3, 2004



Lageplan 1:100

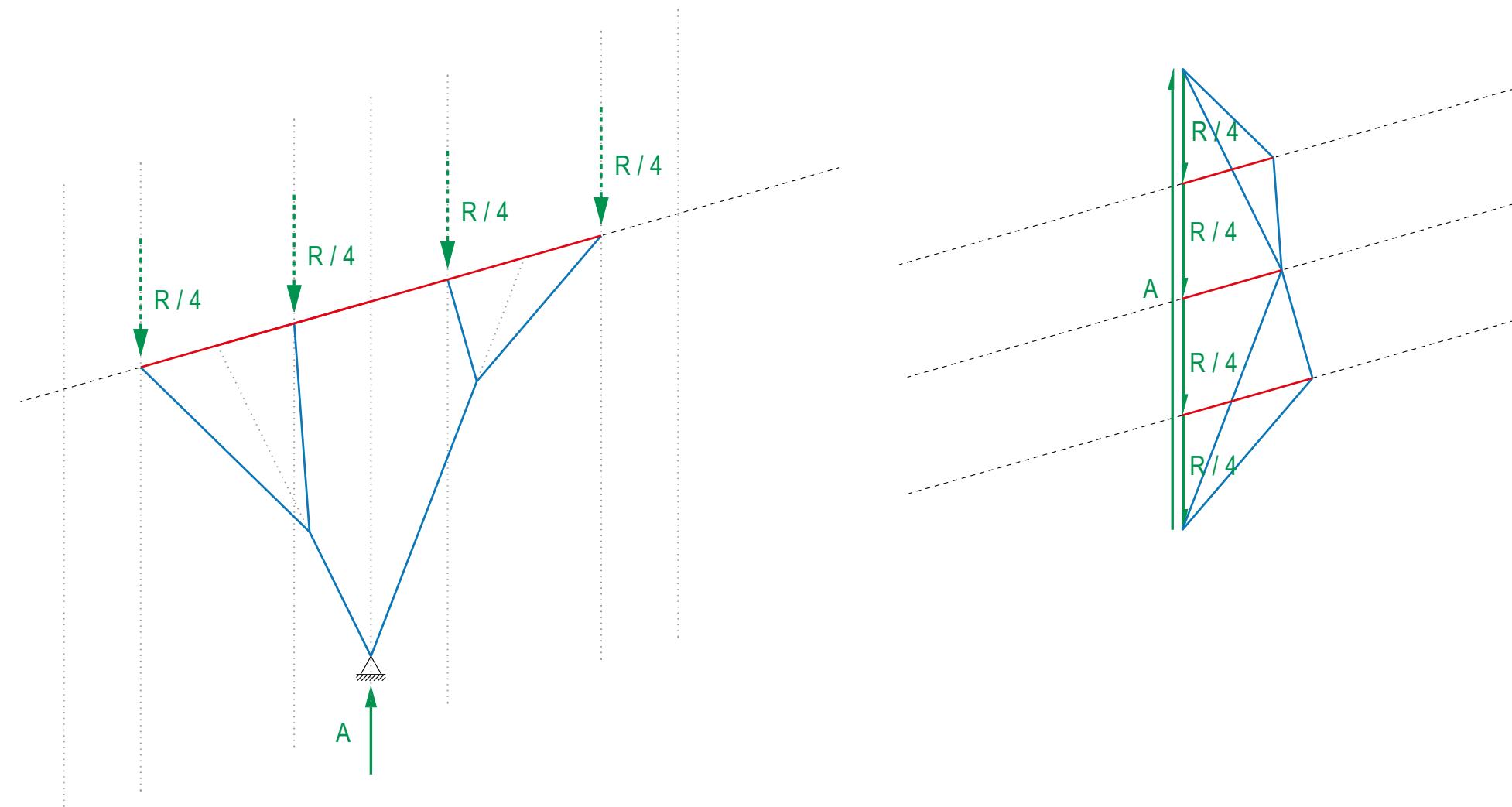
Form diagram 1:100Kräfteplan 1 cm \triangleq 1 kN*Force diagram 1 cm \triangleq 1 kN*



Lageplan 1:100

Form diagram 1:100

Kräfteplan 1 cm \triangleq 1 kNForce diagram 1 cm \triangleq 1 kN



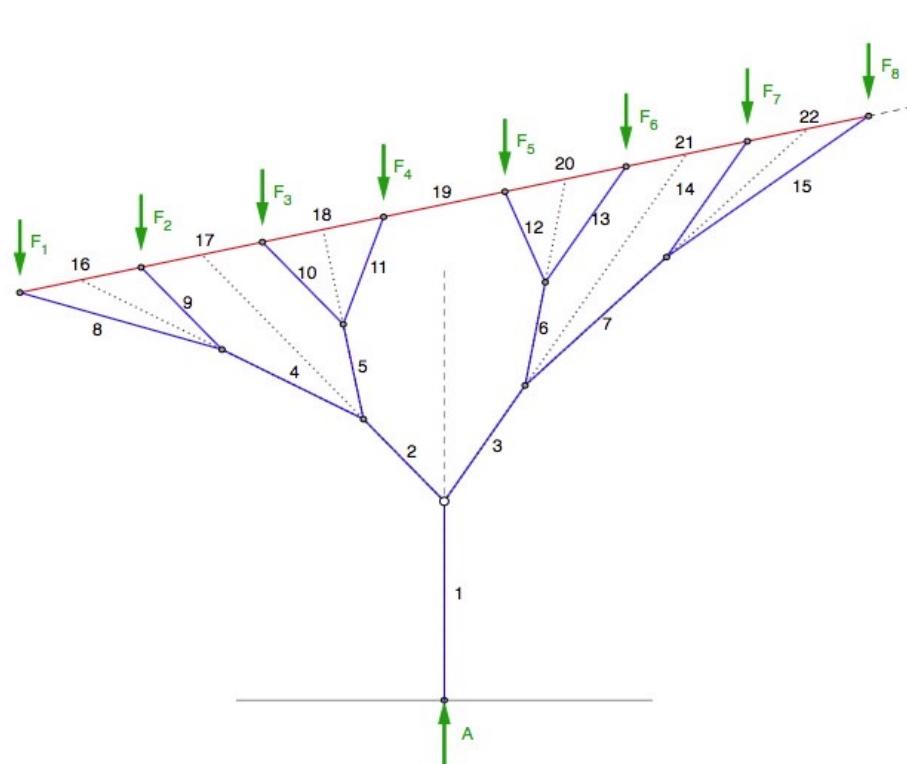
Lageplan 1:100

Form diagram 1:100

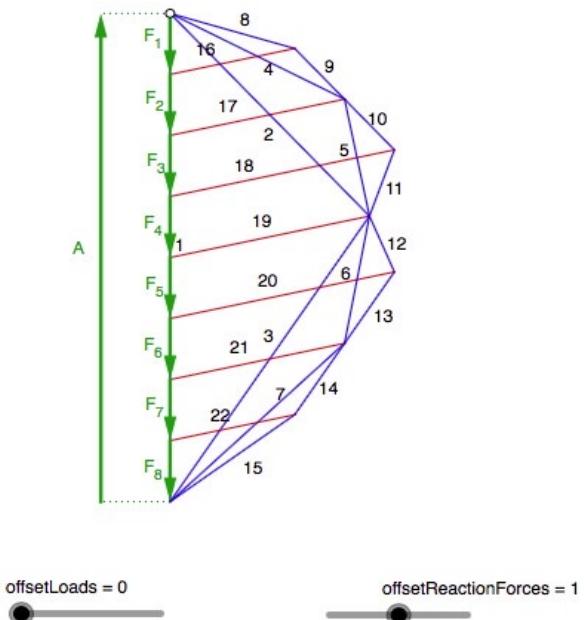
Kräfteplan 1 cm \triangleq 1 kNForce diagram 1 cm \triangleq 1 kN

