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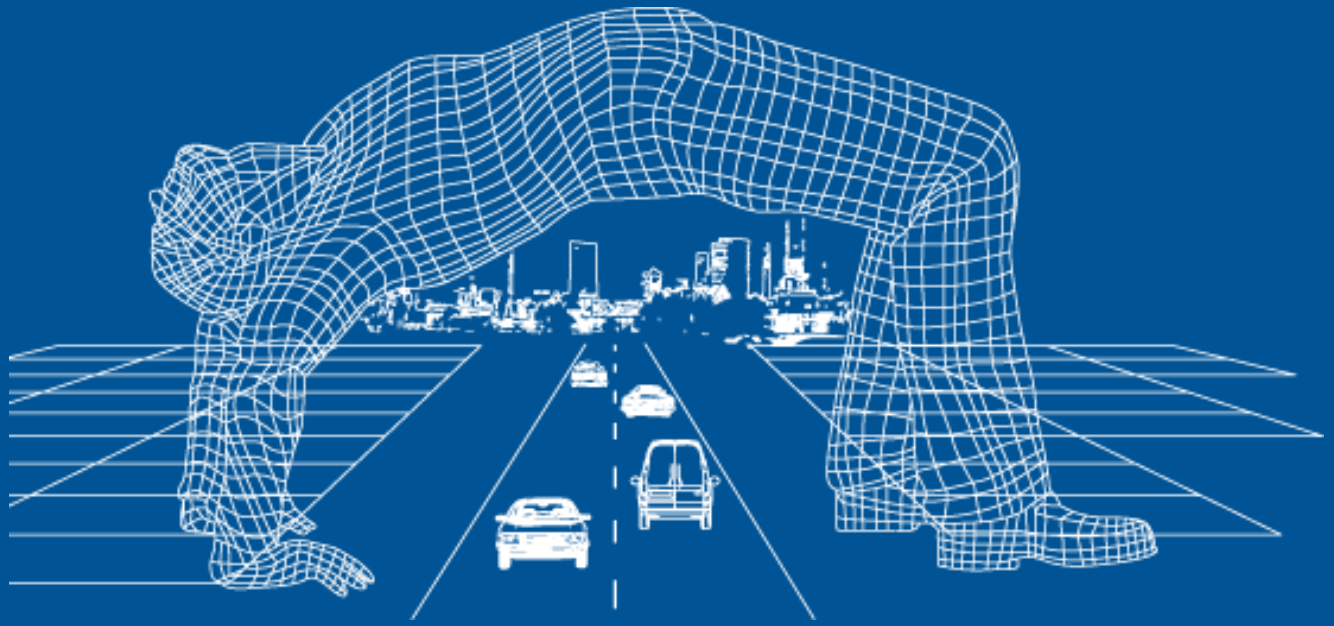
Aluminium Bridge Design



Aluminium bridges

We connect people and places!

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Aluminium for Bridges?

Is Aluminium strong enough?

Why should we use Aluminium?

Aluminium is too expensive!

Analyses of the material aluminium

EN AW-6082 T6 **AlMgSi 1.0** **R_m = 310 N/mm², $R_{p0.2}$ = 260 N/mm²**

Good anticorrosion properties, very good static properties, very good welding and good machining properties
Good suitability for extruded profiles. This material is used for all load-bearing components (e.g.flanges, main supports, cross girders, diagonals, platforms etc..)

EN AW-6005 T6 **AlMgSi 0.7** **R_m = 255 N/mm², $R_{p0.2}$ = 215 N/mm²**

Very good anticorrosion properties, good static properties, very good welding and good machining properties
Good suitability for extruded profiles. This material is used for platforms.

EN AW-6060 T6 **AlMgSi 0.5** **R_m = 195 N/mm², $R_{p0.2}$ = 150 N/mm²**

Very good anticorrosion properties, very good anodizing capacity, good welding properties, very good suitability for extruded profiles
This material is used for covers, plates, screens and other components not subject to static loads or only exposed to low loads.

Comparison values for structural steel:

S235 JR (formerly St 37-2) **R_m = 360 N/mm², R_p = 235 N/mm²**

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Aluminium is strong enough!

Current bridge systems

L system

B system

sL system

R system

R system

- System for small spans
- Simple construction ("girder bridge" with girder grillage)
- Also available without railings or only with single-sided railing as ramp, board-walk or floating jetty.

