

THE BEBO[®] SYSTEM



World 's Best for Overfilled Arches

For Precasters, Bridge Suppliers, General Contractors,
Road/Rail Authorities and Consultants



*Thailand, Exclusive Agent : PPE Machtron Co.,Ltd
99/18 Ratchadapisek Road, Chankasem, Jatuchak District
Bangkok. 10900. Thailand. Tel. +669 8541 5169*

BEBO Cost comparison with others type 9 Bridges in US. (Construction and Field Evaluation of Precast Concrete Arch Structures, Jame J. Hill , Journal :Transportation Research Record 1008)

The cost savings for a BEBO arch compared to a standard bridge can only be exactly calculated by a specific project. **Over all, the cost savings are in the area of around 20%** only in the construction, depending on the specifications, logistic and additional cost. As the example with the railway bridge, the SRT can save a lot of money for the slab track because the bridge is landfilled and they can continue the ballast track without interruption or change of system of the bridge. Besides the savings during the constructions, there are also further savings because of low maintenance and high durability.

Cost: The cost of the project is reduced by quick installation, minimal design cost and low maintenance.

Durability : The use of high strength concrete efficiently compacted during manufacture at the factory ensures a high strength durable product produced under a stringent quality assurance system.

Appearance: The graceful appearance of the arch complements the environment and is aesthetically pleasing. Surface treatment can be tailored to suit specific applications.

Environmental impact : The arches can be sized to span most waterways without midstream support thus preserving the natural stream bed and providing a fish friendly environment. Land based fauna requirements may also be readily accommodated.

Maintenance : The high quality concrete ensures a maintenance free life with minimal inspections required by the owner throughout the life of the structure.

Hydraulic efficiency : The large span-to-height ratio for standard profiles minimizes hydraulic disturbance for wide low flow streams and channels. Other profiles with various span to height ratios can be supplied to accommodate other stream or channel flow requirements.

Versatility of profile : Several basic arch shapes and the option of using multiple cell arches allows easy application to most site configurations. Various spandrel wall and wing wall options at the bridge ends compliment the choice. Pedestal footings may be used if necessary to increase headroom clearances.

Fast construction : BEBO arches are simple to assemble which results in very fast erection times. The ability to manufacture and deliver the arches simultaneously with site works reduces overall project time and allows quick construction access across the spanned distance.

Minimal waste : BEBO arches only require simple strip footings to resist vertical and horizontal forces. No moment is transferred to the footings simplifying their design and construction details. Precast foundations are an option.



Prepared by BEBO Arch System.

March 30th, 2021

Letter of Appointment.

Dear Sir,

This letter is to confirm that **BEBO Arch International AG.** having its registered office at **Witikonstrasse 15, CH-8032 Zurich, Switzerland**, has appointed **PPE MACHTRON Co.,Ltd. 99/18, Lat Phrow 31, Ratchadapisek Road , Chankasem, Jatuchak District, Thailand. 10900 Tel. +662 513 6735** to be the Exclusive BEBO Arch Solution Bridge License Holder within the territory of Thailand.

We hereby confirm that we will provide fully design and technical support related to the performance of our products for all proposed BEBO design products to be licensed by PPE MACHTRON Co.,Ltd.

Yours sincerely,



Roman Arn

Director
BEBO Arch International AG

Tel : +41 43 501 04 52



Gian Nick

Director
BEBO Arch International AG

Tel : +41 43 501 04 51

Overpasses



Bridges

- **Spans of 3.6 m to 31 m and more**
For highway, road, railroad, river, lake, bicycle path, golf course applications and many more
- **Low rise applications for small grade separation**
Design code specific live loads can be handled even for small overfill applications
- **High rise profiles** such as sailboat underpasses
- **Large span / low rise profiles** for wetland crossings
- **High overfill and very large live load applications** such as aircrafts or mining trucks are feasible
- **Aesthetically pleasing structures** due to distinct accentuation of the true arch shape
- **Smooth transition from fill to bridge**
No approach slabs required - no hump
- **Durability - low life cycle costs**
Traffic runs on overfill, not on exposed bridge deck