eQ: Tree structure

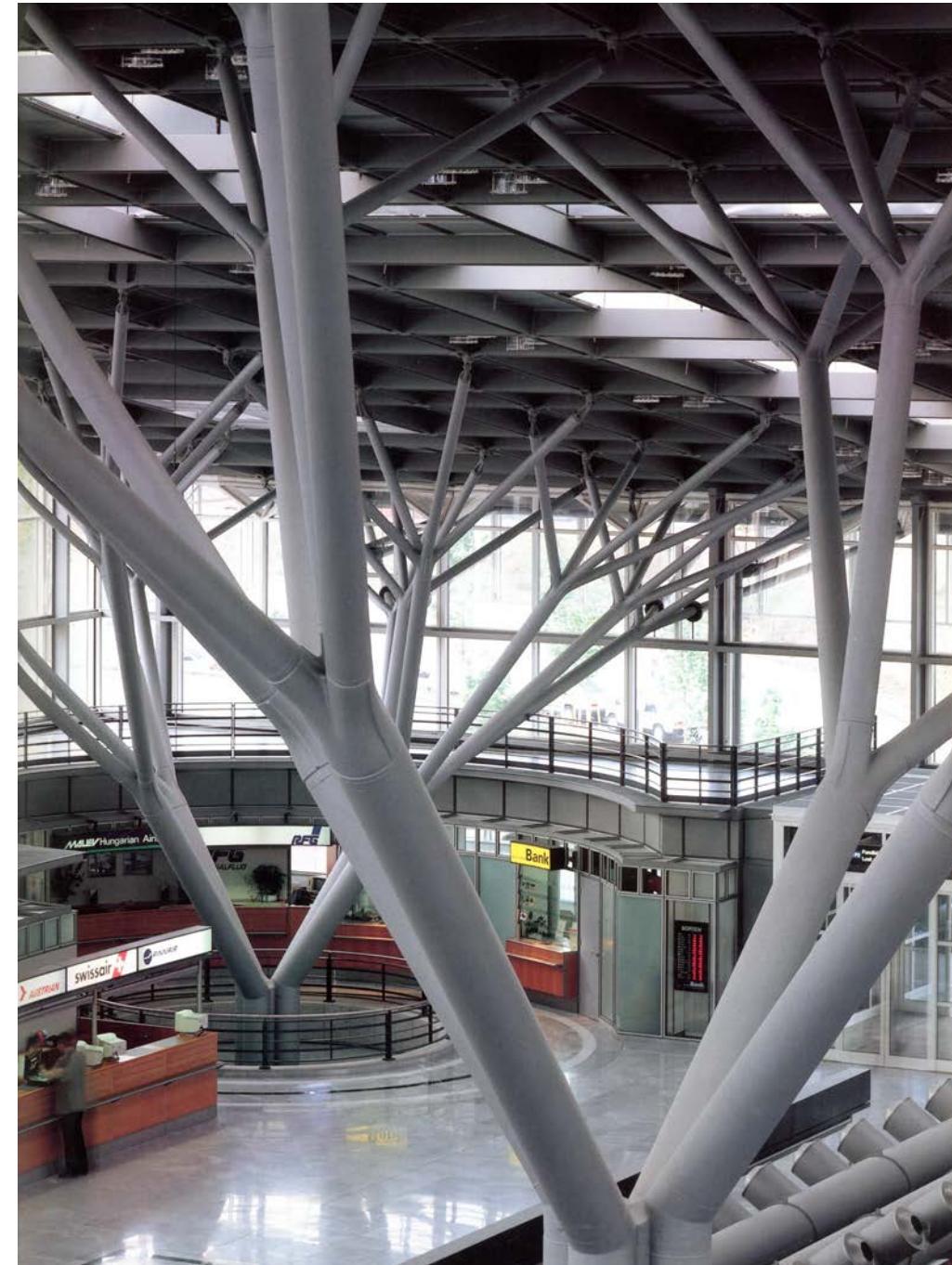
Form Diagram



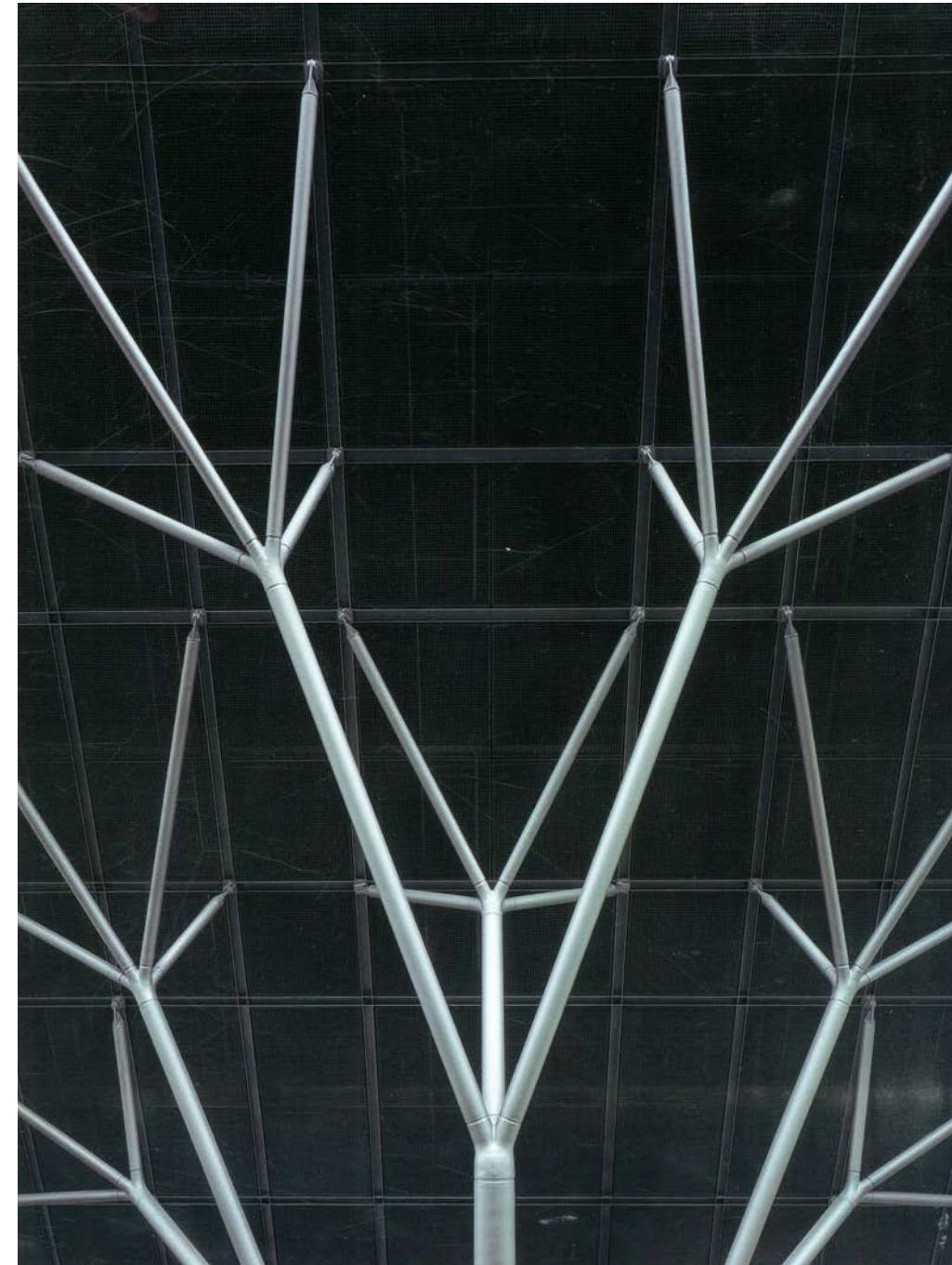
Force Diagram



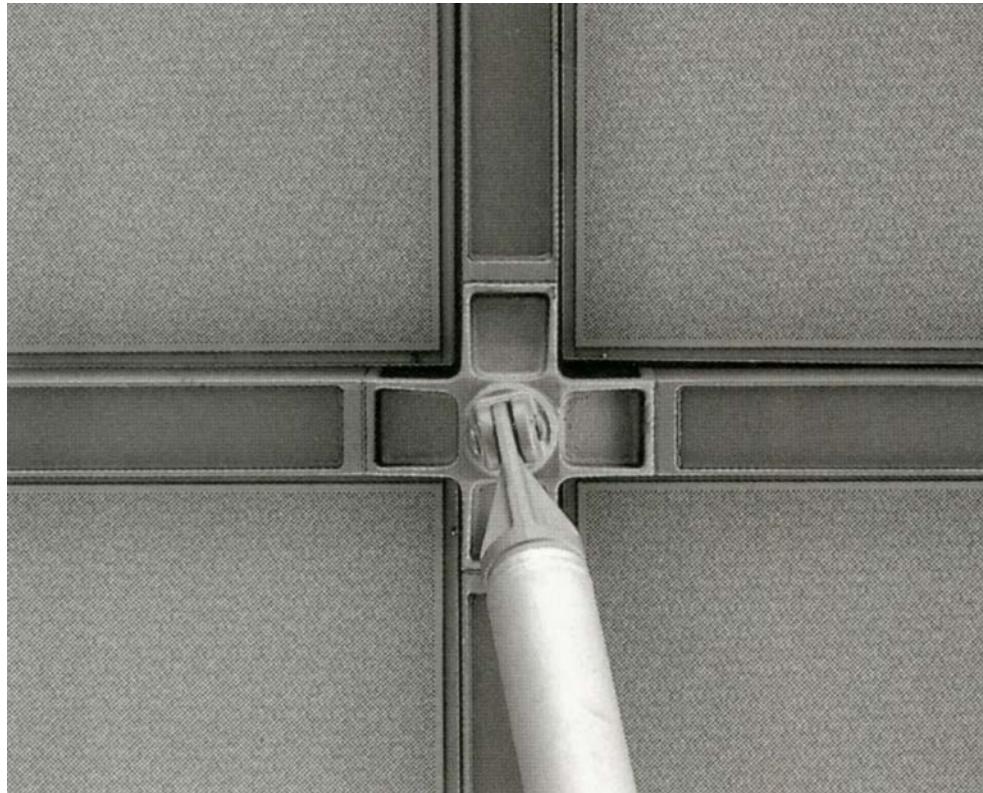
<http://www.block.arch.ethz.ch/eq/drawing/view/25>



Gerkan, Mark & Partner, Schlaich Bergermann: Stuttgart Airport Terminal 3, 2004



Gerkan, Mark & Partner, Schlaich Bergermann: Stuttgart Airport Terminal 3, 2004



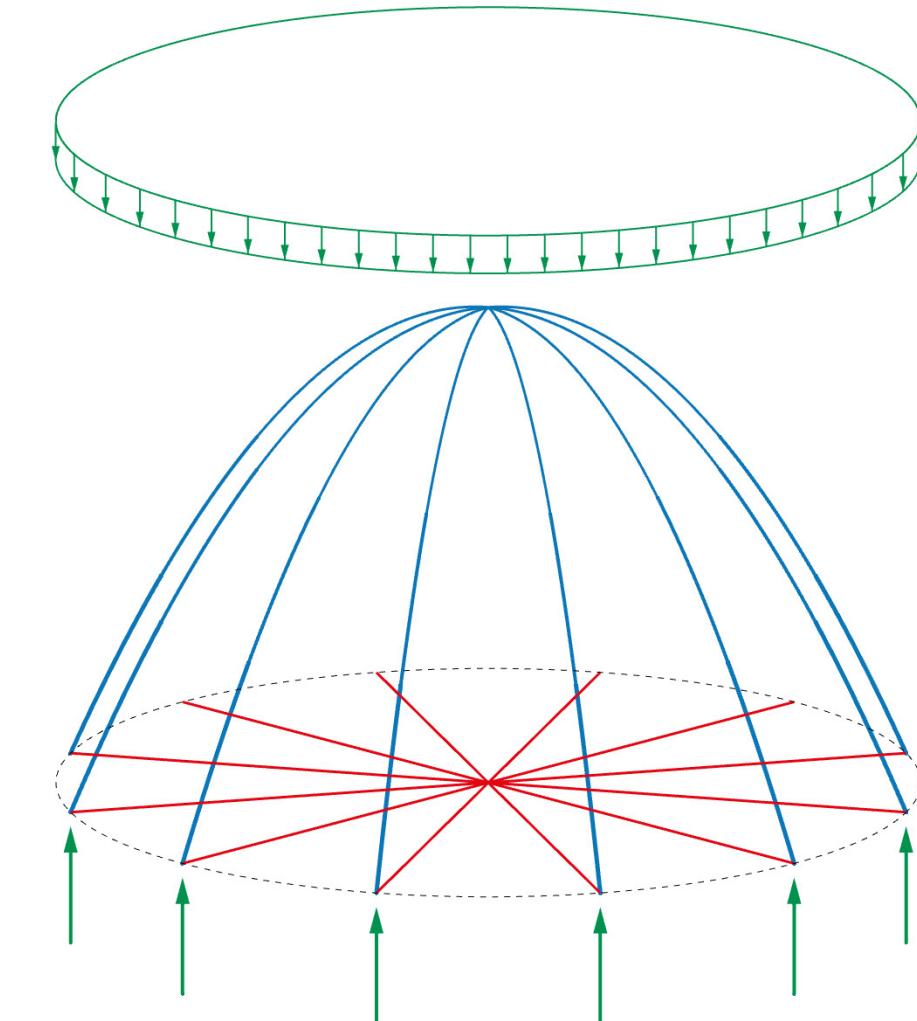
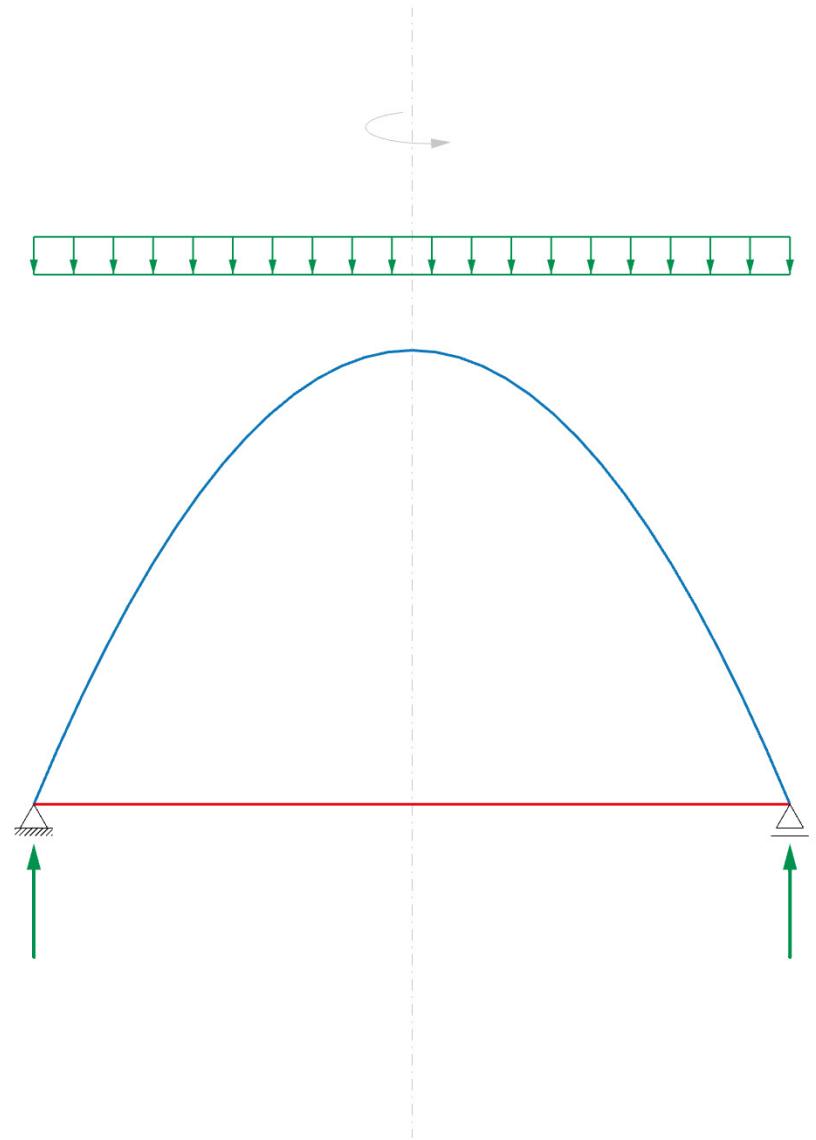
Gerkan, Mark & Partner, Schlaich Bergermann: Stuttgart Airport Terminal 3, 2004