- Area of application: Foot bridges up to 12m length
- Price segment: 10.000 – 40.000 €
- Introduced: 2008



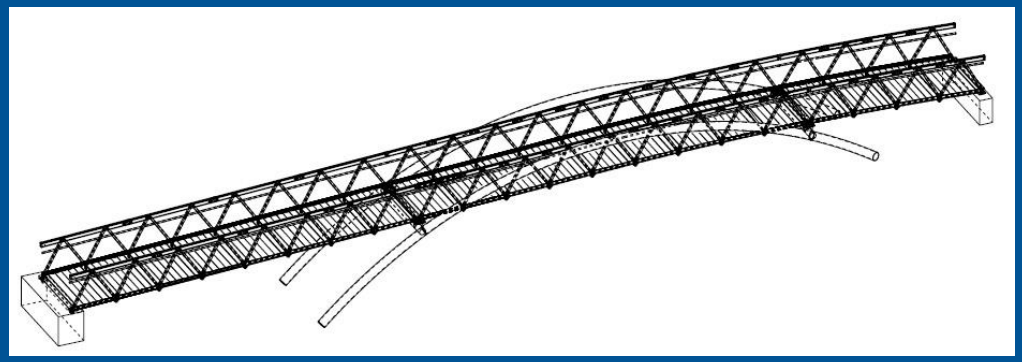


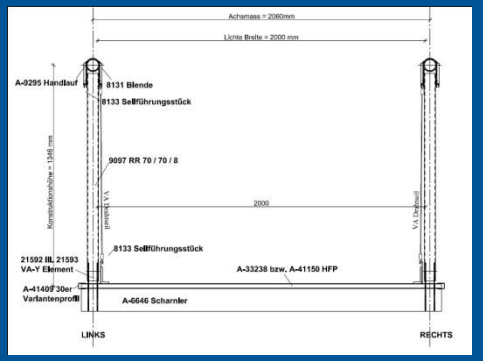
L system

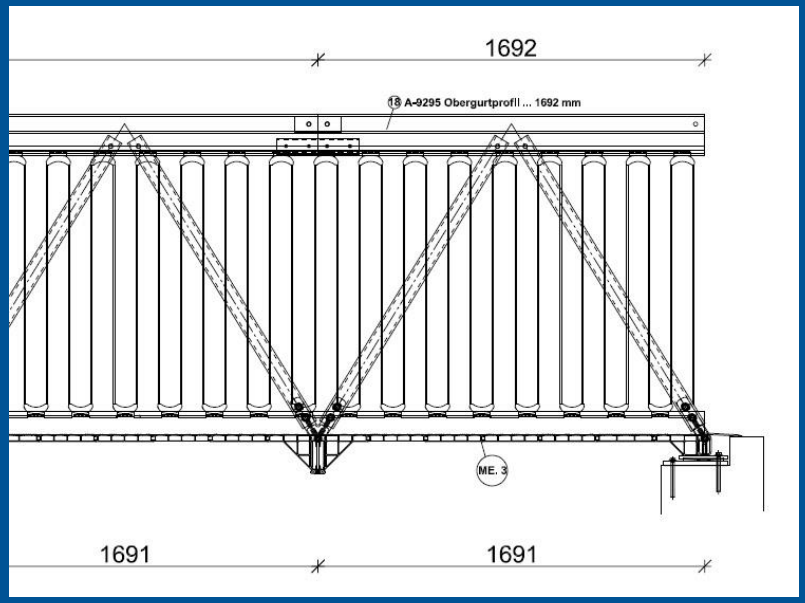
- Material-optimized system for small and medium spans
- Trough bridge with side trussed girders
- Without separate bottom flange; the walkway assumes this task

- Area of application: Bridges from 5 to 22m length
- Price segment: 20.000 – 60.000 €
- Introduced: 1998