Underpasses



Tunnels

- **Cut-and-Cover tunnels** with overfill heights of up to 30m
- **Pedestrian and bicycle crossings** under traffic infrastructure
- **Multiple cell applications and viaducts**
Motorised traffic as well as public transportation (railroads, light rail or metro)
- **Variety of shapes and spans**
Accomodate various clearance profiles, for example railroads or multiple traffic lanes

Culverts

- **Stream or creek crossings** under traffic infrastructure
- **Drainage channels** under heavy airport loading
- **Belt conveyor channels** for mining applications
High- or heavy overfill situations (e.g. iron ore mining and storage) can be handled
- **Open mining with heavy traffic loads**

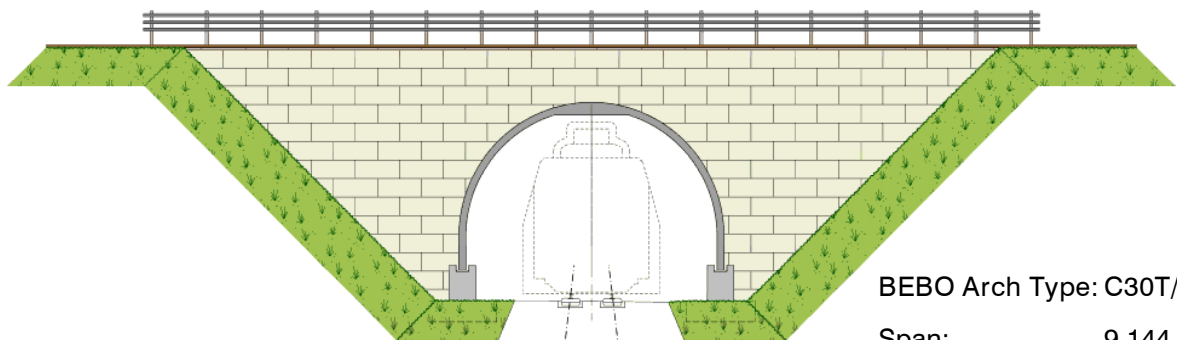


The BEBO® System

Typical Cross Sections for Rail Applications



Single Track Railroad



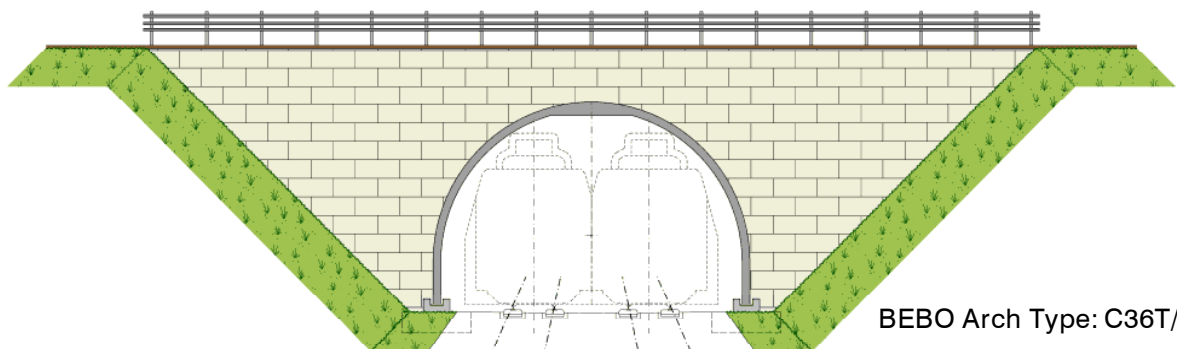
BEBO Arch Type: C30T/7

Span: 9.144 m

Rise: 5.588 m

Concrete Volume: 4.32 m³/m

Double Track Railroad



BEBO Arch Type: C36T/8

Span: 10.970 m

Rise: 6.807 m

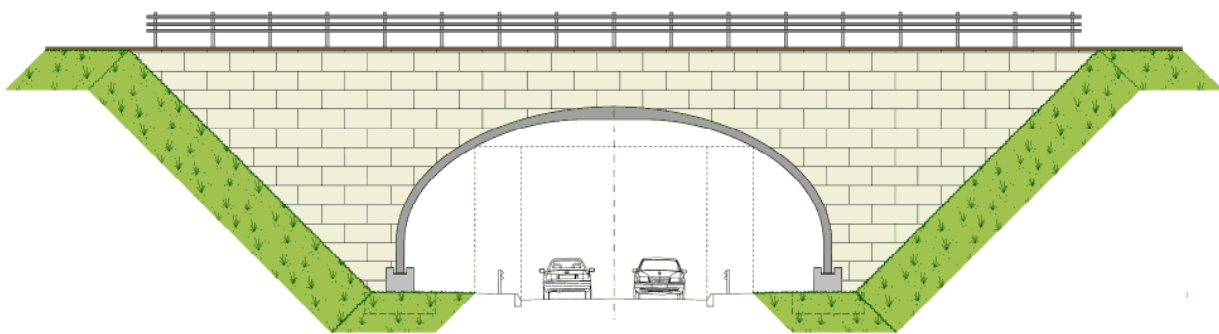
Concrete Volume: 5.73 m³/m

The BEBO® System

Typical Cross Sections for Road Applications



Two Lane Road



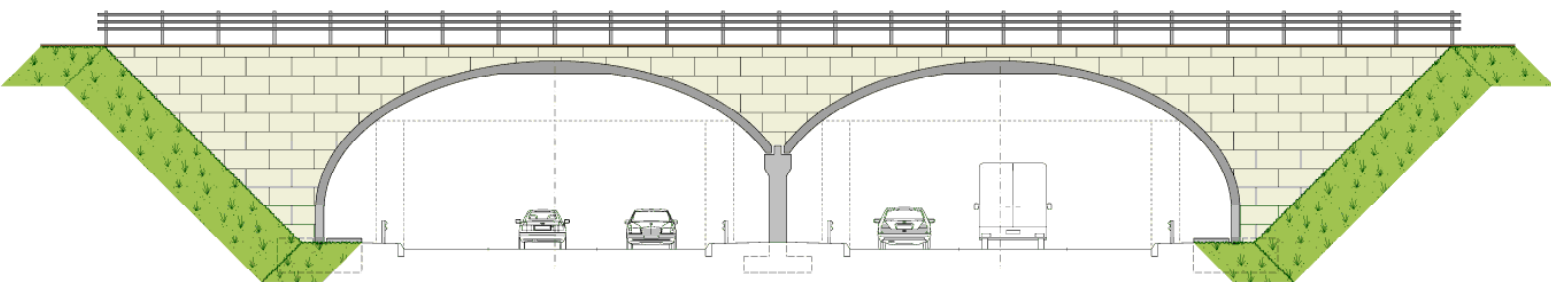
BEBO Arch Type: E48T/6

Span: 14.630 m

Rise: 5.354 m

Concrete Volume: 6.46 m³/m

Four Lane Road (incl. Emergency Lane)