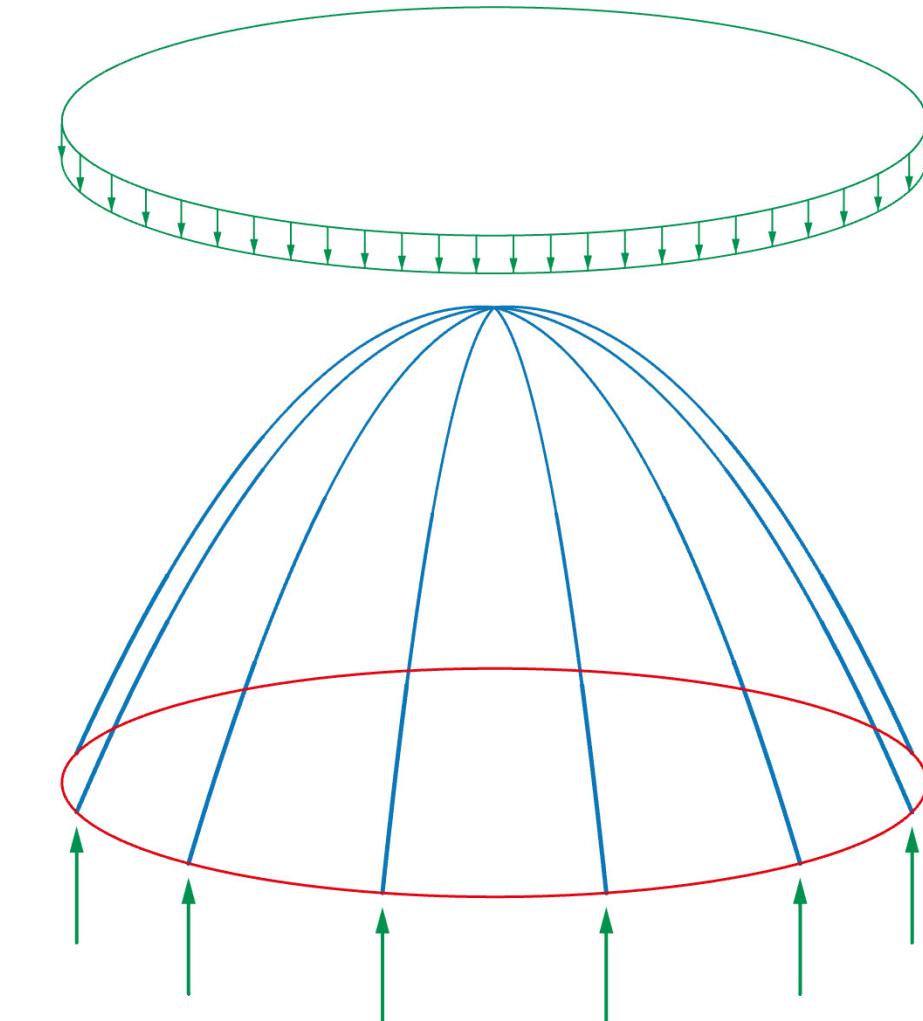
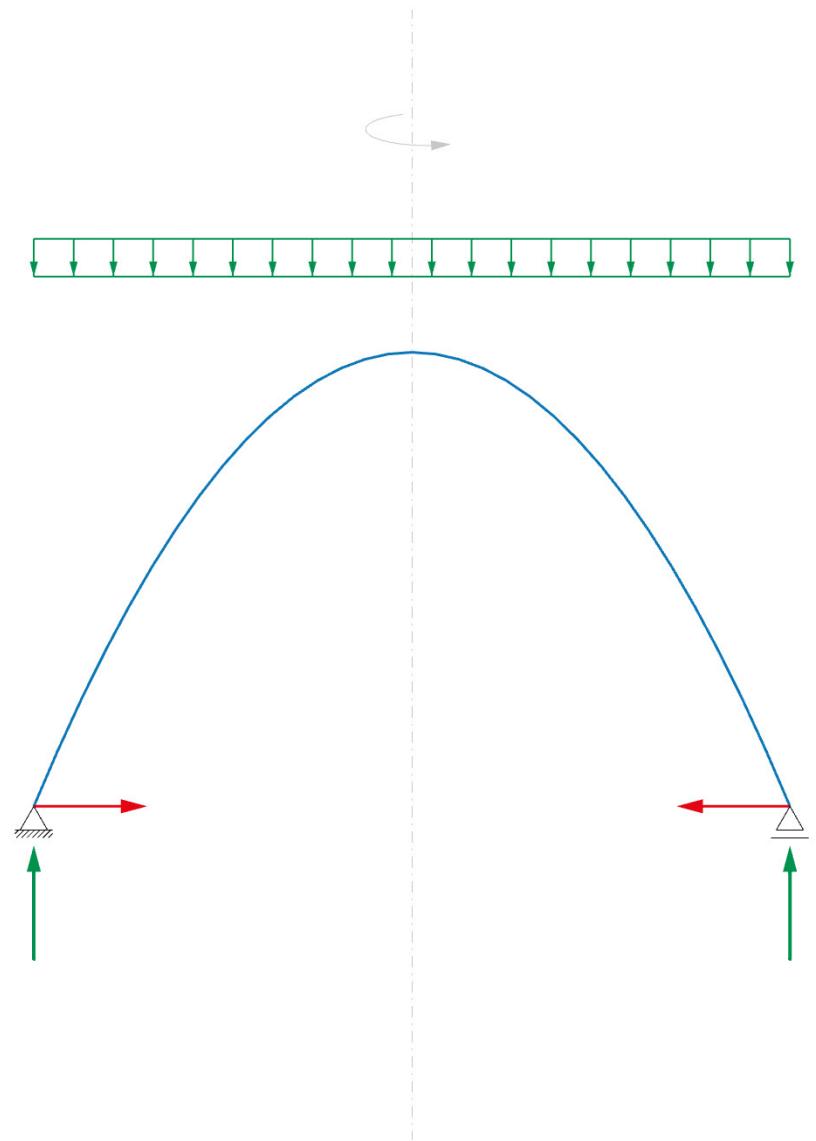
Räumliche Bogen-Seil-Tragwerke

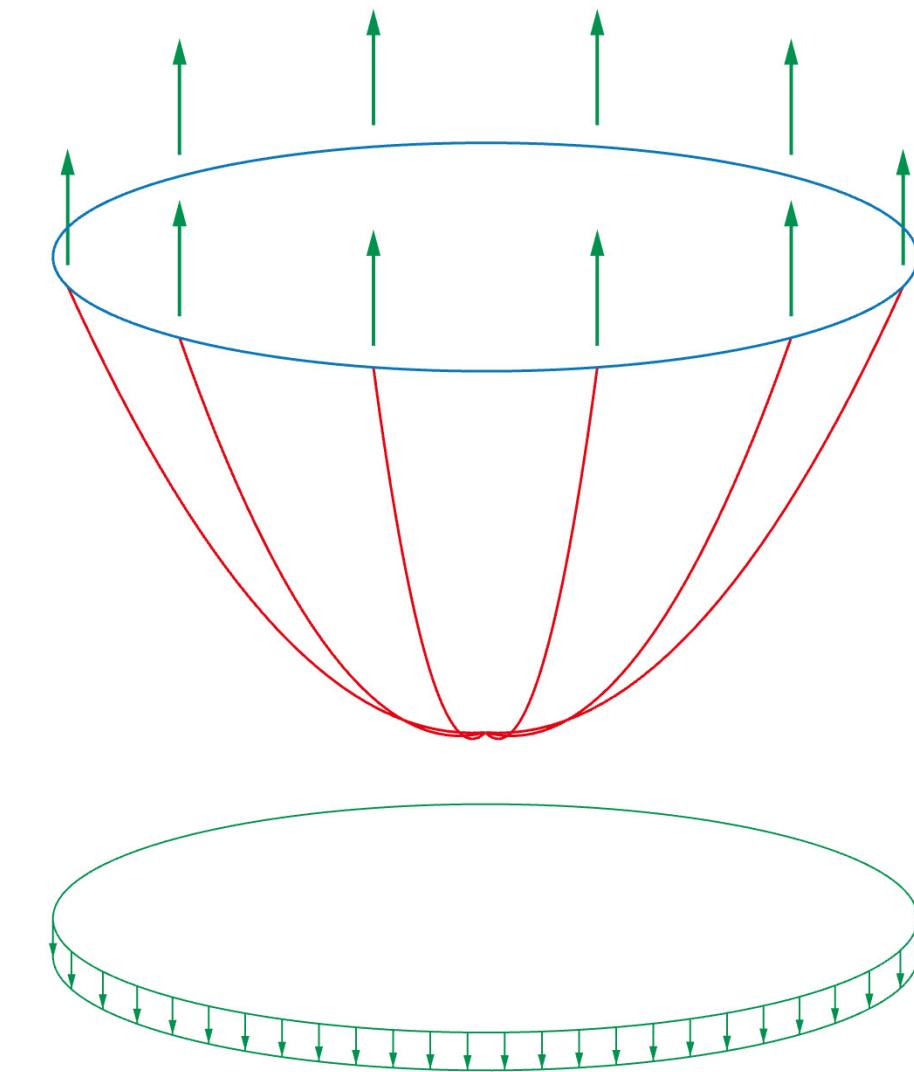
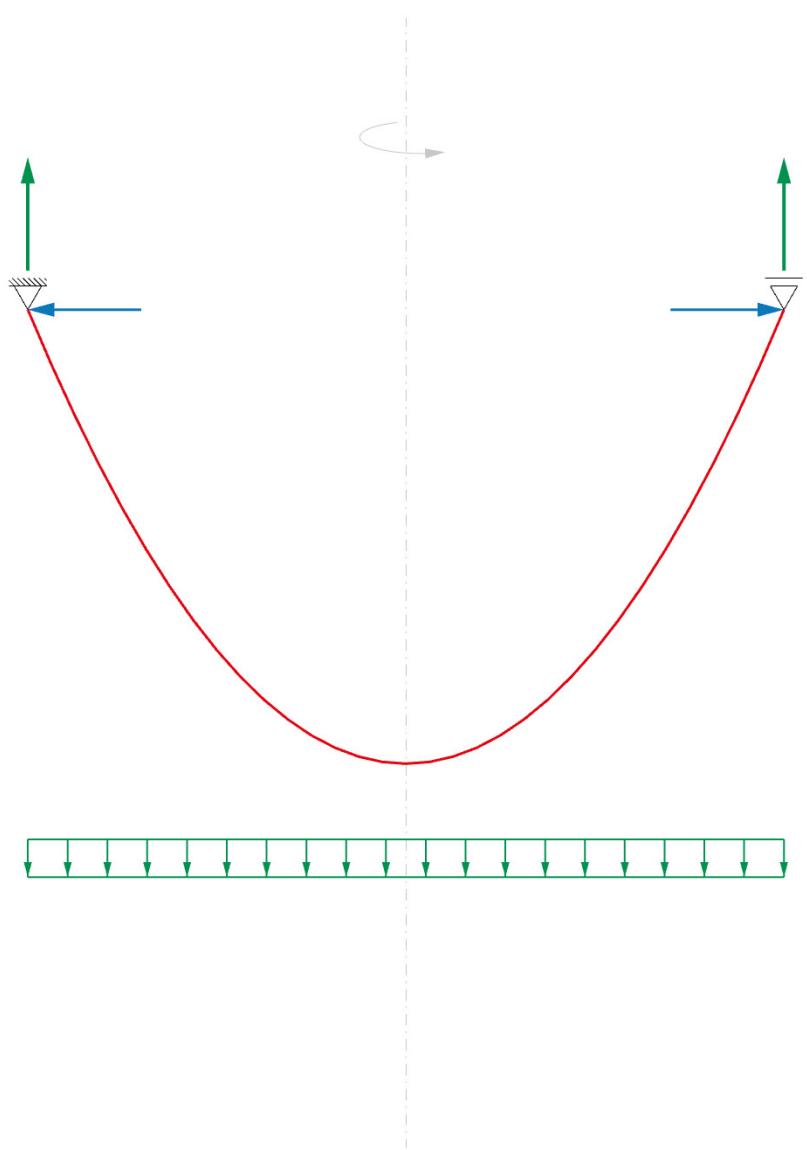
Spatial arch-cable structures