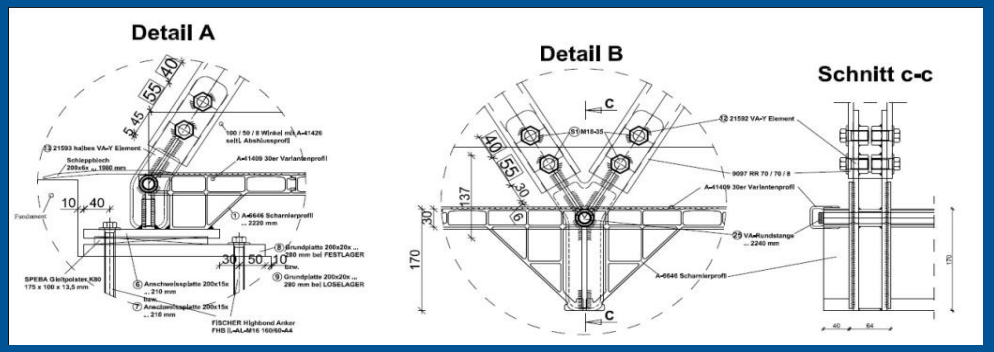






Very material-reduced trussed trough bridge whose platform ensures the load-bearing function of a bottom flange and the transverse bracing of the system at the same time. The connection of the diagonals to the platform is assumed by the V2A nodes specially designed for this. Saving potential (material weight) in comparison to identically sized sL bridges ~ 40% or in comparison to B system bridges ~ 60%.

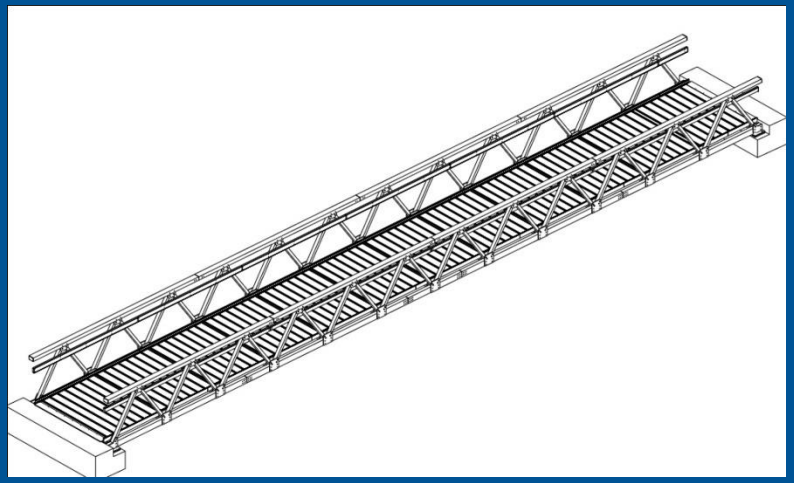


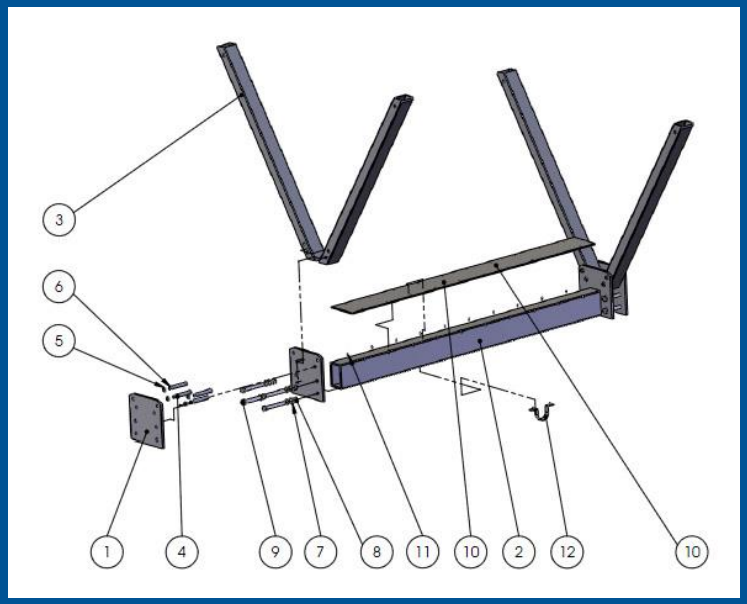
sL system

- Material-optimized system for medium spans
- Trough bridge with side trussed girders
- Economical thanks to the use of bolted joints

- Area of application: Bridges from 15 to 33m length
- Price segment: 70.000 – 200.000 €
- Introduced: 2010





Trussed trough bridge with top and bottom flange as well as diagonals

Weight: (at 3m width)
approx. 220 – 280kg / running m

The diagonals are fastened with joint plates on the top and bottom flange.