BEBO Arch Type: E54T/cut

Span: 15.880 m

Rise: 6.096 m

Concrete Volume: 6.68 m³/m

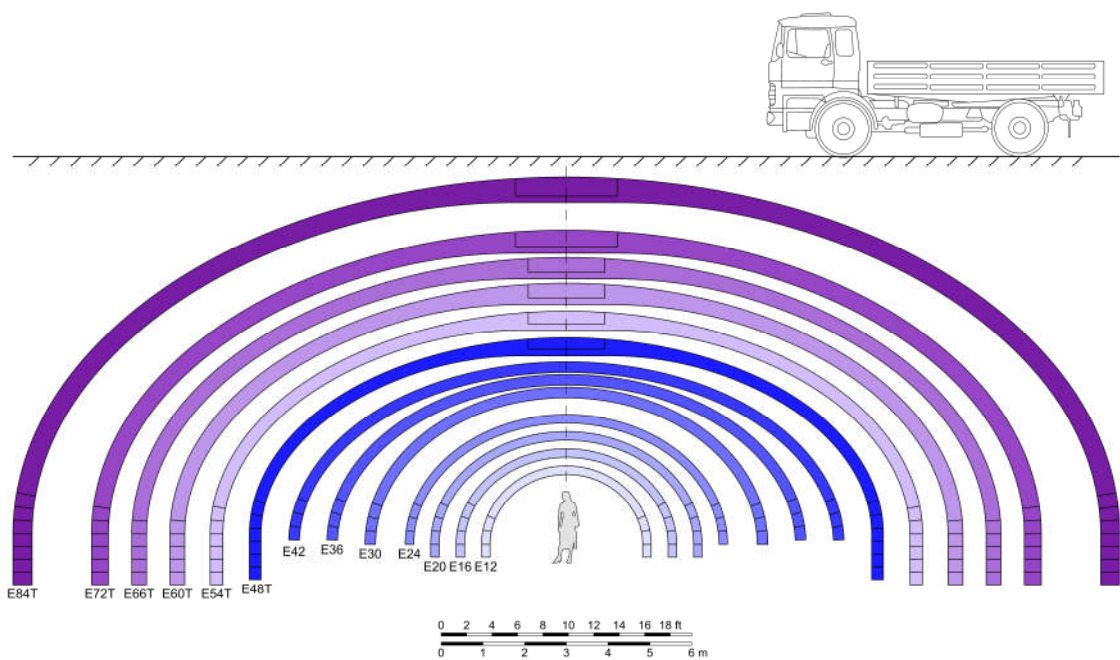
BEBO Arch International AG

www.beboarch.com

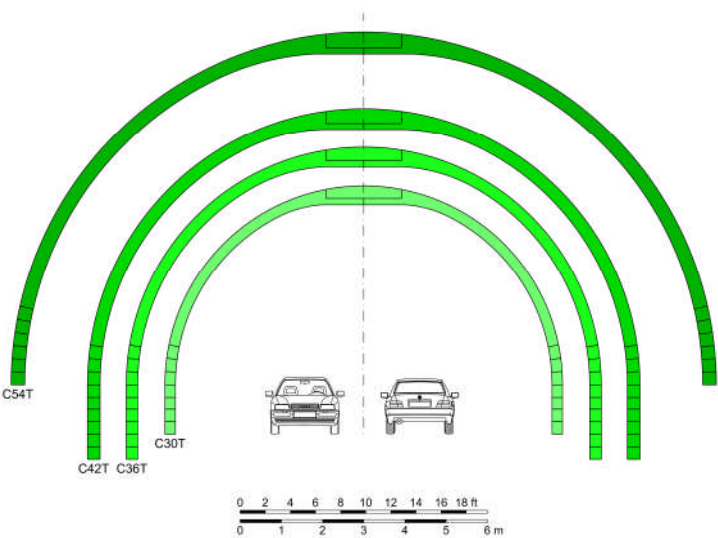
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BEBO®
Arch Solution

