Light rail solutions
Light rail is a very popular choice for public transport systems in Europe, a trend which has now spread to Australia with new systems currently in the works in several cities around the country including the Gold Coast, Sydney, Canberra and Perth.

In anticipation of the demand for precast concrete products on these and future projects Humes is currently in the process of signing a technology transfer agreement with German company Max Bögl, to design and manufacture their precast light rail systems.

Cover image of Gold Coast Light Rail courtesy of Goldlinq Pty Ltd.
Business activities

As an integral part of the cityscape, railways make it necessary to consider various aspects. Therefore, the Max Bögl Group offers a wide range of slab track systems for railway-bound local public transport. The LRB product line ranges from directly driven systems in different surface design to ecological lawn track routes up to track switches and individual special solutions. The following services are available to our customers.

Planning
Max Bögl has developed software for the LRB system which generates an installation plan from the track-geometric project containing all relevant data for production and assembly, the entire logistics as well as for quality assurance and inspection survey.

Manufacturing/machine technology
The Max Bögl Group has decades of experience in advanced prefabricated construction. We plan, build and/or operate project – and customer-specific production facilities to manufacture slab tracks as well as plants and equipment for their assembly. Out of our machinery we provide you with mobile production facilities and assembly-specific equipment for your projects.
Special solutions

- LRB with upstand edges
- LRB with integrated granite kerbs
- LRB for bridges
- LRB as mass spring system
- LRB with dyed/coloured concrete
- LRB with a structured, individually designed surface
- LRB with special installation parts

Advantages

- Highest quality of prefabricated parts
- Long service life and availability
- Reduced construction times
- Flexible and compatible with tram systems
- Significant reduction of noise emissions
- Standard transverse slope of the slabs for directed drainage
The Light Rail Bögl system family consists of the slab tracks which are produced under controlled conditions with integrated mounting parts. Generally, the system is available for all track gauges. The prefabricated slabs are installed on the prepared substructure, adjusted and underpoured using self-compacting concrete.

The concrete for the production of the slab tracks is produced according to DIN EN 206. For the transmission of shear force, the prefabricated slabs are combined with each other in butt joints.

The rails of any type installed in the rail channel are gauged and fixed in a defined spacing by using rail fasteners. Incidentally, the rail is continuously supported on a flexible basis. This flexible basis can be installed as a premanufactured mat or as a hardening casting compound.

To transmit the side force acting on the rail, to reduce the structure-borne sound and for electrical insulation of the rail, flexible materials are also installed on the side of the rail profile. This can either take place using a casting compound on PU basis or by means of filler blocks with concrete casting.

In order to prevent surface water from entering the longitudinal joints, the rail joints are cast using PU or bituminous material.

For a long service life of the LRB system we recommend the installation of a sufficiently dimensioned anti-frost layer with a deformation module of > 120 MN/m² on a stable subgrade.

This construction method leads to a homogeneous track system with a very good long-term behaviour.
# LRB – Light Rail Bögl system variants

<table>
<thead>
<tr>
<th>Type</th>
<th>Cross section</th>
<th>Dimensions L x B x H [m]</th>
<th>Rail support</th>
<th>Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>LRB Grey Line</td>
<td></td>
<td>6 x 2.40 x 0.38</td>
<td>A, B</td>
<td>1, 2, 3, 4</td>
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<tr>
<td>LRB Black Line</td>
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<td>6 x 2.40 x 0.38</td>
<td>A, B</td>
<td>6, 7</td>
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<td>LRB Silver Line</td>
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<td>6 x 2.40 x 0.38</td>
<td>A, B</td>
<td>8</td>
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<tr>
<td>LRB Green Line</td>
<td></td>
<td>6.5 x 2.15 x 0.25</td>
<td>C</td>
<td>5</td>
</tr>
<tr>
<td>LRB Green Line Premium</td>
<td></td>
<td>6.5 x 2.15 x 0.38</td>
<td>A, B</td>
<td>5, 9</td>
</tr>
</tbody>
</table>

Dimensions given are standard dimensions for a standard gauge. Special sizes are available on request.

All rail profiles can be used:
- A = PU full casing
- B = Rail on PU mat, permanently supported with filler blocks
- C = Ribbed slab on PU base

Surfaces:
- 1 = broom finish
- 2 = sand blasted
- 3 = thickened
- 4 = dyed
- 5 = exposed concrete (smooth)
- 6 = mastic asphalt
- 7 = bit. binder and wear & tear layer
- 8 = paving cover
- 9 = pre-grown lawn

Further surface variants are also available on request.
If wheel-rail and heavy wheel-rubber traffic systems, i.e. a tram and lorry/bus traffic, coincide on a shareable way, this situation sets highest requirements to a driving surface. For this, the LRB Grey Line system with the directly drivable concrete carriageway is the best possible solution for public transportation.