The transverse bracing is realized via screwed cross girders.

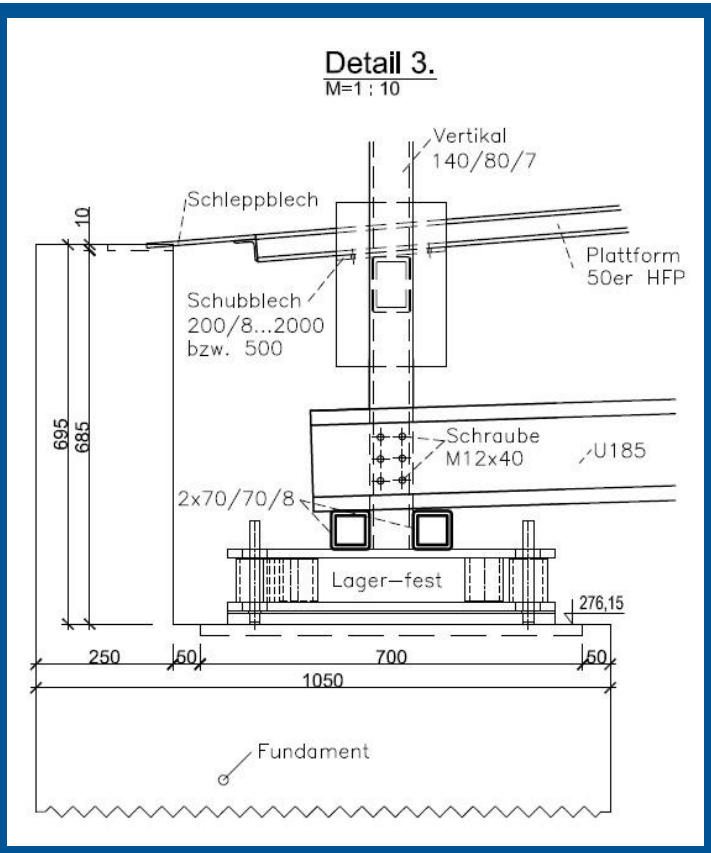
For reinforcement, jointly supporting hollow compartment plates (laser welded) are screwed onto these cross girders.