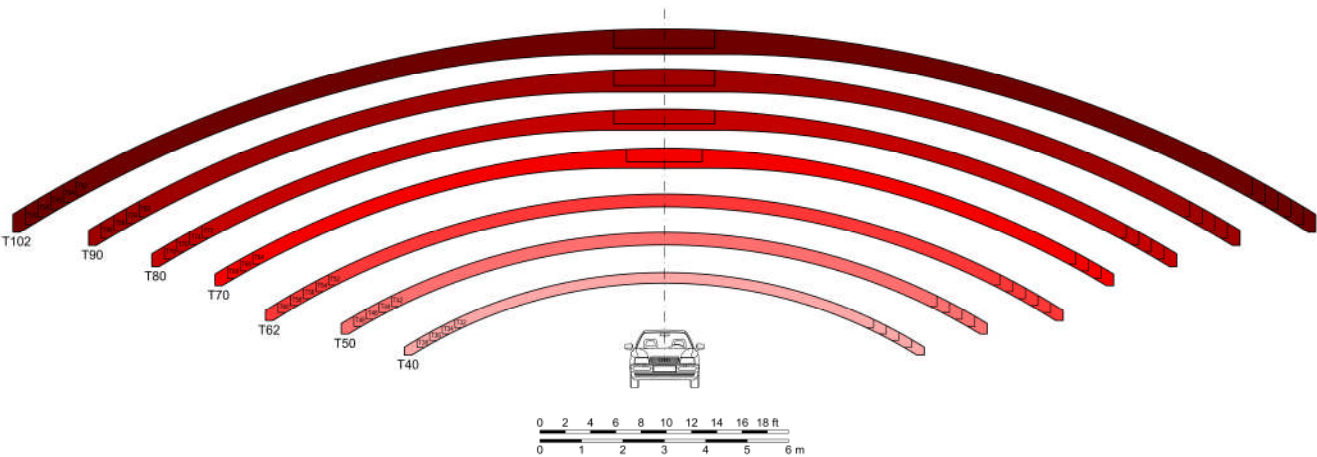
E-Series



C-Series



T-Series



Elliptical Arch Shapes

- **Span Range**
3.6m to 12.8m for single leaf, and 14.6m to 25.6m for twin leaf solutions.
- **Single Leaf Solutions**
For the smaller spans up to 12.8m span **a single arch element forms a complete arch ring**. The thickness of the concrete section along the development is constant.
- **Twin Leaf Solutions**
For the larger spans from 14.6m to 25.6m **two elements form one arch ring**. The thickness of the concrete section is constant except for the crown area. The connection of the two arch elements, the patented crown joint, incorporates a locally thickened section to allow for easy in-situ casting of the monolithic connection (no formwork required).
- **Overfill Heights**
The standard range of overfill above the arch crown is **0.5m (minimum) to 5.0m**. BEBO arches can handle **higher overfill**. Such non-standard applications are designed on a project-by-project basis by the BEBO technical staff.

Circular Arch Shapes

- **Span Range**
9.1m to 16.4m.
- **Twin Leaf Solutions Only**
Due to the dimension of the circular-shaped arches (transportation), for all spans, **two arch elements form one complete arch ring**. The thickness of the concrete section is constant along the development except for the crown area. The connection of the two arch elements, the patented crown joint, incorporates a locally thickened section to allow for easy in-situ casting of the monolithic connection (no formwork required).
- **Overfill Heights**
The standard range of overfill above the arch crown is **0.5m (minimum) to 5.0m**. C-Series arches, however, can handle **considerably higher overfills up to 20m and more**. Such non-standard applications are investigated on a project-by-project basis.

Flat Arch Shapes

- **Span Range**
12.20m to 30m and more.
- **Single- and Twin Leaf Solutions** (depending on arch dimension)
- **Overfill Heights**
The standard range of overfill above the arch crown is **0.5m (minimum) to a maximum of 1.0m**.
- **Foundations**
T-Series arches require a **special foundation to account for large horizontal support forces**. Such foundations have to be designed on a project-by-project basis taking account of the site specific geotechnical data.

“ For over 2000 years, the arch has been recognised as a safe, durable, economical and aesthetic structural form ”



Economy

The arch sections are slender in design

- Concrete savings of up to 50% compared to traditional applications such as box culverts or slab- or frame-type structures

Ideal structural shape to carry vertical loads

- Savings in reinforcement steel of up to 50% and more compared to traditional applications such as box culverts or slab-type structures

Moderate requirements for back- and overfill material

- Cost effective construction procedure

Overall project cost savings of 10 to 30 % and more are regularly achieved with the use of BEBO



Speed

Fully pre-engineered arch design to various design codes

- Quick turn-around times for the complete structural design; Sub-structure design based on **tabulated foundation loads**; Requirements like non-standard live loads can be accounted for within a day

Simple on-site construction

- Installation of arch elements on previously constructed foundations according to BEBO guidelines **within days**
- Backfilling and compaction in layers according to BEBO guidelines with **standard earth-works machinery**
- No restriction for construction machinery** to cross the structure once the minimum overfill height is reached

Quality

Safety through compliance with BEBO specifications and guidelines

- Our experience over many decades and **countless applications** instils confidence in the product and the extensive technical support

Longevity through earth overfill

- Overfilled reinforced concrete arch bridges are **extremely durable** and require **virtually no maintenance** (low life-cycle costs)
- BEBO structures have no exposed bridge deck, no transition joints or approach slabs and no moving bearings

Aesthetically pleasing

- The look of the **true arch shape** is always well received by officials, contractors, private property developers and the public

The BEBO Arch System

The BEBO System is a **patented precast concrete arch system** for the design and construction of **earth overfilled bridges, culverts and underground structures**. The fully pre-engineered BEBO System features the world 's largest span precast concrete arches, offering **spans from 3.6m up to 25.6m and more**.

BEBO 's experience and dedication over many decades as well as countless applications instil confidence – each shape has been applied numerous times. The fully pre-engineered system stands apart from other products through the strength of its distinctive arch action and **extensive technical support by local BEBO Licensees and the BEBO Design Centre in Zurich, Switzerland**.