Due to its homogenous, monolithic and simple structure, the LRB Grey Line slab is the ideal system for these demands. What is to be highlighted for this type of driving surface is the variety of design options for the surface regarding patterns, structure as well as colouring. The prefabricated part’s surface is usually designed with a grip of > 55 scale divisions according to DIN 13036-4.

By using hard stones as concrete aggregates, an extreme wear behaviour is achieved that corresponds to class XM3. Requirements regarding frost and road salt resistance are met according to DIN EN 206-1/DIN 1045-2.

The prefabricated slabs are combined in longitudinal direction to transmit shear forces. This combination can be done by interlocking the transverse joint and/or by using shear force plugs. The butt joints are sealed.

Drainage of the trackway surface takes place in a defined and controlled way via a transverse slope of the concrete surface which was already incorporated in the formwork shape as well as via free spaces integrated in advance in longitudinal direction for the rail drainage boxes.

The rail channel is filled after installing the rail. The insertion criteria specified by the customer determine the selection of the filling material.

Advantages:
- High durability
- High load capacity
For the common use of trackways through individual and public transport traffic, the LRB Black Line system with asphalt driveway is the ideal solution for the transport company or town planners.

Apart from high flexibility, this solution offers well-known Max Bögl quality and a short construction period. This system design accounts for the exposure classes according to DIN EN 206-1/DIN 1045-2.

To transmit the side force acting on the rail, to reduce the structure-borne noise and for electrical insulation of the rail, flexible filler blocks are installed on the side of the rail profile.

When using filler blocks, the rail channels are filled with grout after the rail has been gauged and fixed. The grouting must at least fulfil the requirements of the concrete of the prefabricated slab, with the grain adjusted to the grouting thickness.

The thickness and the layer structure of the trackway cover conform to the specifications of the customer.

Advantages:

- Flexible surface design
- Efficiency
Public transport companies and town planners more and more frequently attach importance to unsealed areas in order to avoid adverse effects on urban water supply. With the LRB Green Line system, the whole track route space is vegetated.

With this system, the positive characteristics with regard to reduced sound emissions have to be highlighted.

The high-quality and position-stable finished part and lead frame combines the advantages of the slab track with ecological and design demands.

LRB Green Line is available in two design variants:

Green Line:
With the Green Line system, the rail fastening is visible and therefore easy to access for maintenance works.

Green Line Premium:
With this Green Line system, the rail is covered with PU material thus offering the opportunity for maximum vegetation planting as well as the advantage of minimum sound emission.

That way, with the LRB Green Line system we make an important contribution to the microclimate and environmental protection.

Advantages:
- Environmentally friendly system
- Natural townscape
- Noise and vibration protection
- Improved microclimate
- Large-area seepage of the surface water
- Little maintenance effort
Concrete elements with project-related dimensions and installation weights are manufactured for the prefabricated switch and turnout system LRB TS. The rail is either supported in a support point distance specified by the points manufacturer or in a continuous way.

The rail guidance of a switch must be reproduced as rail channel in the prefabricated slabs. The recessing bodies required for this are manufactured under consideration of installation and fastening parts using CNC milling machines, and they are anchored in the concrete formwork.

The LRB switch and turnout elements are delivered to the switch plant for pre-assembly and purchased there from the client after they have been assembled. Completely pre-assembled with all installation parts and rails, the prefabricated slabs are delivered to the construction site in ready-to-plug-in condition and just in time. And there they are exactly gauged in height and position to the compressed anti-frost layer.

After they have been underpoured, the switch rails can be welded. Then the rail channels are completely filled in the welding zone. Finally, the connection areas are manufactured as well as the driveway cover applied.

Advantages:
• Short construction time
• Quick switch replacement
• Flexible switch support
• Noise and vibration protection
Using this system from the LRB family of the Max Bögl Group, operators and planners have special design options available.

The slab track surface of the LRB silver line can be made of different materials like concrete- or natural block pavement as well as in different format and colours. A customised adoption to the rail track within the individual city optic is therefore possible.

Furthermore, the rail embedded into the PU mass ensures excellent reduction of structure-borne noise.

The concrete surface of the rail channel can be matched to the paving cover in terms of structure and colour.

The construction sequence is similar to the LRB product line.

Advantages:
• Surface creation
• City trackway planning
Construction process

Installation of the LRB track system basically takes place in the following steps:

- Manufacture of the sub-structure
- Preparations, such as survey jobs
- Delivery and unloading of the LRB slabs
- Precise height adjustment via integrated spindles
- Transverse sealing for the grouting mass
- Grouting the LRB slabs with self-compacting concrete
- Rail welding
- Lifting the rails into the rail channel
- Adjustment and fixation of the rails
- Pouring all block-outs and rail channels
HGK Cologne-Frechen

Following 40 years of permanent operation, the light rail track of tram line 7 in the inner city of Frechen located to the west of Cologne had to be redeveloped in 2011. The worn-out tram rails of an approximately 480 m long, single-track section had to be replaced. As restraints and obstructions due to construction should be kept to a minimum in the cramped pedestrian zone, a short construction time was required. That is why the client has opted for the LRB system with its deep prefabrication.