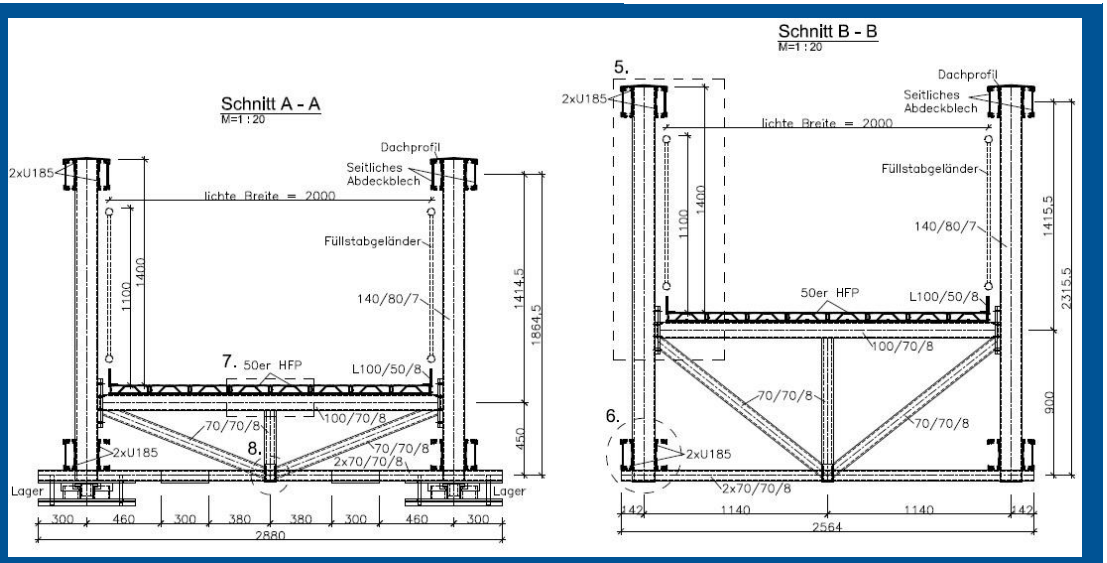
B system

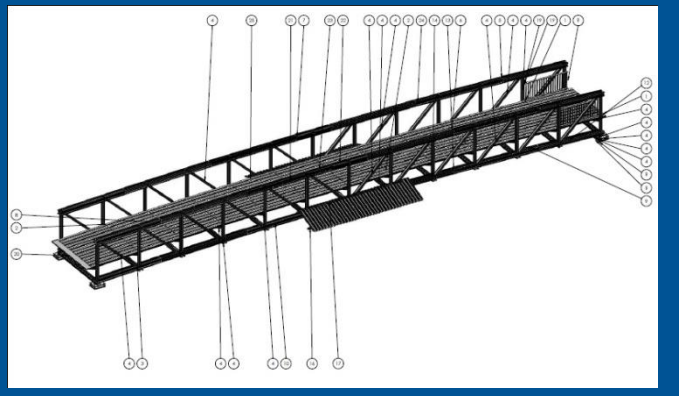
- System for large spans or wide bridges (>3m)
- Trough bridge with triaxial trussed girders
- Widths up to 8m have already been realized

- Area of application: Bridges from 25 to 80m length
- Price segment: 100.000 – 900.000 €
- Introduced: 2007







The B system involves a trussed trough bridge with its own trussed transverse frame. It represents our largest system for spans up to 80m and widths up to 8m.
Weight: (at 3m width) approx. 350 - 450kg / running m)

pml aluminium pedestrian bridges

Advantages:

1. Elegant, slender, filigree construction
2. Installation in just a few hours – no interruption to traffic
3. Corrosion free! No wear! Unlimited service life! Maintenance free!
4. Own profile technology with great opportunities to the design
5. Environmentally friendly! Recycling compatible!
6. Strength retention verified via tests
7. High load-bearing capacity
8. Corresponds to the international standards for pedestrian bridges
9. Flexible! Easy to move, modify, rebuild

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That´s why you should use Aluminium!

Long-term experience with the material:
aluminium in bridge building

50 years ago, in the spring of 1956, the Schwansbell Bridge, Germany's first road bridge made from aluminium was opened. The trussed frame bridge made from extruded profiles spans the Datteln-Hamm Canal near Lünen and remains in a structurally excellent condition even today.
Ever since its opening, the Schwansbell Bridge has incurred hardly any costs for maintenance: neither an additional corrosion protection nor a repair were necessary.

Although aluminium is more expensive in comparison to other materials used in bridge building, the lightweight metal offers a range of advantages. "Aluminium is an ideal material owing to its low weight and easy forming properties during extrusion and offers tremendous opportunities for creativity in terms of planning and design", states Werner Mader, Construction Consultant at the GDA - Gesamtverband der Aluminiumindustrie e.V. in Düsseldorf. On account of its low weight, aluminium represents an interesting alternative for bridge building in case of difficult terrain, soft ground or transport problems. The most important advantage of aluminium as a material in bridge building, however, is its maintenance friendliness. Thanks to the high corrosion resistance of the lightweight metal, aluminium bridges often fully withstand the effects of the weather without any protective coating. The maintenance costs are therefore extremely low over decades.

In order to test the corrosion resistance of the material, the application of a corrosion protection was omitted with when building the bridge. The result in respect to the corrosion protection remains astonishing up to the present.

"Although the Schwansbell Bridge is located in the Ruhr and has been exposed to high levels of industrial gas emissions in the past 50 years, neither an additional corrosion protection nor a repair have been necessary since construction", states Werner Mader.

In 2003 the Schwansbell Bridge was certified with an excellent condition of the structural fabric during one of the regular structural inspections. The resistance of aluminium to environmental influences is based on the following chemical properties: A transparent, tight and permanently adhesive oxide payer that protects against corrosion forms naturally on the metal surface. It compacts further under the effects of the weather with alternately humid and dry, hot and cold periods. If the surface is damaged, for example by scratches, the protective layer immediately forms again. Only alkaline solutions and acids are capable of destroying this protective layer.

The bridge has a span of 44.20 metres. The total width of the bridge is 5.10 metres, the useful bridge width 4.50 metres and the road lane width 3.50 metres. With a dead weight of 25 tonnes, the Schwansbell Bridge is approved for a vehicle weight of up to 12 tonnes. In comparison to the planned steel bridge, which would have weighed 60 tonnes, the total weight saved by using aluminium was about 58 percent.