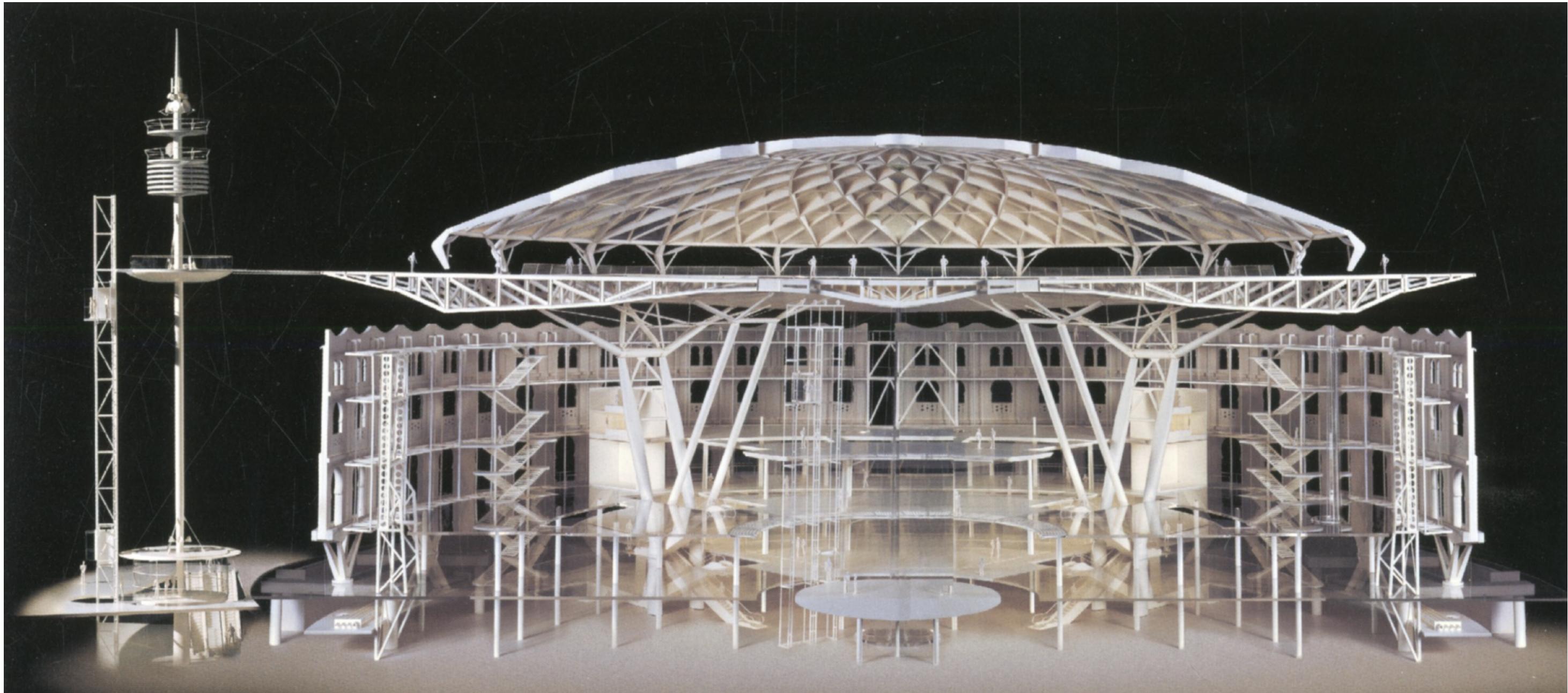
>> Bogen-Seil-Tragwerke mit Druck- und Zugringen
Arch-cables with tension and compression rings

Kombinationen von Bogen und Seil
Combinations of arch and cable





Arch-cables with tension and compression rings



R. Rogers: Las Arenas, Barcelona, 2009

Arch-cables with tension and compression rings

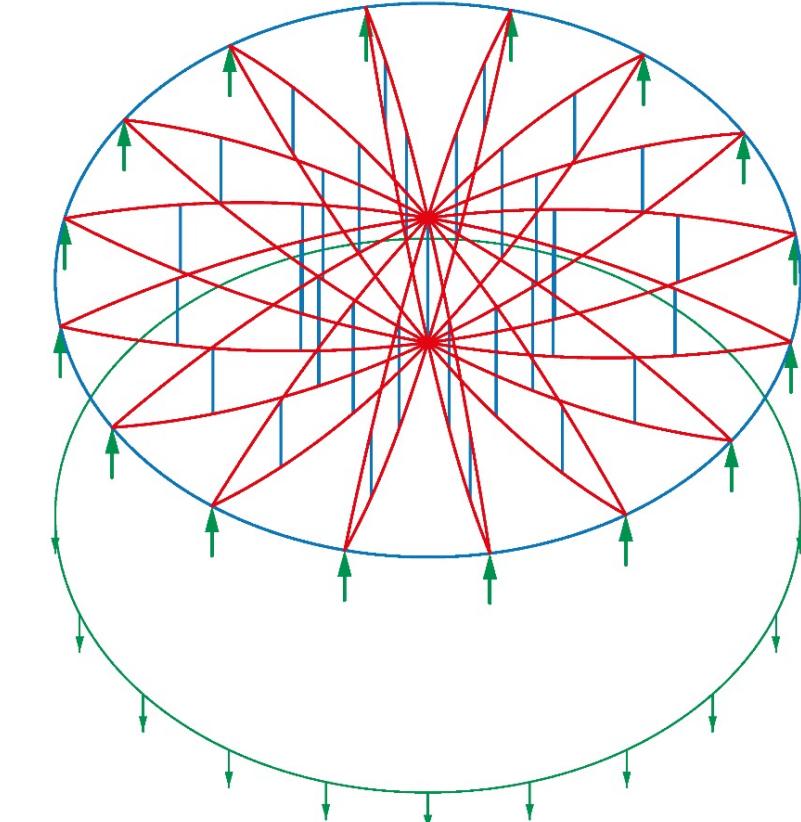
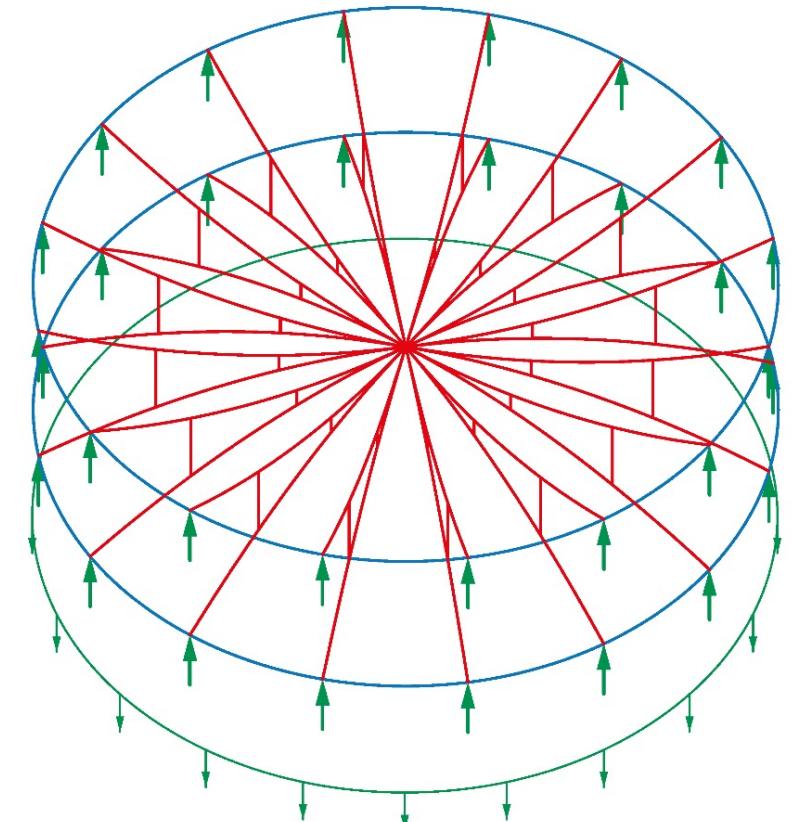
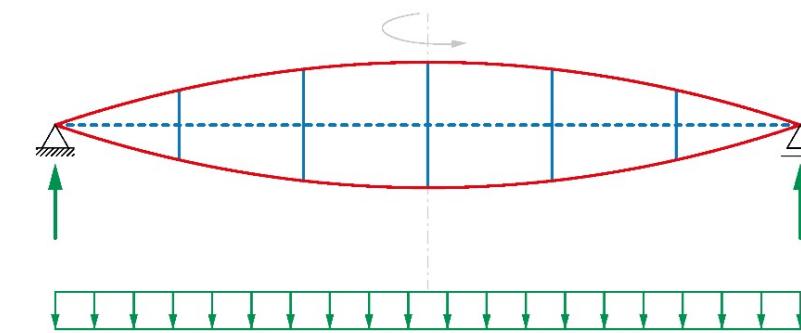
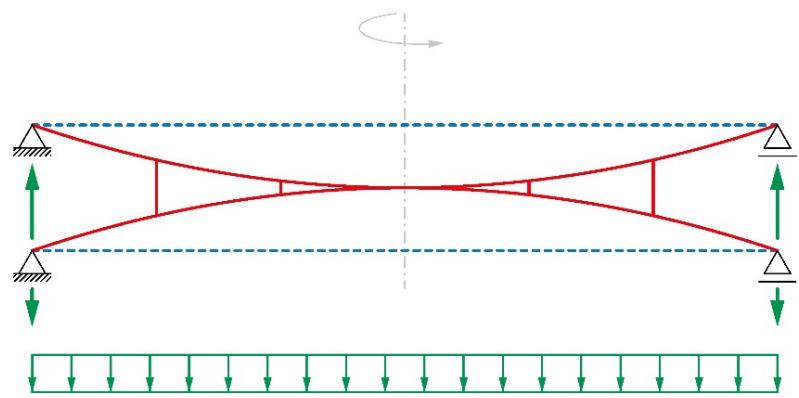