A total of 80 slab tracks were installed in single lengths of 6 m made of concrete that is resistant to frost and thawing salts. For reasons of design, the concrete prefabricated slabs were provided with a surface structure in cobblestone optics. To visually distinguish the route from the pedestrian area, the concrete was anthracite pigmented.
Prague

Already since 1896, the transport company of the Czech Capital Prague has been operating an electric tramway. With 26 daily and 9 night lines, the approximately 141 km long tram network is the most comprehensive one in the Czech Republic. As there is not an own route available on every section, Max Bögl was commissioned in 2009 to renew a highly stressed road/tramway crossing. The System LRB Grey Line, particularly suitable for this application, was successfully built in during a weekend break of operation.
The LRB Black Line system was used for the first time in 2004 when 110 m of tramway lines were replaced by partly maintaining the road traffic.

- Radius $R_{\text{min}} = 100 \text{ m}$
- Slab length = 6 m
- Special slabs with accurately fitting parts such as manhole coverings and earthing technology
- Mastic asphalt overlap

The scope of works on the construction site, running in 24-hour operation, included the delivery and installation of prefabricated slabs, bonding of the filler blocks as well as precise installation and mounting of the rails. The smooth execution of the construction works, the quick reopening of the public transport, the high quality of the prefabricated slab system and the significantly reduced noise emission convinced the awarding authorities of the right system selection.
At the beginning of 2006, a 400 m long tramway route in Munich was replaced by the LRB system. Apart from the simultaneous use of the lane by individual traffic and the tramway, a part of this track section is also used by the tramway and public-service buses. Due to the bus traffic, an enormous load of the local roadbed occurs, which in a very short time can lead to lane grooves and deformations. Therefore two variants of the LRB system were used:

The lane driven on by buses and trams was created with the LRB Grey Line system, with the rails being embedded in PU full compound. In order to separate this lane from the lanes adjoining on the side, kerbs were directly integrated into the finished parts. To ensure the abrasion resistance and durability of the prefabricated slabs, a high-performance and particularly dense concrete was developed in cooperation with the Technical University of Munich that resists the physical and chemical attacks as well as the traffic and the environmental conditions.

The track used by individual traffic and the tramway was realised by means of prefabricated slabs of the LRB Black Line system which were overbuilt with two-layer mastic asphalt. Based upon the positive experiences made with our system, over the next few years further projects were implemented.
At international level, the LRB Black Line system has been a great success ground with a major order in Bucharest (Romania). Two sections with a length of 4.6 km and 9.0 km could be realised between 2006 and 2008.

The manufacture of the track elements was realised in cooperation with a local company. For this, a new state-of-the-art precast plant was put into operation with our support and guidance at the beginning of 2007. The rate of production was adjusted to the installation and building performance of 18 elements per day.

Prefabricated concrete parts with a thickness of 31 cm and a length of 6.0 m and a width of 2.4 m were used. For circular arcs < 150 m, shorter slab lengths were also produced. A 7 cm thick asphalt layer forms the track surface. Involving the full-surface grouting of 8 cm, this results in a building system height of 46 cm.

The longitudinal transport to the mounting place and the installation of the prefabricated slabs took place using a gantry crane from our large machinery. The easily flowing and shrinking free concrete was approved in Romania in the course of the nationalisation of our system. All planning, logistic and organisational tasks could be successfully carried out with our support for both projects.

A technical innovation to our LRB system, the longitudinal coupling of the slabs with coated steel plugs, was carried out in Bucharest for the first time. For this reason a further substantial contribution was made to the durability of the LRB system. In combination with the high ground-borne noise reduction and specially adjusted concrete, the longitudinal coupling sets new standards for the roadbed and track of tramways.
In March 2008, LRB TS slab tracks were realised for the first time on a continuous rail support within the Black Line system in Frankfurt, together with the switch manufacture BWG.

The planning performance first consisted in dividing the 25 m long conventional switch construction into handy elements. This resulted in five switch supporting slabs which were produced in one of our precast plants. The switch slabs were then mounted and gauged to the precise installation position with the switch producer.

The switch rails and switch parts adjusted to the length of the prefabricated slabs were adjusted in the planned cut-outs, measured, inspected and then cast in. Due to this preliminary measure, the installation time on site could be reduced to a minimum.

Coordinated with the remaining track construction works of the project, preparations for the installation of the prefabricated switch took place. By means of a truck-mounted crane, the switch supporting slabs were placed on previously positioned load distribution panels and aligned in an accurate-fitting way by means of integrated height spindles. Parallel to these works, the drainage and electrical connections were installed. Following that, the switch supporting slabs were underpoured with special, self-compacting concrete. After the grouting, the rail joints were connected by filler wire welding and the block-outs closed.

Finally, an asphalt layer was applied to the concrete surface of the switch, which was already ready for operation, thus ensuring that individual traffic could drive over the surface.