BEBO History, Full Scale Load Tests

Swiss ETH Engineer Dr. Werner Heierli started designing slender overfilled concrete arch structures after his postgraduate studies at the Massachusetts Institute of Technology in 1961-62. His BEBO System design for overfilled precast reinforced concrete arches (BEBO is an abbreviation of the German word „**BE**ton**BO**gen“, meaning concrete arch) was considered for a whole series of underpasses on Swiss Federal Highway No 1 that was under construction at that time.

In order to verify the theoretical investigation results, the Swiss Federal Government - as the owner of the highway - required a **full scale load test of the proposed system**. This test was performed in 1965/66 in a gravel pit near Zurich (below left).

The first BEBO arches were installed 1966 and are **still in excellent shape**. Experience has shown that overfilled reinforced concrete arch bridges are extremely durable and require virtually no maintenance: They have no exposed bridge deck, no transition joints or slabs and no bridge bearings.

Additional full scale load tests in Germany, in Australia and in the USA **confirmed the validity of the BEBO System arch analysis** and the **huge carrying capacity of the overfilled BEBO arches**.



Zurich, Switzerland; 1965/66



Recklinghausen, Germany; 1973



Massachusetts, USA; 1996

Modular Precast Panels (Recommended VSol® by VSL International Ltd.)

Modular type MSE wall systems are a great addition to BEBO Arches. Segmental panel walls are self supporting, horizontal support by an arch end element is not required.



The VSol® earth retaining MSE wall system by VSL is built from rectangular segments resting on top of and adjacent to each other with geotextile/metal reinforcement tied into the retained backfill.

Full Height Precast Panels MSE

Full height earth retaining MSE spandrel- and wing walls for the BEBO Arch System are built from a number of segments resting on the arch element.



Various options for reinforcement grid type are available depending on client 's requests. The pre-cast panels are set and braced. They attain their final stability once the structure is overfilled.

Standard Precast

The segmental spandrel wall for the BEBO Arch System is built from 2 or 3 spandrel segments resting on an arch end element including a curb for horizontal support for the wall.



In addition, the lateral segments are horizontally supported by wing walls. The segmental spandrel wall attains its final stability once the structure is back- and overfilled.

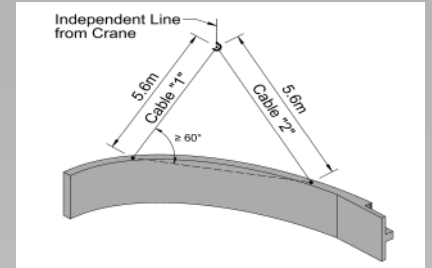
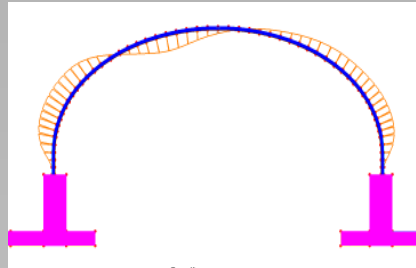
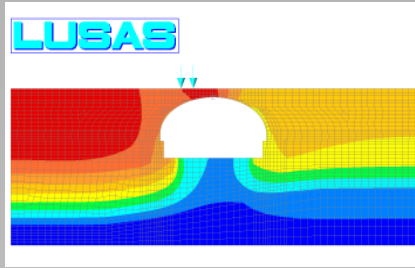
Bevelled Ends

The solution adopted by BEBO to form bevelled ends using cut-off precast BEBO units, connected by means of cast-in-situ loop joints, has been successfully used for various projects.



The loop joint is derived from early BEBO technology, laboratory tested for both strength and fatigue.

Design



The BEBO standard arches are fully pre-engineered and designed to meet the requirements of various design codes such as US AASHTO, Canadian Standard, British Standard and Eurocode.

- State of the art finite element analysis software
- Proprietary design models of all arch types
- Spandrel- and wingwall design is carried out upon request

Production



BEBO Arch Structures exhibit all the advantages of the precast concrete technology for the production in a controlled environment.

- Shelter from atmospheric conditions
- Maintain high level of quality control (materials used, geometric tolerances, etc.)
- Highly trained and experienced staff
- Storage of the produced elements in the yard before sending the complete shipment to the site

Site Preparation



The foundation design is based on site specific geotechnical data and can either be carried out by local engineers or by the BEBO technical staff. The required information to perform such designs is provided by BEBO Arch International:

- Foundation loads for the governing load cases
- Geometry of the foundation keyway

Shipping and Installation



The required data for safe and economic shipping and installation is provided by BEBO Arch International:

- ⌒ Element geometries and weights
- ⌒ Center of gravity
- ⌒ Waterproofing

Backfilling



Instruction and requirements for backfilling and compaction operation is provided by BEBO Arch International:

- ⌒ Moderate requirements for fill material (generally, in-situ excavation material can be used)
- ⌒ Standard machinery can be used to achieve the required compaction of the backfill material
- ⌒ Standard compaction testing

Completion



Canning River Bridge

Bloom Lake Iron Ore Mine, Labrador, Canada

**Arch Type:**

1 x E84T + 2 x E54T

Geometry:

84 ft span (25.6m)

54 ft span (16.5m)

Overall Length:

7.2m

Walls:

MSE-type

Installation Date:

2012

BEBO License Holder:

Shaw Precast Solutions

www.shawprecastolutions.ca/#



The Opening of the Bloom Lake Iron Ore Mine in Fermont, north-east Quebec, Canada brought the need for a rail line to transport the iron ore concentrate from the mine to Wabush Junction near Labrador City.

The rail stretch crosses Walsh- and Canning Rivers approximately 10 km west of Labrador City. Two bridges of high load carrying capacity had to be built to allow for a safe and long-lasting passage of the heavy freight trains.

BEBO Arch Solution was chosen to fulfill this task because it provided the required spans with cost-effective structures. Further benefit of particular interest to the client was the low maintenance requirements of the structures.

The BEBO design of the arch elements included the consideration of Cooper E90 Rail Loading to AREMA (American Railway Engineering and Maintenance Association) design standards.

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FabCor Rail Bridge

USA



Arch Type:

E30

Geometry:

30 ft span (9.15m)

Overall Length:

9.5m

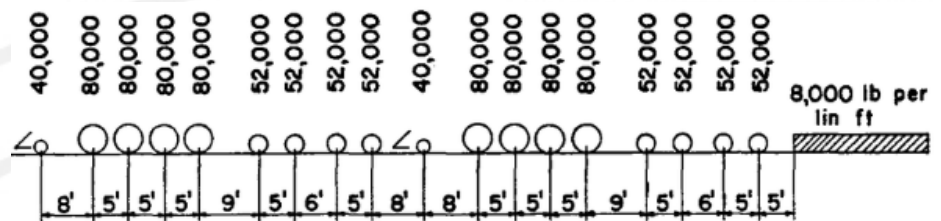
Walls:

BEBO Precast

Installation Date:

before 2000

BEBO License Holder:



The BEBO design of the arch elements included the consideration of Cooper E80 Rail Loading to AREMA (American Railway Engineering and Maintenance Association) design standards.

BEBO Arch International AG

www.beboarch.com

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BEBO®
Arch Solution

Walsh River Bridge

Bloom Lake Iron Ore Mine, Labrador, Canada



Arch Type:

1 x E60T + 2 x E30

Geometry:

60 ft span (18.3m)

30 ft span (9.15m)

Overall Length:

7.2m

Walls:

MSE-type

Installation Date:

2012

BEBO License Holder:

Shaw Precast Solutions

www.shawprecastolutions.ca/#



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BEBO Arch International AG, Switzerland



« The comprehensive BEBO Products and the extensive support package provided by the technical BEBO staff are difficult to beat »

Khoo Chun Heng (Sales Manager at Hume Concrete Precast Solutions, Malaysia)

« The BEBO System includes a large selection of highly efficient pre-engineered arch designs »

Michael J. D'Agostino (Inside Project Consultant at Contech CPI, USA)

« Proposals and full engineering design services including foundation, arch, and wall options made by the BEBO Technical Support Team are a great asset to our offering. Our customers especially appreciate the comparative visualisations and the quick turn-around times »

Richard McTavish (Director of Asset International Structured Solutions, UK)



Roman P. Arn

Civil and Structural Engineer, ETH

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