R. Rogers: Las Arenas, Barcelona, 2009



R. Rogers: Las Arenas, Barcelona, 2009

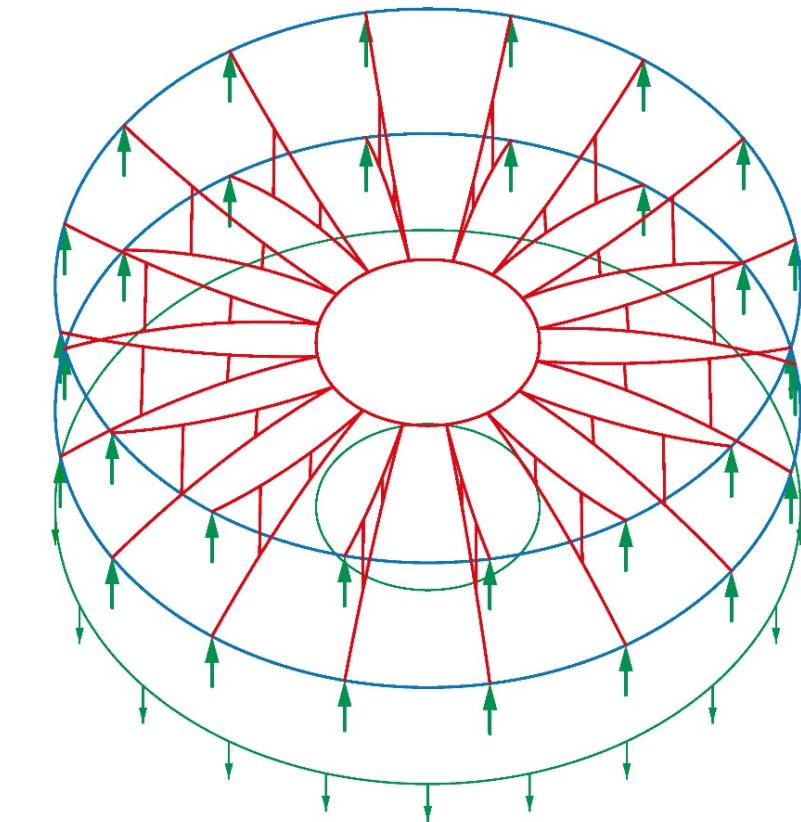
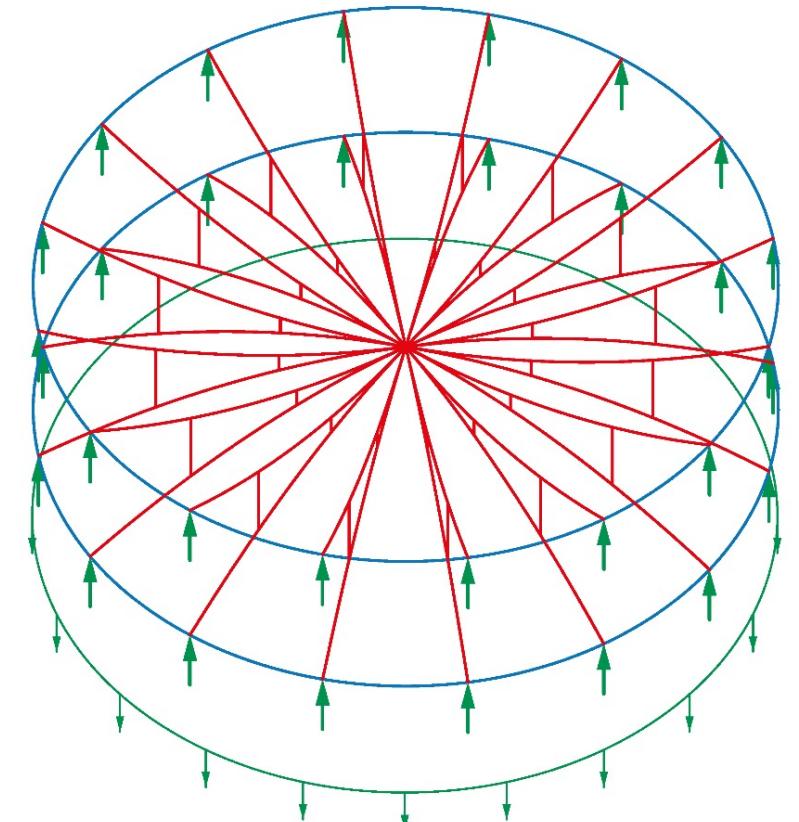
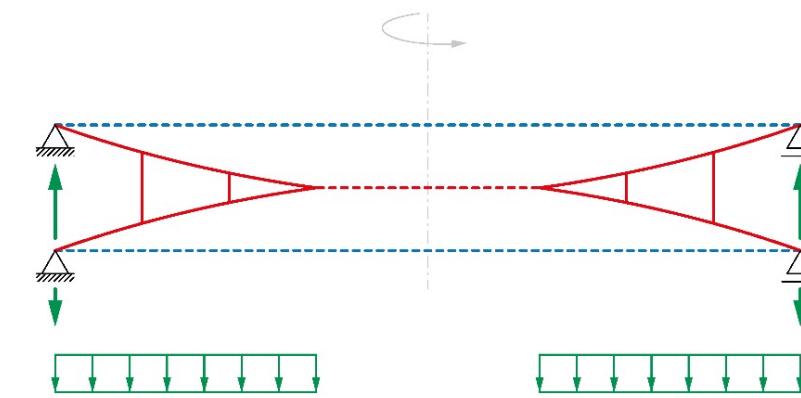
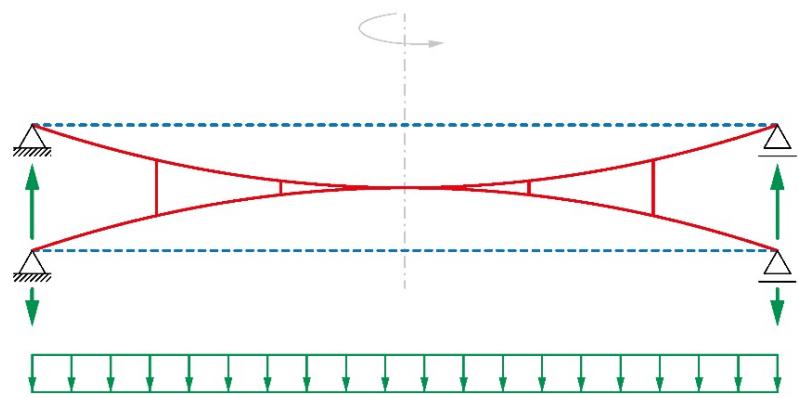
Arch-cables with tension and compression rings



Aussteifungskonzepte

Concepts for stiffening

Arch-cables with tension and compression rings

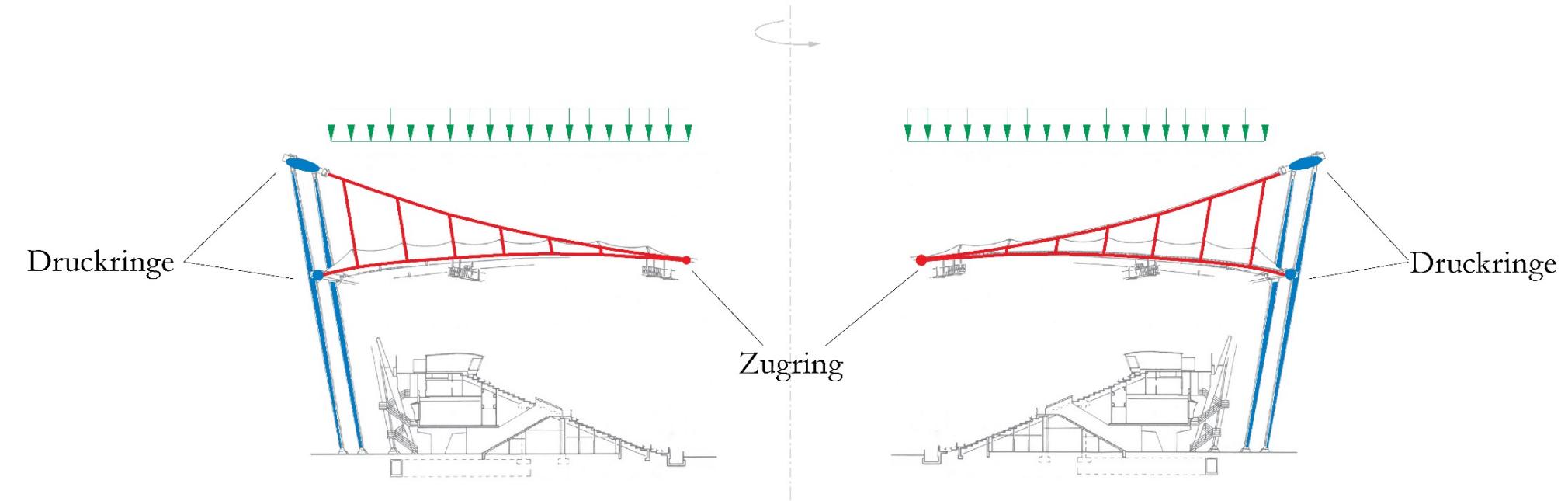


Öffnung der Fläche

Openings



Asp Architekten, Schlaich Bergermann & Partner: Mercedes Benz Arena, Stuttgart, 1993



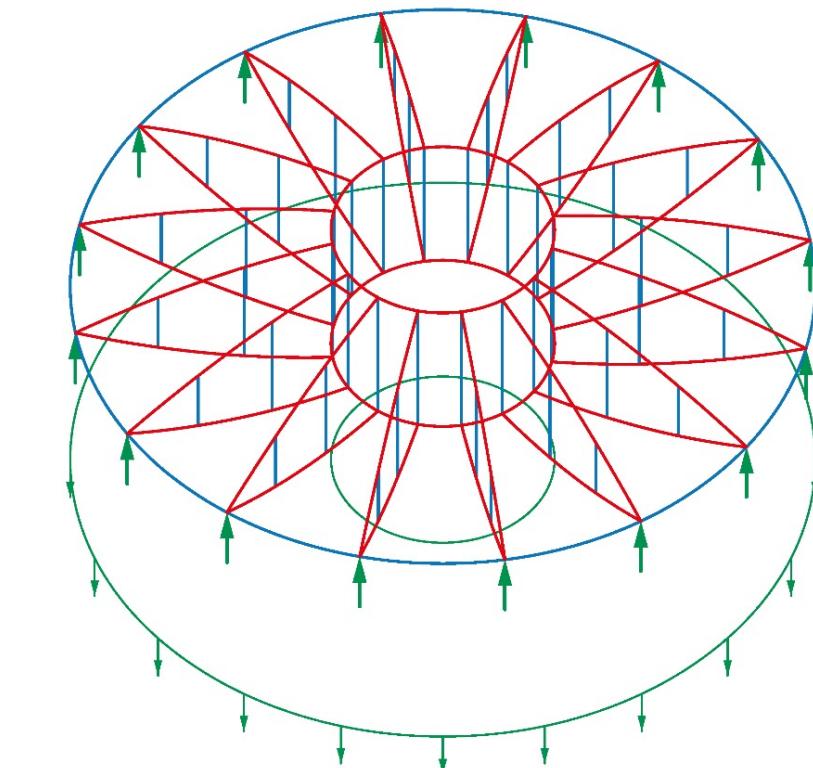
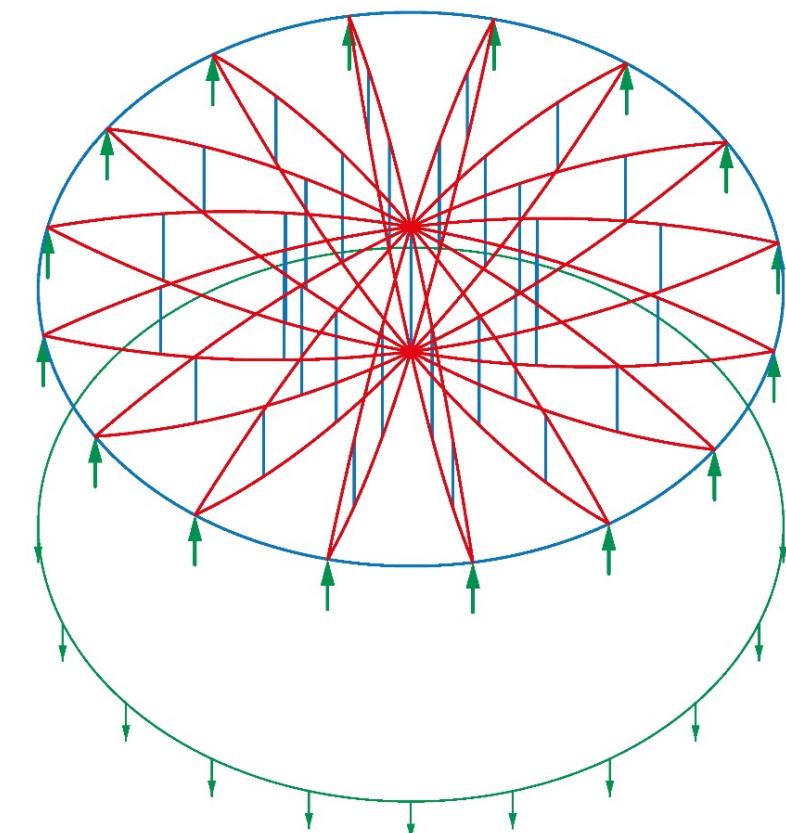
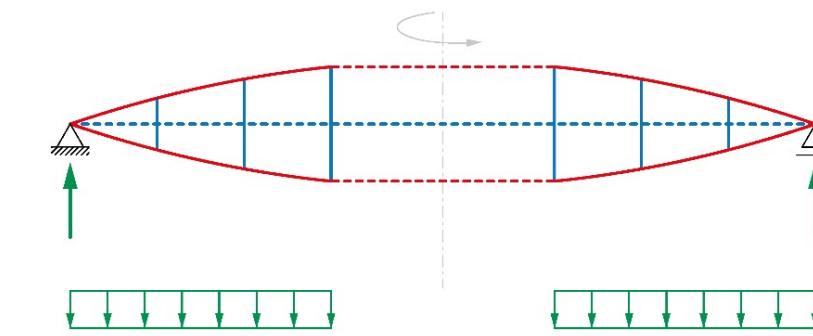
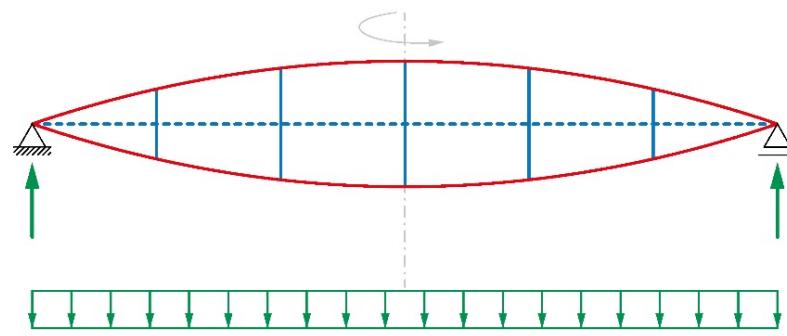
Asp Architekten, Schlaich Bergermann & Partner: Mercedes Benz Arena, Stuttgart, 1993

Arch-cables with tension and compression rings



Asp Architekten, Schlaich Bergermann & Partner: Mercedes Benz Arena, Stuttgart, 1993

Arch-cables with tension and compression rings



Öffnung der Fläche

Openings

Arch-cables with tension and compression rings



Daniel Fernandes, S. Bergermann & Partner: Maracana Stadion, Rio de Janeiro, 2013



Daniel Fernandes, S. Bergermann & Partner: Maracana Stadion, Rio de Janeiro, 2013

Räumliche Bogen-Seil-Tragwerke

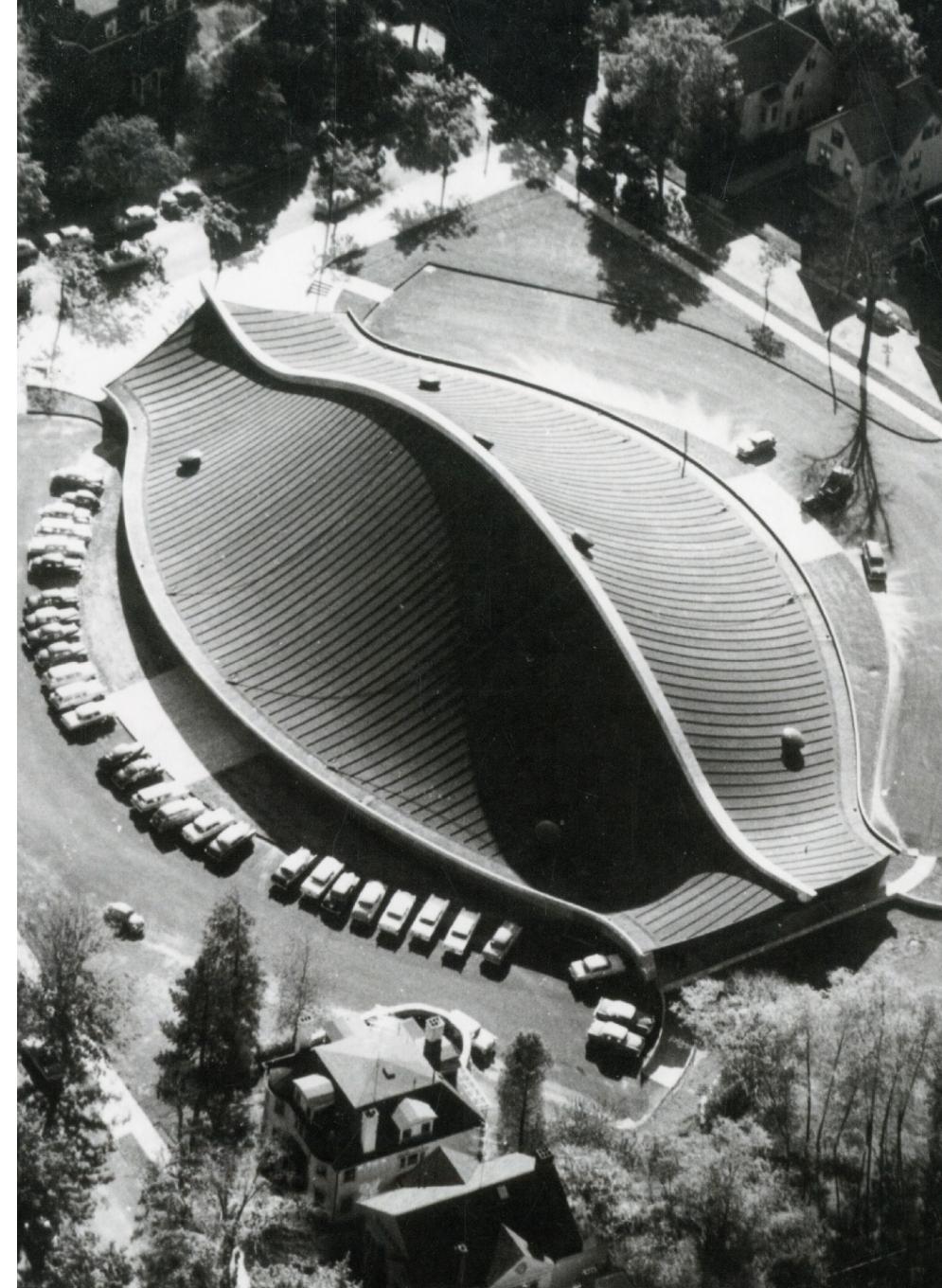
Spatial arch-cable structures

Bogen-Seil-Tragwerke mit Druck- und Zugringen

Arch-cables with tension and compression rings

- >> Kombinationen von Bogen und Seil

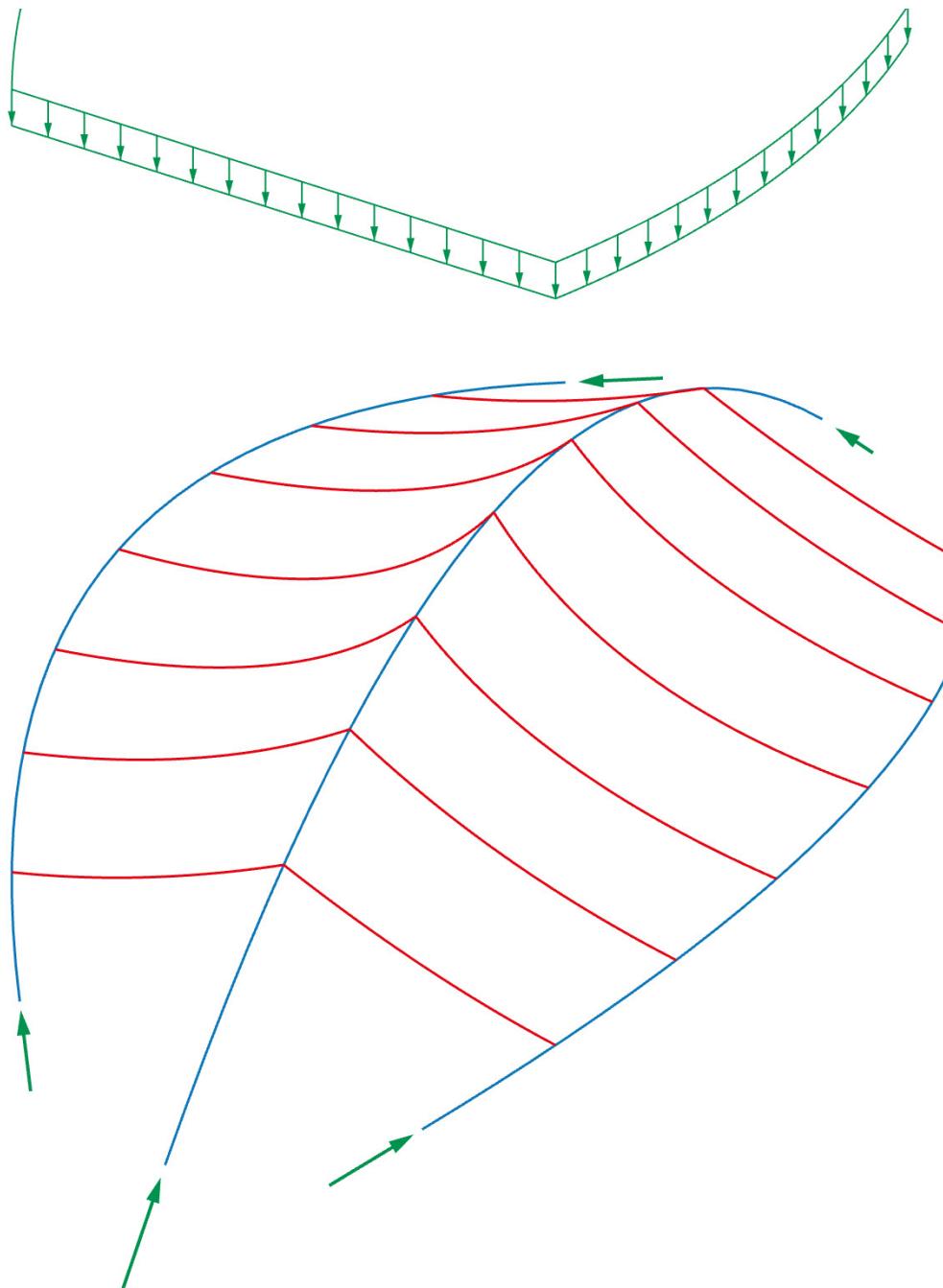
Combinations of arch and cable



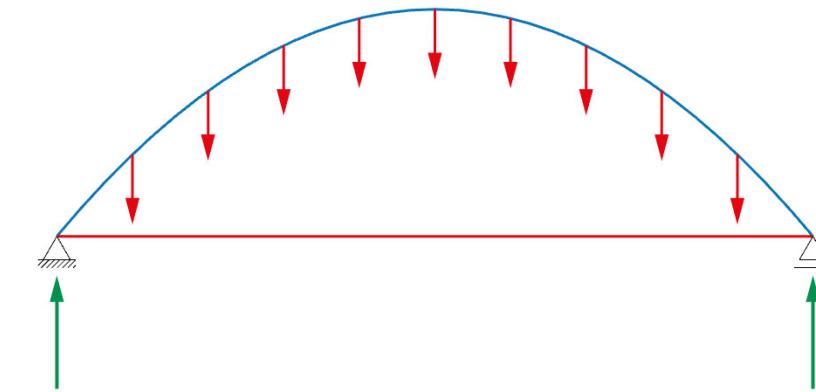
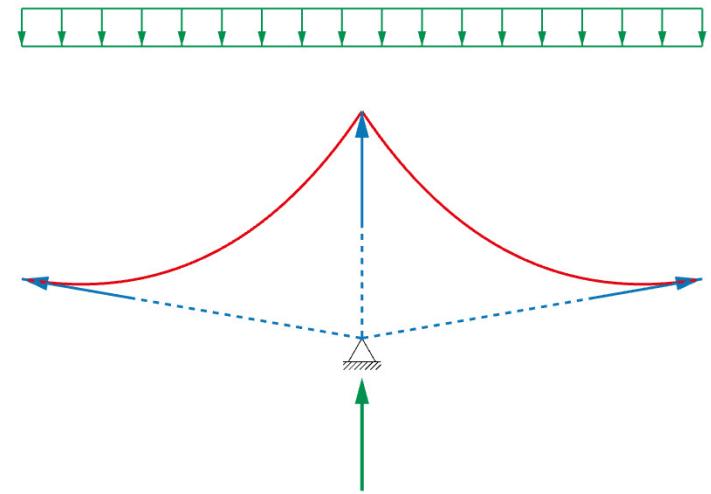
Eero Saarinen: D.S. Ingalls Hockey Stadion, New Haven, 1958



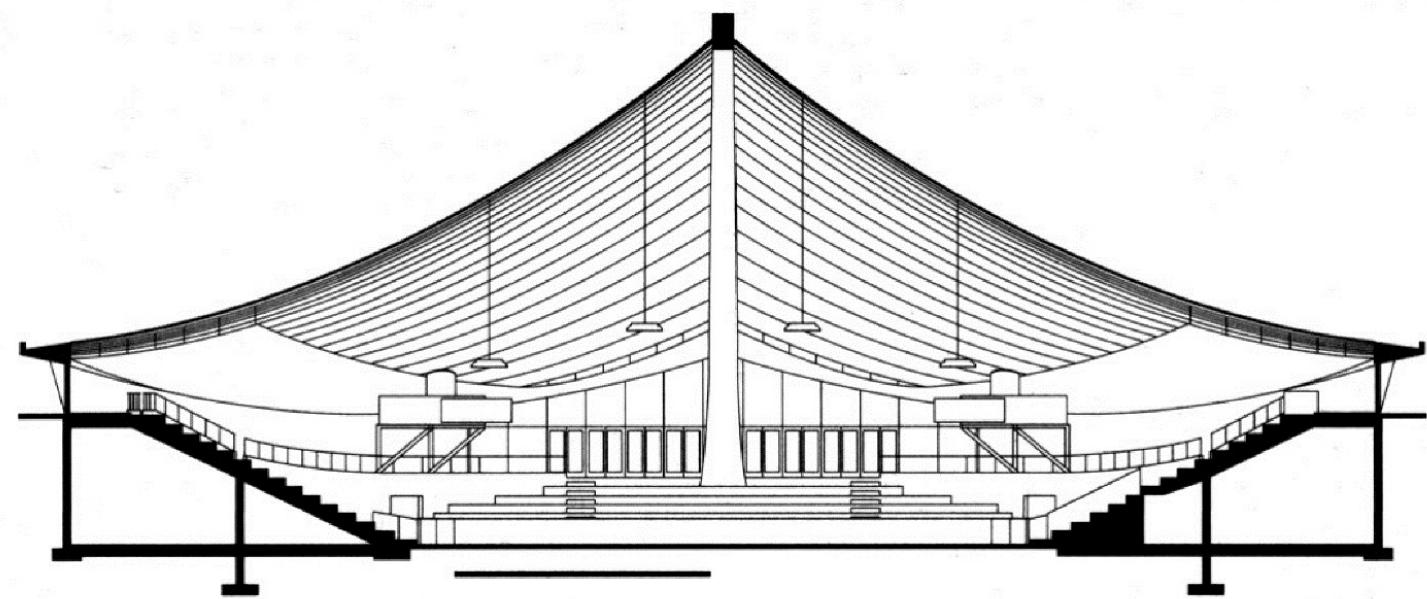
Eero Saarinen: D.S. Ingalls Hockey Stadion, New Haven, 1958



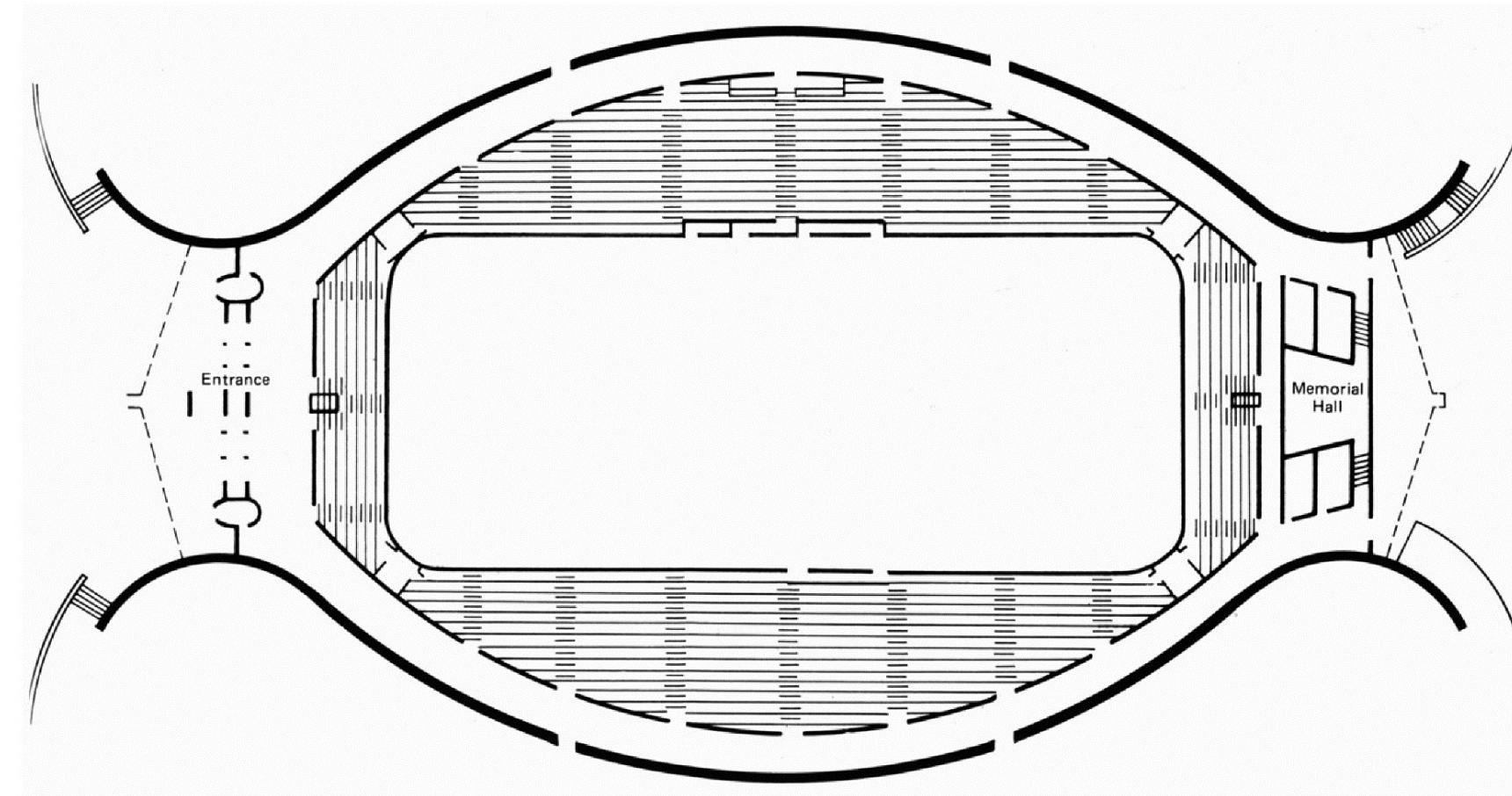
Eero Saarinen: D.S.Ingalls Hockey Stadion, New Haven, 1958



Eero Saarinen: D.S.Ingalls Hockey Stadion, New Haven, 1958



Eero Saarinen: D.S. Ingalls Hockey Stadion, New Haven, 1958



Eero Saarinen: D.S. Ingalls Hockey Stadion, New Haven, 1958

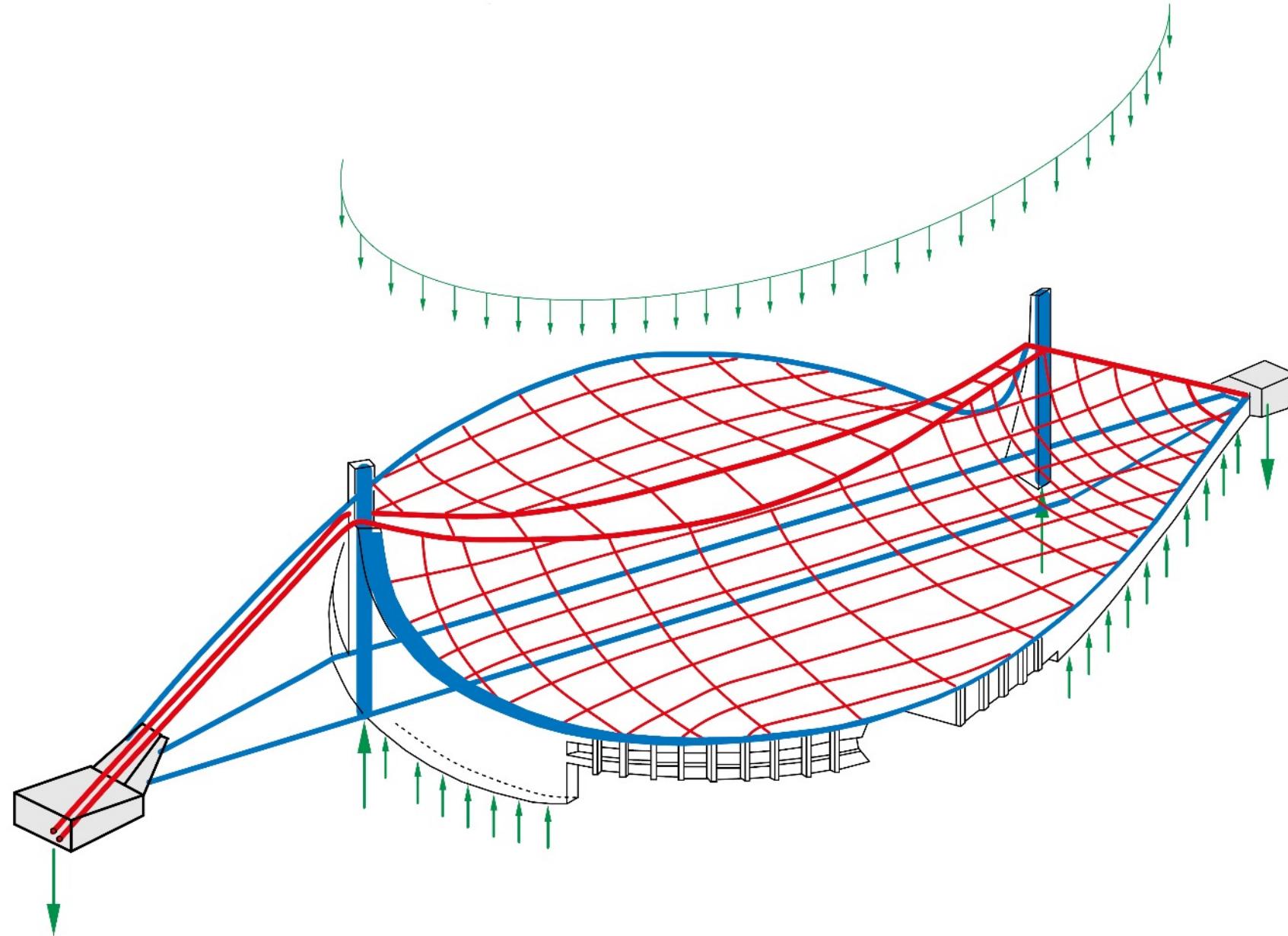
Combinations of arch and cable



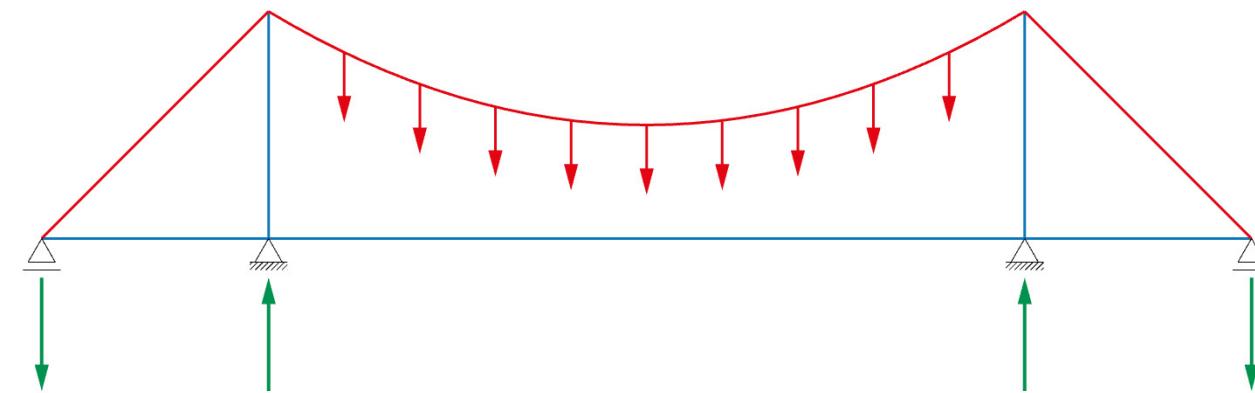
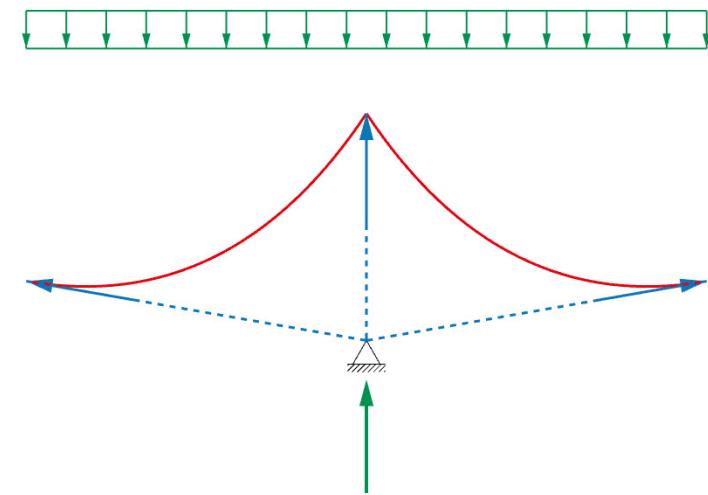
Kenzo Tange: National Gymnasium, Tokio, 1964



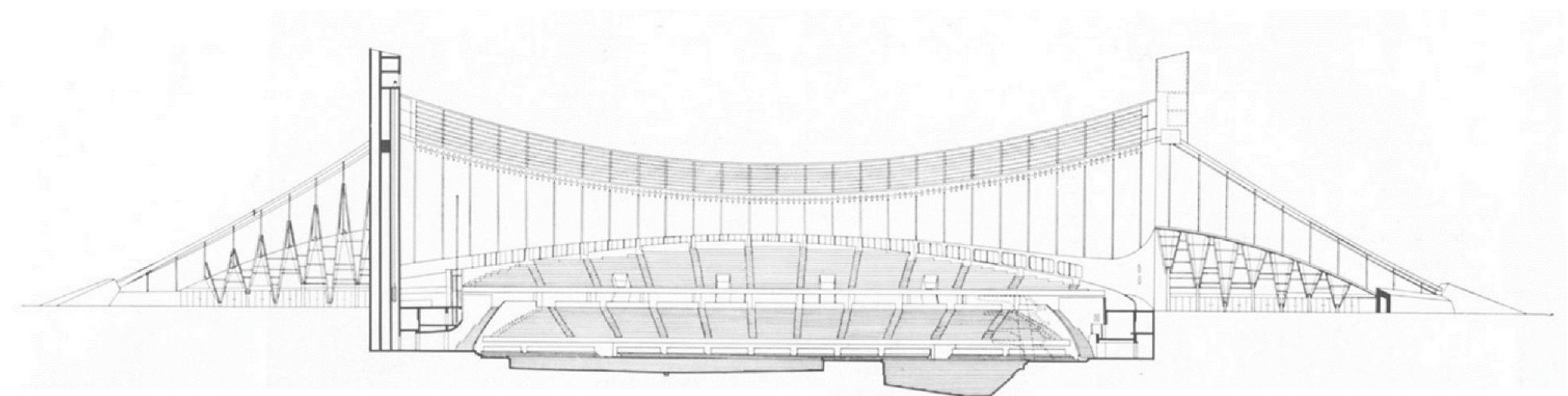
Kenzo Tange: National Gymnasium, Tokio, 1964



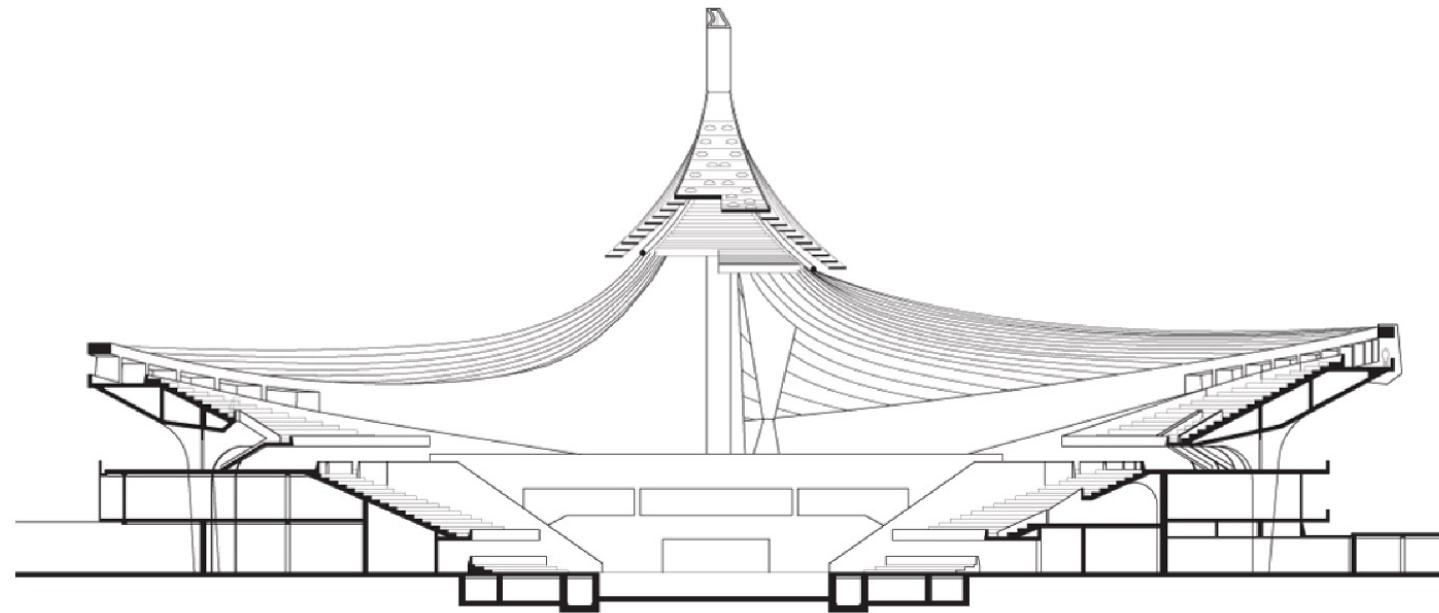
Kenzo Tange: National Gymnasium, Tokio, 1964



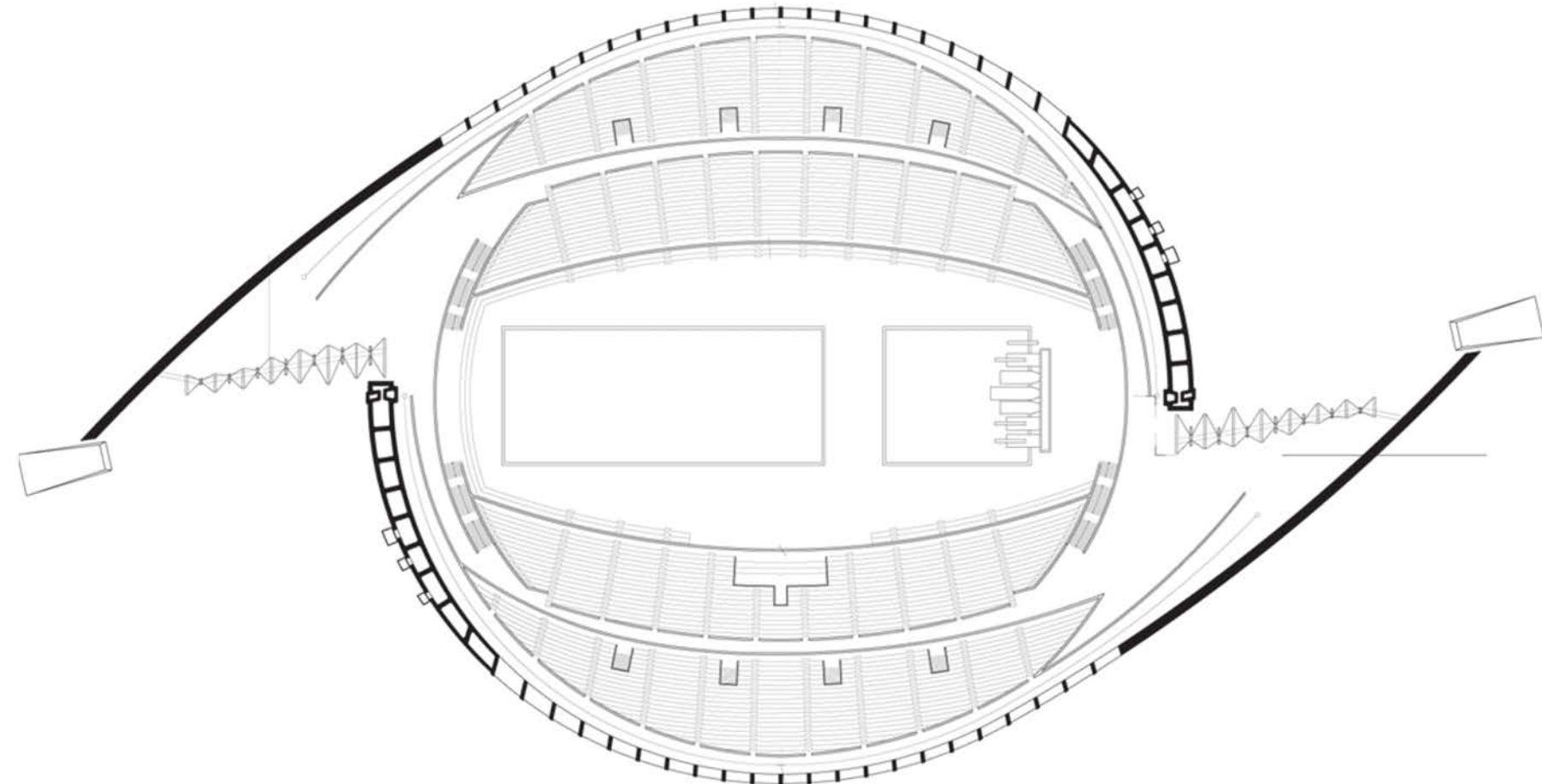
Kenzo Tange: National Gymnasium, Tokio, 1964



Kenzo Tange: National Gymnasium, Tokio, 1964



Kenzo Tange: National Gymnasium, Tokio, 1964



Kenzo Tange: National Gymnasium, Tokio, 1964



Kenzo Tange: National Gymnasium, Tokio, 1964