Overview of aluminium as a material

Strengths:

- No need for maintenance work (low maintenance costs)
- Low weight (cost saving for foundation work and construction preparation)
- Long service life due to high natural corrosion resistance of the material.
- Value retention, as material can be recycled
- High sustainability of the material, as high recycling component with new aluminium
- Intelligent use of resources (material is used as the load of a pure pedestrian bridge requires).
- Individual design/adaptation of the profiles possible; saves connecting material and assembly time
- Short construction phase due to prefabrication at the factory

Weaknesses:

- High market price of the basic material
- Limited profile selection, as mostly individual geometry and comparatively few standard goods in stock
- Risk of theft due to high raw material prices
- Degree of recognition is low, as "new" material in the area of application

Opportunities

- "New" market with relatively little competition
- Trend towards personnel reduction among established customer base leads to need to use low-maintenance products
- Huge potential customer base, as interesting for "public sector" (all towns/cities, municipalities and organizations)
- Trend towards leisure-oriented society leads to increased need for leisure-compatible infrastructure among the customer base

Threats

- Greater recognition of the material in bridge building leads to greater competition
- Almost complete dependence on public sector customers with often limited budgets at present

Analyses of the material aluminium

Anticorrosion properties

Aluminium is a metal which becomes spontaneously plated with an oxide skin upon contact with atmospheric oxygen. In dry rooms, the expansion of the natural oxide layer is limited to 0.01 µm. Depending on the humidity and temperature, the oxide layers extend to 01 µm.

Under the effects of the weather with alternately humid and dry periods (outdoor application e.g. for bridges), the oxide skin is transformed into a thicker oxidized top layer, comprising corrosion products and integral dirt particles. Although the top layer lends the metal a dull grey appearance, it has a high anticorrosive effect. This passivation of the metal surface by the natural oxide layer formation enables the use of aluminium without additional surface corrosion protection in weather conditions.

For even greater protection (recommended for the planned use of aluminium constructions in the offshore sector etc.), the option of anodizing is available.

During the anodic oxidization of aluminium – also referred to as anodization – the surface of the aluminium workpiece is transformed into an oxide layer in an electrochemical process. This oxide layer is strengthened by more than a hundred-fold in comparison to the naturally formed oxide layer. It can be defined in its thickness and hence makes the products treated in this way resistant to wear and corrosion; It also provides the option of coloured designs (6 basic colours).

A colourless anodic layer is first produced, which can then be coloured either organically or electrolytically, whereby the characteristic metallic appearance of the surface is always retained.


LCCA Comparison
costs in %
years
0
50
100
150
200
250
300
350
400
450
500
1
5
10
15
20
25
30
33
40
45
50
Wood
Steel
Concreate
Aluminium
100
120
145
170
295
320
345
360
395
420
445
100
116
136
156
176
296
316
328
356
376
396
100
112
127
142
157
172
187
296
317
332
347
100
100
100
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100
100
100
100
100
100

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Aluminium is not too expensive!

Doha, Qatar

First Pedestrian Bridge in Qatar for the FIFA World Championship in 2022

Total lengths:
84.0m x 4.0m including:

- Staircases
- Lift
- Aircondition
- Slidding doors

Total value:
approx. 3,500,000 EUR

Completion:
June 2015

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Beijing, China

Diverse B system bridges for the Olympic Games 2008 in Beijing

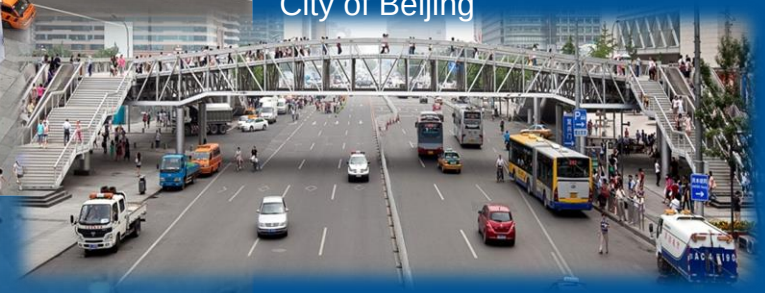
Total lengths:
135m x 8.0m (Appendix 1)
85m x 6.5m (Appendix 2)
10m x 6.5 m (Appendix 3)

