

THE BEBO[®] SYSTEM









World 's Best for Overfilled Arches

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

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
- Aestethically 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



E-Series



C-Series



T-Series



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 insitu 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 Range9.1m 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; Substructure 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 "BEtonBOgen ", 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 precast 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:

- $m{\gamma}$ Foundation loads for the governing load cases
- \frown
- 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



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 Solutioons, 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)



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