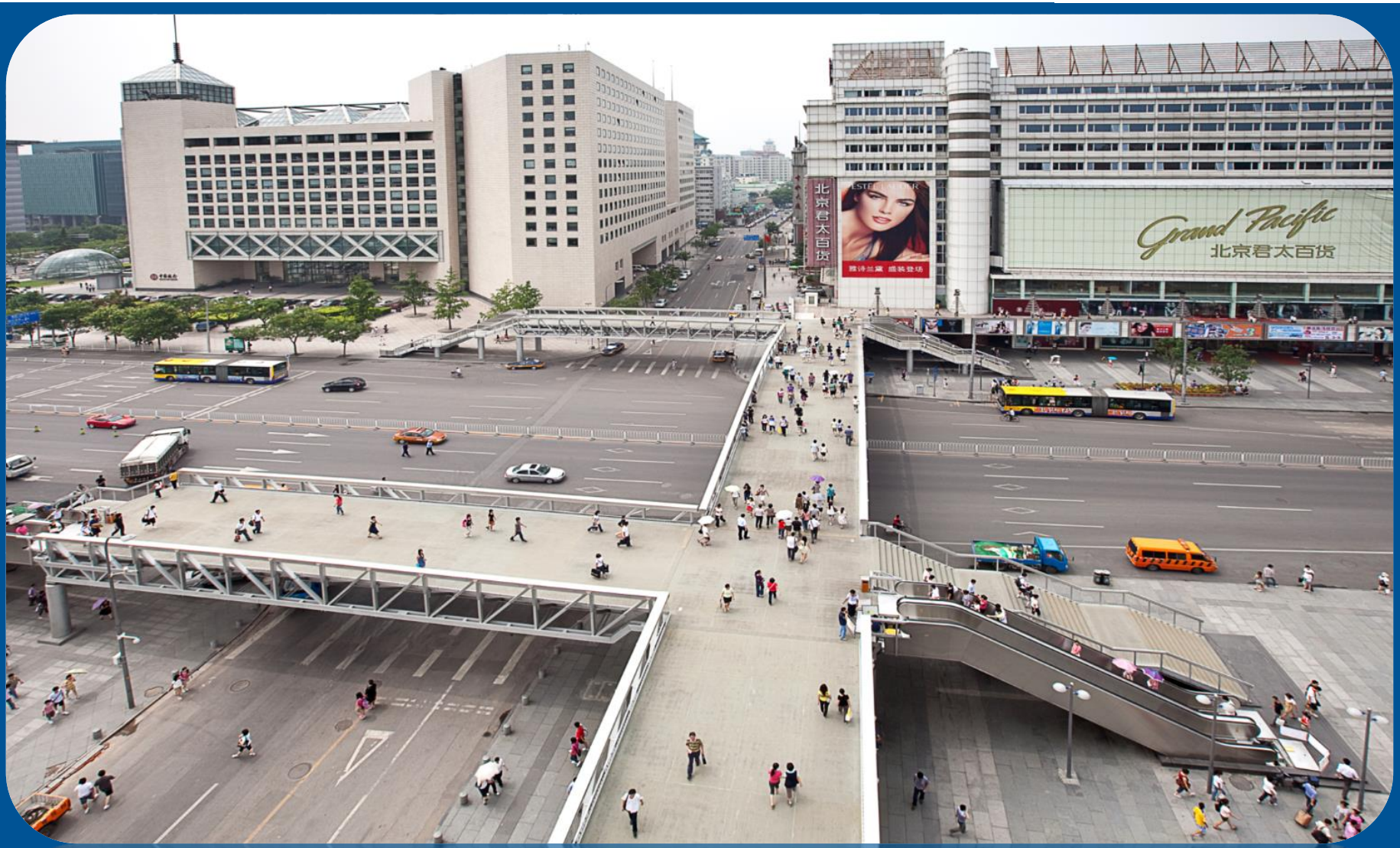
Total value:
approx. 4,000,000 EUR

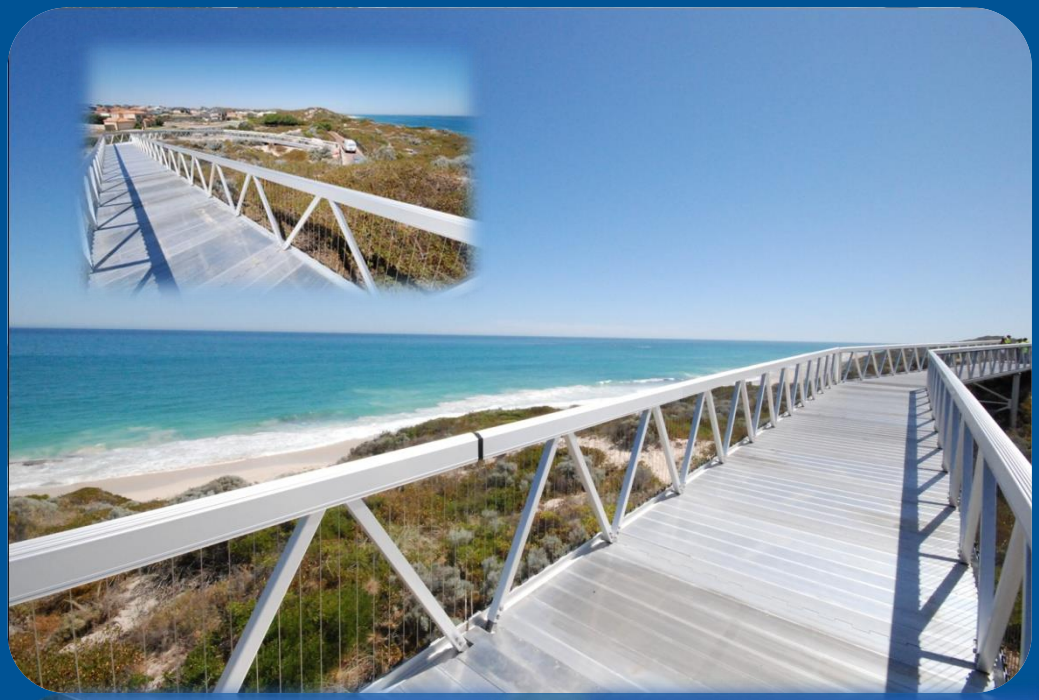
Completion:
August 2008

Construction period:
June 2007 – August 2008

Customer:
City of Beijing




北京君太百货
Grand Pacific
北京君太百货



Wanneroo, Australia

Boardwalk / Access to the beach in Western Australia (Location: Yanchep)

Bridge type:
L system

Total length:
180m x 2.0m

Total value:
approx. 600,000 AUD (approx. 330,000 EUR)

Completion:
March 2009

Construction period:
November 2008 - March 2009

Customer:
Australian building contractor

Lockyer Valley, Australia

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Offenburg, Germany

Bridge over German Highway

Bridge type:
B system

Total length:
48.0m x 3.0m

Total value:
200.000,- €

Completion:
July 2015


杭州市商业银行
Hangzhou City Commercial Bank
OTIS

Pedestrian bridge over the River Salat in the French Pyrenees (Location: St. Girons)

Bridge type:
B system

Total length:

50 x 3.0m

Total value:

approx. 190,000 EUR

Completion:

November 2007

Construction period:

July 2007 – November 2007

Customer:

Town of St. Girons

Pedestrian crossover (footbridge and stair complex) over the railway in Odenwald (Location: Michelstadt)

Bridge type:
L system

Total length:
45x 2.5m

Total value:
approx. 140,000 EUR

Completion:
October 2008

Construction period:
February 2008 - October 2008

Customer:
Deutsche Bahn AG

Pedestrian bridge on the campus of the Ruhr University as a link between two student residences
(Location: Bochum)

Bridge type:
L system

Total length:
45m x 3.0m

Total value:
approx. 115,000 EUR

Completion:
October 2010

Construction period:
June 2010 – October 2010

Customer:
German building contractor

Foot and cycle path bridge, dark anodized with wooden railings in the Kurfürstlicher Park in Donaueschingen

Bridge type:
B system

Total length:
25m x 3.3m

Total value:
approx. 100,000 EUR

Completion:
July 2009

Construction period:
February 2009 – July 2009

Customer:
Town of Donaueschingen

Aluminium for Bridges!

Aluminium is strong enough!

You should use Aluminium!

Aluminium is not too expensive!

Aluminium Bridge Design

Thank you for your attention!

Our partner in Australia: