



Reference projects

# Project References – Public Transportation Infrastructure





Reference projects

# Introduction

## mageba – your one-stop partner

The Swiss company **mageba** is one of the world's leading suppliers of **structural bearings, expansion joints** and other **high quality products and services** for the transport infrastructure and building construction sectors. In the last 10 years, mageba has also significantly expanded its range of products and services relating to **earthquake protection and structural monitoring**.

### engineering connections® – since 1693

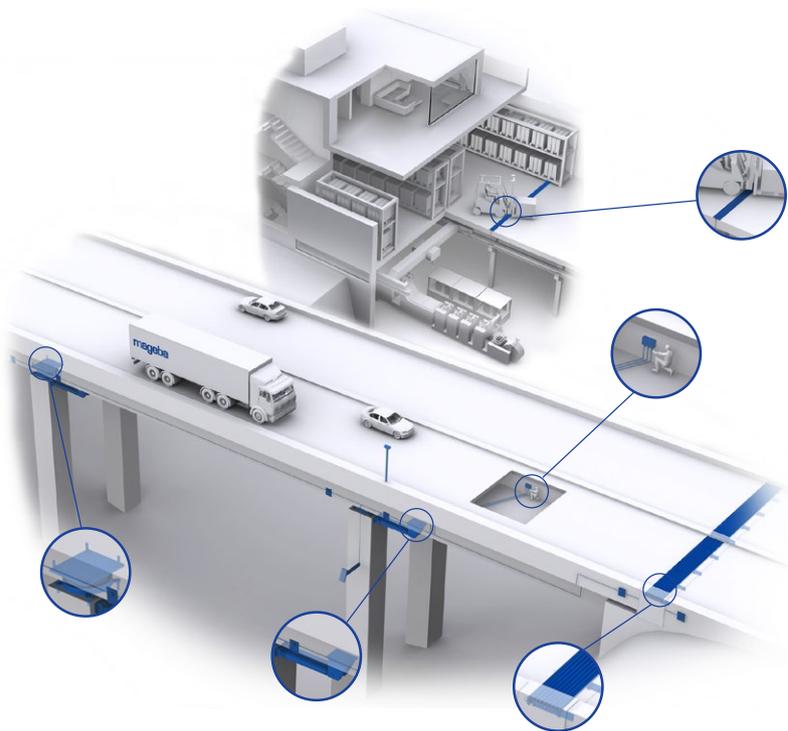
Whenever static and dynamic forces are transferred between structural elements, whenever forces interact with movements and rotations, whenever structural elements need to be protected against over-stress, whenever vibrations and noise need to be reduced: **mageba provides systems with its wide range of engineered products and services.**

Originating decades ago from the bridge industry, mageba has continuously extended its expertise in engineered connections to different types of structures. As a provider of high-quality structural support systems, mageba **supports owners, engineers, designers, architects and main contractors** from planning stage to project completion.

### mageba's Systematic Quality Management and Technical Excellence:



## Infrastructure, Industrial structure and Building products



### The particular challenges presented by transport infrastructure

Today's transport infrastructure tackles various challenges: **access to remote places, balancing structures in busy environments and providing safety for exceptional features of architecture.**

As this crucial infrastructure is frequently used by human, **safety enjoys priority.** Key components hence provide a **longer life span and higher reliability.**

Having supported a broad variety of **renowned and challenging projects worldwide** during the past five decades, mageba is your reliable partner in **ensuring your structure's safety and durability.**

The following is a **brief overview of selected projects**, highlighting some of their **specific structural design challenges and developed solutions.**



# Index

Project	Country	Installed	Products delivered	Page
Oakland Airport Connector	USA	2012	LASTO®BLOCK elastomeric bearings	4
Gatwick Airport Bridge	United Kingdom	2009–2010	RESTON®POT bearings	5
Panamá City Metro Line 2	Panama	2016–2017	LASTO®BLOCK elastomeric bearings	6
Bangkok MRT Red Line	Thailand	2015–2017	RESTON®SPHERICAL bearings	7
Western Express Highway (WEH) Mumbai Metro	India	2015	ROBO®CONTROL permanent monitoring system	8
810 Rail Link Station Roof	China	2015	RESTON®POT bearings, ROBO®CONTROL monitoring and height adjustment system	9
Bangkok MRT Green Line Extension	Thailand	2014	RESTON®POT bearings	10
Bangkok MRT Blue Line Extension	Thailand	2012	RESTON®POT bearings	11
Panamá City Metro Line 1	Panama	2012	LASTO®BLOCK elastomeric bearings	12
Vancouver Skytrain “Evergreen”	Canada	2014	LASTO®BLOCK elastomeric bearings	13
Chenab Railway Bridge	India	2014–2017	RESTON®SPHERICAL bearings	14
Hyderabad Metro Railway	India	2014–2015	RESTON®POT and LASTO®BLOCK bearings, MIGUTRANS®FSL and MIGUTEK®KF joints	15
TGV Viaduc de la Courbe	France	2014	RESTON®SPHERICAL bearings	16
Rail Car Loading Station	Brazil	2013	RESTON®SPHERICAL bearings	17
Gstaad Railway Viaduct	Switzerland	2013	RESTON®FORCE and RESTON®POT bearings, RESTON®STU shock transmission units, LASTO®BLOCK elastomeric bearings	18
Flendruz Railway Viaduct	Switzerland	2011	RESTON®FORCE and RESTON®POT bearings, RESTON®STU shock transmission units	19
Railway bridge WK432	Poland	2011	TENSA®MODULAR joints, ROBO®MUTE noise-reducing mats	20
Ganga Rail-Road Bridge, Patna	India	2007–2014	RESTON®FORCE and RESTON®POT bearings, TENSA®MODULAR and TENSA®GRIP joints	21
Ganga Rail-Road Bridge, Munger	India	2007–2014	RESTON®FORCE and RESTON®POT bearings, TENSA®MODULAR and TENSA®GRIP joints	22
Ventabren TGV Railway Viaduct	France	1998	RESTON®SA hydraulic dampers	23
Transbay Transit Center	USA	2015–2016	RESTON®PENDULUM Mono bearings	24
Zurich Central Train Station	Switzerland	2015	POLYFLEX®SLIM flexible plug expansion joint	25
Tocumen Airport Access Road	Panama	2014	RESTON®POT HP bearings	26
Car Park P6 Zurich Airport	Switzerland	2013–2016	TENSA®SEISMIC special joint RS-Fuse	27
Amsterdam Airport Schiphol	Netherlands	2013	POLYFLEX®ADVANCED PU flexible plug joints, TENSA®MAT mat joints	28
Muscat International Airport	Oman	2012–2016	RESTON®POT, RESTON®SPHERICAL, LASTO®FLONPAD and LASTO®FLONBLOCK bearings, TENSA®MODULAR joints	29
Teleférico de Mérida	Venezuela	2015	RESTON®SA shock absorbers, TENSA®COMPRESS expansion joints	30
Kai Tak Cruise Terminal	China	2012	RESTON®POT and LASTO®BLOCK elastomeric bearings	31



# Oakland Airport Connector (USA)



## Project description

Oakland International Airport, one of the key transportation hubs in the Bay Area of northern California, is now connected to the Bay Area Rapid Transit (BART) network by a new Automated People Mover (APM) system. The system features Doppelmayr cable-car technology, delivering passengers along the 3 miles (5.1 km) track in just 8 minutes. The system will be fully automated, driverless and all-electric.

The cost of the project has been estimated at \$492 million. California-based Flatiron/Parsons Joint Venture won the contract to design and build the system, and Doppelmayr Cable Car, Inc. won the contract to operate and maintain the system once built.

## mageba scope

mageba supplied 775 elastomeric bearings for the elevated structure, supporting the steel guideway above its concrete columns. The bearings are of Type C in accordance with EN 1337, and thus have steel reinforcement plates at the core, and external connection plates on the upper and lower surfaces. The connection plates are vulcanised into the elastomer (a neoprene mix) of the bearing, and thus securely connected. They have threaded holes for easy bolting to the structures above and below, preventing sliding and allowing resistance to horizontal movement to develop. The use of this type of bearing therefore permits some elastic movement, providing a damping effect to the supported system.

## Highlights & Facts

### mageba products:

Type: 775 LASTO®BLOCK elastomeric bearings  
Features: Steel fixing plates  
Installed: 2012

### Structure:

City: Oakland, California  
Country: USA  
Completed: 2014  
Type: Railway viaduct  
Length: 5.1 km  
Contractor: Flatiron/Parsons JV

The APM system serves Oakland International Airport in California, USA



Rigorous testing of the APM system, including bearings, was carried out on a special test track



View of four LASTO®BLOCK elastomeric bearings at one pier



# Gatwick Airport Bridge (UK)



## Project description

A major project to replace the bearings along the entire length of the Inter-Terminal Transit System of London's Gatwick Airport was initiated in 2007, with specialist support provided by mageba to optimise the effort required and impact on train services on this vital piece of infrastructure. Replacement of all 633 pot bearings, pier by pier, commenced in spring 2009, and was completed in early 2010.

## mageba scope

The design, manufacture and installation of the bearings required several years of close cooperation with the contractor, Structural Systems (UK) Ltd, due to the project's many challenges. For instance, it was stipulated that all bearings should be

replaceable, with fixed steel connections to the existing concreted-in dowels of the piers beneath and bolted connections to the steel deck. In order to ensure that the bearings could be installed, regardless of the precise locations of the holes, dowels, and bridge deck at time of installation, a clever and highly efficient solution was proposed by mageba.

The fabrication of the bearings was split between mageba's Bülach (Switzerland) and Shanghai production facilities, the majority being manufactured in Shanghai to allow cost savings to be passed on to the customer. Crucially for the installation programme, the first batch of bearings required could be manufactured in Switzerland, saving the time required for transport from Asia to Europe.

## Highlights & facts

### mageba products:

Type: 633 RESTON®POT  
Pot bearings  
Installation: 2009-2010

### Structure:

City: London  
Country: England  
Type: Railway bridge

Gatwick Airport is located south of London



View from below of the viaduct which connects the airport's two terminals



One of the 633 successfully installed bearings





# Panama City Metro Line 2 (Panama)



## Project description

After completion of Metro Line 1, Panama City decided to build Metro Line 2, in order to improve the current transportation system in the city. On its first stage, the line 2 will have a total length of 21 km of elevated railway and it will have 16 stations. Its completion is planned in December 2018. It will have capacity for 16,000 users per hour each way.

It will be a project equipped with the highest technologies that bring benefits to the population like the use of electricity as the main power source and integrated automatic security systems to avoid collisions.

## mageba scope

mageba will provide 6,080 elastomeric bearings LASTO®BLOCK type B of natural rubber (NR) with dimensions of 450x300x92 mm. These bearings work as elastic connections between columns and the main beams that transfer vertical and horizontal forces without restrictions, from superstructure to sub-structure, allowing movements in all directions and rotations around all axis.

To ensure the expected performance of the bearing, during the production stage, a strict quality control is carried out to the all materials according to the norm ASTM D 4014.

## Highlights & Facts

### mageba products:

Type: LASTO®BLOCK type B  
Installed: 2016–2017

### Structure:

City: Panama  
Country: Panama  
Built: 2018  
Type: Metropolitan railway  
Contractor: Consorcio Línea 2

Metro Line 2, is located in Panama City, Panamá



Samples for quality control of physical properties of materials



LASTO®BLOCK bearings ready to be installed





Reference projects

# Bangkok MRT Red Line (Thailand)



## Project description

The MRT (Mass Rapid Transit) red line in Bangkok is part of the MRT master plan for the Bangkok metropolitan region. With a total length of 26.3 km, the red line is planned to run from Bang Sue to Rangsit and Bang Sue Stations, bringing passengers to the north.

The construction project is part of the infrastructure investment programs led by the Thai Government.

Moreover, the master plan comprises a 26.4 km long line to the north (North Line) and 14.6 km long line to the west (West Line) providing a fully elevated rail system.

## mageba scope

In 2015, mageba manufactured more than 5'000 RESTON®SPHERICAL bearings. The installation schedule runs from 2015 to 2017.

The bearings are designated of types KF, KE or KA, depending on their ability to accommodate sliding movements.

As the bearings are installed in this high-dynamic stressed railway bridge, the requirements in terms of assuring zero friction for smooth transmission of horizontal forces had to be fulfilled.

A further peculiarity features the precast-segment structure that makes great demands on the type of connection to be used.

## Highlights & Facts

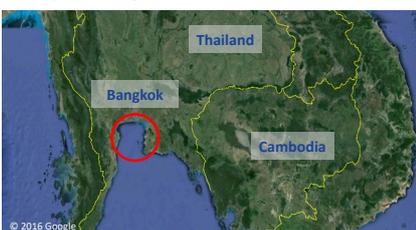
### mageba products:

- Type: RESTON®SPHERICAL bearings of type KA, KE and KF
- Features: With ROBO®SLIDE high-grade sliding material
- Installation: 2015–2017

### Structure:

- City: Bangkok
- Country: Thailand
- Type: Mass transit system
- Owner: Ministry of Transport State Railway of Thailand
- Designer: Team Consulting Engineering and Management Company NorCiv Engineering Co., Ltd

The MRT red line is located in Bangkok, the metropolitan region of Thailand



RESTON®SPHERICAL bearings packed and ready for delivery



Load testing of the RESTON®SPHERICAL bearings





Reference projects

# Western Express Highway (WEH) Mumbai Metro (India)



## Project description

The Mumbai Metro construction project began in 2008 and had been executed in order to meet the city's rapid population growth.

Mumbai is the capital city of Maharashtra, the most economically developed state of India with a population growth rate of around 2% per annum (as per 2011). The main objective of the Mumbai Metro is to provide mass rapid transit services to people within an approach distance of between one and two kilometres, and to serve the areas not connected by the existing Suburban Rail network.

At the WEH junction, trains pass over the highway on a cable-stayed bridge and at the same time traffic on the highway crosses on another concrete bridge, making the junction a very complex intersection.

## mageba scope

As shown on the picture above, the cable-stayed bridge is located over the highway bridge hence being built in a critical environment where any damage would cause significant repercussions. Therefore, the bridge had to be equipped with a system that is able to immediately react to any alarming impact.

The installed ROBO®CONTROL structural health monitoring system is mageba's reliable product development to monitor the structure's condition, behaviour and performance during operation. In particular, it monitors the pylon's inclination, the cable's vibration and tension, the deck's deflection as well as the concrete's deformation allowing any critical deviation to be detected and accordingly presented to the engineers in charge.

## Highlights & facts

### mageba Products:

Type: ROBO®CONTROL permanent monitoring system

Features: Straingauges, displacement, laser, humidity sensors, accelerators, inclinometers

Installation: 2015

### Structure:

City: Mumbai

Country: India

Completed: 2011

Type: Cable-stayed bridge

Length: 175 m

Owner: Mumbai Metropolitan Region Development Authority

Contractor: Mumbai Metro One Private Limited (MMOPL)

The project is located in Mumbai, one of the most bustling cities of the Indian subcontinent



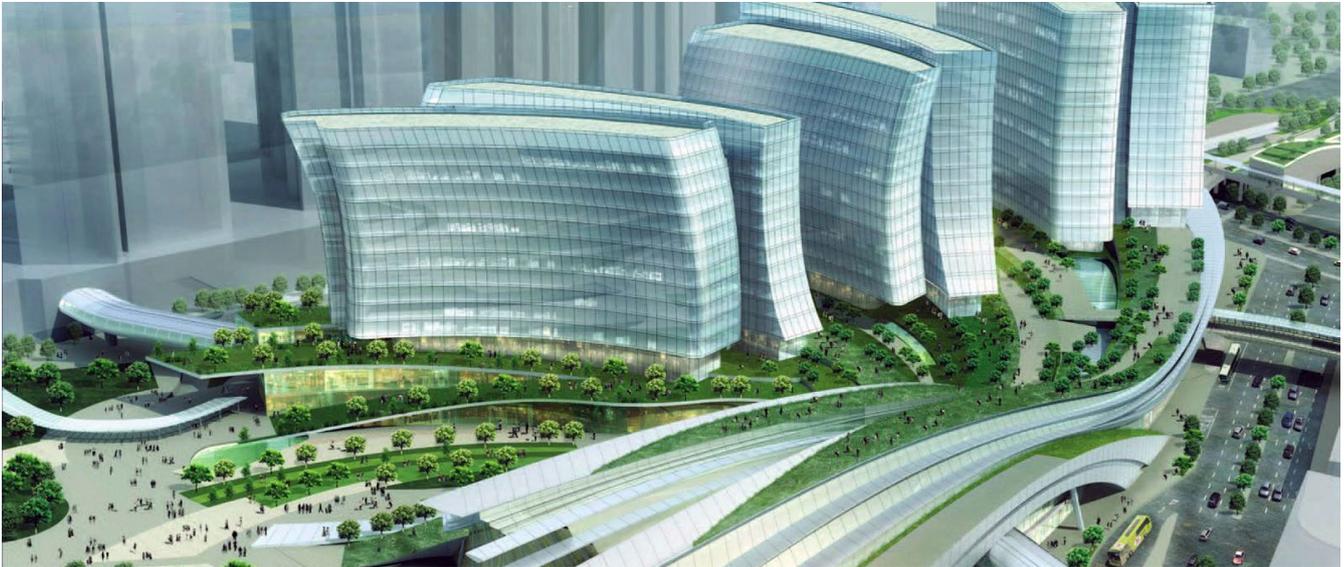
Night-installation of a wind sensor



The cables have been equipped with accelerometers measuring its vibration and tension (see red circle)



# 810 Rail Link Station Roof (Hong Kong)



## Project description

The West Kowloon Terminus (WKT) is an underground railway terminus which is part of a large scale transport infrastructure project that will provide high-speed, cross-boundary rail services between the major cities of Mainland China and Hong Kong.

The structure is formed from three geometrically complex lattice trusses supported at only nine locations by 30 meters high curved steel columns.

The state-of-the-art terminus will integrate sustainable features maximizing the use of natural daylight and create a green cultural plaza for the public with substantial green plants and vegetation on top of the terminus roof.

## mageba scope

In 2015, mageba installed RESTON®POT HP (High Performance) bearings for the West Kowloon Terminus.

These high performance bearings have been selected in order to ensure the controlled transfer of loads between the structure's complicated roof structure and its substructure. They also accommodate rotations about any axis and – where appropriate – movements of the superstructure, and also can be subjected to low or high loading and frequent movements and rotations.

Some bearings are also equipped with load measuring cells and are specially designed to be prestressed by injection possibility in order to overcome future loads and movements during replacement.

## Highlights & Facts

### mageba products:

Type: RESTON®POT HP bearings  
 Features: Combination of ROBO®CONTROL monitoring and height-adjustment system (injection)  
 Installation: 2015

### Structure:

City: Hong Kong  
 Country: China  
 Completed: 2017/2018  
 Type: Terminus of Express Rail link  
 Owner: MTR Corporation Hong Kong  
 Architect: Aedas

The West Kowloon Terminus is located in Hong Kong



Vertically installed guided bearings



Vertically installed free sliding bearings





# MRT Green Line Extension (Thailand)



## Project description

The existing Green Line of Bangkok’s Metropolitan Rapid Transit (MRT) system is being extended to the south by a 12.6 km-long elevated rail track. In total, there will be nine new stations from Soi Sukhumvit 107 (Bearing) to Samutprakarn.

This addition to Bangkok’s public transportation system will serve up to 57,000 passengers a day after completion in 2017, and thus help to ease traffic congestion in the capital. The route is being extended from Bearing along Sukhumvit road, crossing the southern ring road and continuing further south to Samutprakarn.

## mageba scope

The southern extension of the MRT Green Line is equipped with 652 RESTON®POT bearings. 460 of these are RESTON®POT UPLIFT bearings which are designed to resist temporary uplift forces.

All mageba RESTON®POT bearings consist of a steel pot with a lid and an elastomeric pad. Thanks to mageba’s special POM sealing chain, which is securely anchored into the pad through vulcanisation, the mageba RESTON®POT bearings offer exceptional wear resistance and can freely adapt to deformations.

## Highlights & facts

### mageba Products:

- Type: 676 RESTON®POT bearings
- Features: 460 designed to resist uplift
- Installation: 2014

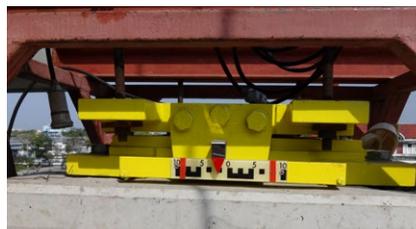
### Structure:

- Location: Bangkok
- Country: Thailand
- Construction: 2014–2017
- Type: Rapid Transit System
- Length: 12.8 km
- Builder: MRTA Thailand

Location of the MRT Green Line in Bangkok, Thailand



mageba pot bearings during installation on the construction site



The Puchao Saming Phrai station after construction



# MRT Blue Line Extension (Thailand)



## Project description

The Metropolitan Rapid Transit (MRT) is Bangkok's public transport system, opened in 2004. Currently, only the Blue and Green Lines are in service. A Purple and a Red Line are under construction. In total ten new lines are planned to be constructed by 2029.

The existing MRT Blue Line is being extended by a total of 27 km of railway track. Of this total, 5.4 km is underground and 21.5 km is elevated.

The elevated structure consists of a twin-track viaduct of precast segmental box girders. The structure is continuous with spans of up to 35 m and supported by a row of single columns beneath the middle of the road.

## mageba scope

mageba supplied 979 RESTON®POT bearings for the 11 km-length of elevated tracks from Taopoon to Tha Pra, Bangkok. Four of the bearings, supporting the structure over the Chao Phraya River, each have a load-carrying capacity of 10,000 kN.

All RESTON®POT bearings are equipped with a special POM seal developed by mageba. This POM seal is considered by many to be one of the best in the world in terms of durability, service life and reliability.

The steel components of the RESTON®POT bearings are corrosion-protected with the mageba C4 protection according to ISO 12944.

## Highlights & facts

### mageba Products:

Type:	RESTON®POT bearings
Features:	Highest load carrying capacity 10,000 kN
Installation:	2012

### Structure:

City:	Bangkok
Country:	Thailand
Type:	Rapid transit system
Length:	27 km
Builder:	MRTA of Thailand
Contractor:	UNIQUE - CHUN WO JOINT VENTURE

Location of MRT Blue Line extension



In total, 979 RESTON®POT bearings were supplied for the MRT Blue Line extension



The 11 km-long elevated tracks from Taopoon to Tha Pra are equipped with mageba RESTON®POT bearings





# Panamá City Metro Line 1 (Panama)



## Project description

The city of Panamá constructed a new metro system, which was inaugurated in April 2014.

Line 1 of the system generally follows a north-south route, from Los Andes to the Albrook bus station, and is 13.7 km long, including 7.2 km of tunnel and 6.3 km of viaduct.

An extension of Line 1 to the final elevated station in San Isidro was opened in August 2015 – added 2.1 kilometers of route to the system, extending the metro's total route length to 15.8 kilometers (9.8 mi) and a total of 15 stations.

The project was carried out by Línea Uno Consortium (Odebrecht and FCC), based on a detailed design by Systra.

## mageba scope

mageba supplied bearings of type LASTO®BLOCK Type B for this project. Due to the length of the railway lines and the associated structures, more than 1,600 bearings were required.

The mageba LASTO®BLOCK bearing is a reinforced elastomeric bearing, featuring high-strength steel sheeting vulcanized into its core. The steel plates are fully enclosed in elastomer to ensure absolute corrosion protection and complete freedom from maintenance – an important consideration for a transport system which should not be subjected to closures for maintenance and repair.

## Highlights & Facts

### mageba products:

Type:	LASTO®BLOCK Type B elastomeric bearings
Installed:	2012

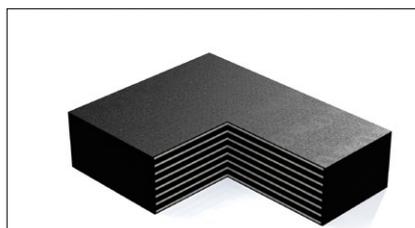
### Structure:

City:	Panama City
Country:	Panama
Type:	Metropolitan railway
Built:	2010–2014
Length:	15.8 km

Panamá City Metro Line 1 located in downtown Panama City



Iso-cut of LASTO®BLOCK elastomeric bearing of type B



The Los Andes Metro station a couple of months before opening



# Vancouver Skytrain “Evergreen” (Canada)



## Project description

To extend Vancouver’s Skytrain rapid transit network, a new line, to be known as the Evergreen Line, is currently under construction. The Skytrain is a metropolitan train system that features many elevated guideways – hence its name.

The new line has a length of 10.9 kilometres (6.8 miles), and its construction includes the building of six new stations as well as major upgrades to two existing stations. Service on the new route is planned to begin by middle of 2016 and is expected to serve 70,000 passengers per day in 2021.

## mageba scope

Part of the Evergreen Line’s elevated structure will be supported by LASTO®BLOCK bearings, the tried and trusted elastomeric bearings from mageba’s bearing range. LASTO®BLOCK bearings allow rotations by deformation of their rubber layers, and this deformation also facilitates structure movements (as may an additional sliding surface). Rubber bearings also offer excellent damping of noise and vibrations – which is often of interest in rail structures.

288 elastomeric bearings with sizes up to 800 mm × 800 mm and heights up to 190 mm are being supplied, for loads of up to 6,300 kN.

## Highlights & Facts

### mageba products:

Type: Elastomeric bearings  
 Features: Masonry plates  
 Installation: 2014

### Structure:

City: Vancouver  
 Country: Canada  
 Type: Metro system elevated guideway  
 Built: 2013–2016  
 Length: 10.9 km  
 Builder: SNC-Lavalin

The Skytrain is a key part of Vancouver’s public transit system



Part of the new line’s elevated structure will be supported by LASTO®BLOCK elastomeric bearings

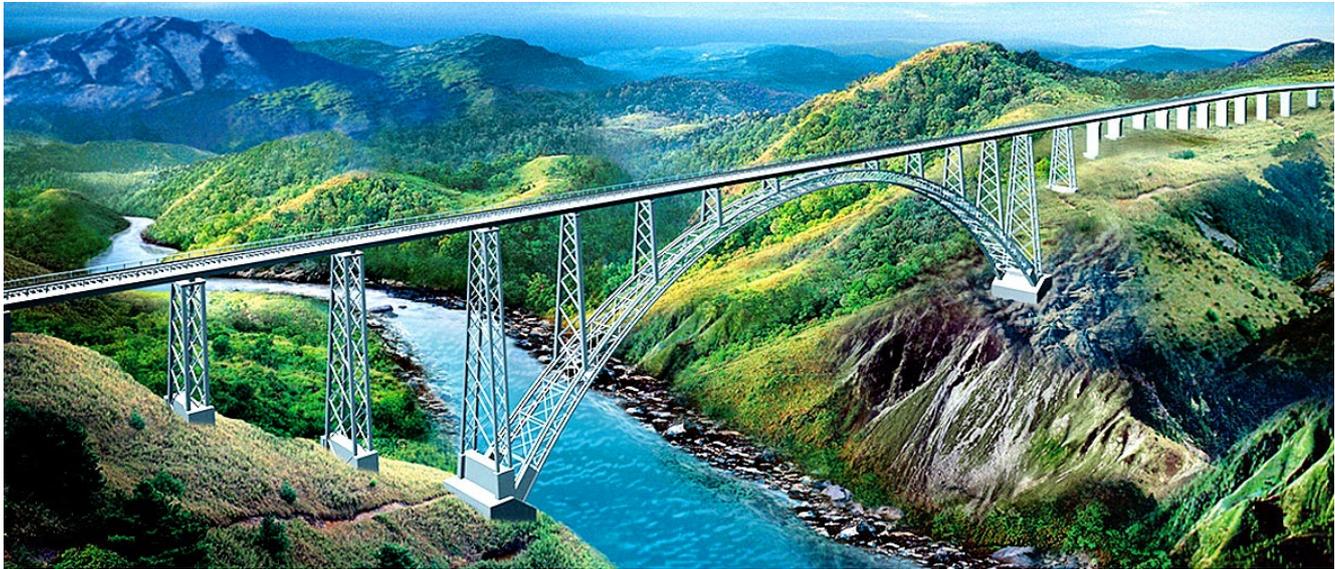


LASTO®BLOCK bearings allow rotations and movements while also providing good damping





# Chenab Railway Bridge (India)



## Project description

When completed in 2018, the Chenab Railway Bridge will become the world's highest railway bridge, with a height of 359 m. Crossing the River Chenab, it will enable the Indian mainland to be connected by rail with the state of Jammu & Kashmir for the first time.

The 17-span bridge will have a length of 1,315 m, including a trussed arch main span of length 469 m.

The arch is being constructed with the help of two self-propelled auxiliary cable cranes, moving along cables spanning between 100 m-high temporary pylons at each side of the valley.

The steel box chords of the trusses will be filled with concrete to help resist wind forces and save internal painting.

## mageba scope

mageba is supplying 22 RESTON®SPHERICAL bearings and 38 LASTO®BLOCK elastomeric stopper bearings for the construction of this remarkable bridge.

All of the spherical bearings are of type KA (free-sliding), meaning that they allow sliding movements in all horizontal directions.

They are designed to carry vertical loads of up to 14,160 kN, and 12 of the bearings are also designed to resist uplift forces.

LASTO®BLOCK elastomeric stopper bearings with PTFE have been designed for horizontal force up to 5,100 kN.

## Highlights & facts

### mageba Products:

Type: 22 RESTON®SPHERICAL bearings (type KA), 38 LASTO®BLOCK elastomeric stopper bearings

Features: Uplift resistance spherical and elastomeric stopper with PTFE

Installation: 2014–2017

### Structure:

State: Jammu & Kashmir

Country: India

Built: 2018

Type: Arch bridge

Length: 1,315 m

Contractor: Afcons Infrastructure

Owner: Northern Railways

The bridge is located in northern India, in the state of Jammu & Kashmir



Illustration of a RESTON®SPHERICAL Type KA bearing – exploded view showing central calotte



A typical RESTON®SPHERICAL bearing during application of grease to upper sliding surface



# Hyderabad Metro Railway (India)



## Project description

Hyderabad Metro Rail (HMR) is the world's largest PPP (Public Private Partnership) construction project. The project, to construct a new metro rail service for Hyderabad, India's fourth largest city, is being implemented in two phases – Phase I creating a network with a length of 71 km, and Phase II extending this by an additional 85 km.

The system is elevated above ground level, minimising conflicts with other land uses and forms of transport. Once completed, it will be world's largest elevated metro railway system. It is estimated that HMR will be carrying 1.5 million passengers per day by 2017.

## mageba scope

mageba is supplying a great number of bearings and expansion joints for the construction of the metro system.

These include 7,000 LASTO®BLOCK bearings, consisting of blocks of elastomer reinforced by steel plates, which transmit vertical and horizontal forces from the superstructure to the substructure while accommodating rotations about any axis.

68 RESTON®POT bearings, designed for loads of up to 14,280 kN, are also being supplied. The expansion joints being supplied, of types MIGUTRANS®FSL and MIGUTEC®KF, have a total length of approximately 9,000 m.

## Highlights & facts

### mageba Products:

Type: RESTON®POT bearings, LASTO®BLOCK bearings, MIGUTRANS®FSL joints, MIGUTEC®KF joints

Installation: 2014–2015

### Structure:

City: Hyderabad

Country: India

Completed: 2015 (Phase 1)

Type: PSC box girder elevated metro bridge

Length: 71 km (Phase 1)

Contractor: Larsen & Toubro

Owner: Hyderabad Metro Rail

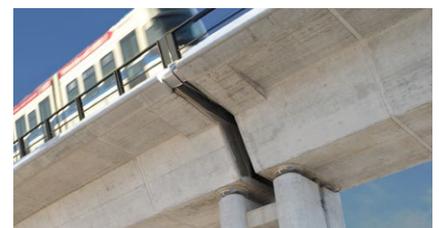
Hyderabad, India's fourth largest city with seven million inhabitants, is located in central India.



20 of the LASTO®BLOCK bearings, loaded on a pallet for delivery to site.



RESTON®POT bearings have proven their worth in many railway viaduct applications.





# TGV Viaduc de la Courbe (France)



## Project description

The LGV Bretagne-Pays de la Loire is a high-speed rail line being built in north-western France. Construction, at an estimated cost of €3.4 billion, is scheduled to be completed in late 2016. The line will be serviced by TGV trains operated by SNCF, the French national railway company.

The Viaduc de la Courbe is an eight-span viaduct on the line near the city of Le Mans. It has a total length of 374 m, including six spans of 50 m and two end spans of 37 m each. Its composite deck has a width of 12.5 m, and is at a maximum height of 21 m above the ground.

## mageba scope

18 RESTON®SPHERICAL bearings support the viaduct's deck, designed to resist downward forces of up to 23,840 kN while accommodating longitudinal movements of up to +/- 215 mm. The use of mageba's specially developed sliding material, ROBO®SLIDE, instead of PTFE in fabricating the bearings maximises their strength and durability.

The bearings at both abutments are additionally designed to resist occasional uplift forces of 450 kN which may arise during de-ballasting operations. They do this by means of external clamps, which are also equipped with ROBO®SLIDE sliding interfaces to enable the bearings to accommodate sliding movements even under uplift conditions.

## Highlights & facts

### mageba products:

- Product: RESTON®SPHERICAL bearings
- Features: Uplift protection, ROBO®SLIDE material
- Installation: 2014

### Structure:

- Country: France
- Completed: 2015
- Type: High-speed rail viaduct
- Length: 374 m
- Contractor: Eiffage
- Architects: RFF

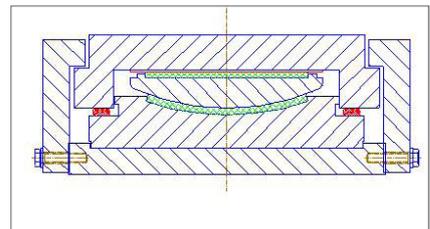
The viaduct is being constructed on the route of the new TGV line in north-western France



Assembly of a RESTON®SPHERICAL bearing, showing its upper greased ROBO®SLIDE disc



Cross-section of a RESTON®SPHERICAL bearing with external uplift clamps



# Rail car loading station, Pará (Brazil)



## Project description

Transport of freight by rail accounts for a large proportion of the total transport of goods around the world, especially in relation to dry bulk commodities such as coal, ore and grain. Within the U.S., for example, railroads carry 39.9 % of freight by ton-mile, followed by trucks (33.4 %), oil pipelines (14.3 %), barges (12 %) and air (0.3 %). Hopper cars, which are loaded from above and emptied through the bottom, are widely used to transport dry bulk commodities. This project involved the construction of a hopper car loading facility for iron ore in a mining area of northern Brazil.

## mageba scope

The hopper car loading facility, which allows trains to be parked beneath it for loading from overhead silos, is supported by 22 RESTON®SPHERICAL bearings. These are designed for vertical loads of up to 7950 kN. Some of the bearings also resist horizontal forces, while others accommodate longitudinal and/or transverse sliding movements. The long-term sliding performance of the bearings in this demanding industrial location, where impacts and dust can be expected at all times, is ensured by the use of mageba's ROBO®SLIDE high-grade sliding material instead of the typically used PTFE.

## Highlights & facts

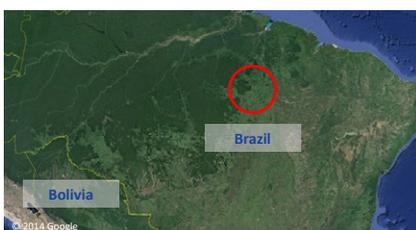
### mageba products:

Type: RESTON®SPHERICAL bearings  
 Features: ROBO®SLIDE high-grade sliding material  
 Installation: 2013

### Structure:

City: Canaã dos Carajás  
 Country: Brazil  
 Completed: 2013  
 Type: Rail car loading station  
 Client: Polysius do Brasil

The facility is located in Canaã dos Carajás city, in the southwest of Pará State, Brazil



Exploded view of a RESTON®SPHERICAL bearing (guided sliding type), showing calotte in middle



Assembly of a RESTON®SPHERICAL bearing, with calotte being placed on concave lower part





# Gstaad railway viaduct (Switzerland)



## Project description

The “chalet village” of Gstaad in the Swiss Alps is world famous for its scenic beauty and its charm. Much of the town’s charm is due to its well-maintained heritage – such as the railway viaduct near the town centre. This was constructed in 1905 to carry the railway line that was opened in 1905 to support the region’s booming tourism industry.

In 2011, after more than a century of service, the viaduct needed to be completely renovated. The structure was strengthened to enable it to withstand increased modern loading, and the work included measures to reduce noise emissions under railway traffic.

## mageba scope

mageba supplied all of the bearings required to support the bridge deck. RESTON®POT Type TE (guided sliding) bearings at each end now resist the deck’s vertical loads and accommodate longitudinal sliding movements of +/- 25 mm, while RESTON®FORCE horizontal force bearings resist the transverse forces at these locations while allowing the same movements. LASTO®BLOCK Type NBe bearings support the deck at both internal pillars.

mageba also supplied four RESTON®STU shock transmission units, two for each end, which ensure the safe, controlled transmission of unusually large forces between the deck and the abutments.

## Highlights & Facts

### mageba products:

Type: RESTON®FORCE bearings  
RESTON®POT bearings  
RESTON®STU shock transmission units  
LASTO®BLOCK (NBe)

Installation: 2011

### Structure:

City: Gstaad  
Country: Switzerland  
Type: Lattice girder railway viaduct

Construction: 1905

Renovated: 2011

Owner: Montreux–Oberland Bernois railway

Contractor: Burn & Künzi AG  
Adelboden

Engineer: Wüst Rellstab  
Schmid AG

Gstaad is located between Lausanne and Interlaken in western Switzerland



Two RESTON®STU shock transmission units at one end of the bridge deck



Installation of a LASTO®BLOCK (type NBe) bearing under one of the bridge’s main girders



# Flendruz railway viaduct (Switzerland)



## Project description

The Flendruz railway viaduct carries the Golden-Pass railway line, a tourist-orientated train route in the Swiss Alps between Montreux and Lucerne, across a small valley. It was built at the time of the railway line's original construction, which was completed in 1905.

After more than a century of service the viaduct needed to be completely renovated, with a focus on enabling it to carry higher loads and reducing noise emissions under railway traffic. These works were carried out in 2011.

## mageba scope

mageba supplied a variety of bridge components for this renovation project. RESTON®POT bearings of type TE (guided sliding), designed to carry loads of 1,460 kN and accommodate longitudinal sliding movements of +/- 25 mm, now support the ends of the main girder beams, while RESTON®FORCE horizontal force bearings resist the transverse forces at these locations while allowing the same longitudinal movements.

At each end of the deck, two RESTON®STU shock transmission units ensure the safe, controlled transmission of unusually large forces between the deck and the abutment.

## Highlights & Facts

### mageba products:

Type: RESTON®FORCE bearings  
RESTON®POT bearings,  
RESTON®STU shock transmission units

Installation: 2011

### Structure:

City: Flendruz  
Country: Switzerland  
Type: Lattice girder railway viaduct

Construction: 1905

Renovated: 2011

Owner: Montreux–Oberland Bernois railway

Contractor: Burn & Künzi AG  
Adelboden

Engineer: Theiler Ingenieure AG

The village Flendruz is located close to Montreux in western Switzerland



A RESTON®POT bearing as installed under the end of one of the bridge's main steel girders



Two RESTON®STU shock transmission units during installation at one end of the bridge deck





# Railway bridge WK432, Bytom (Poland)



## Project description

This bridge was constructed in 2010-2011 near the city of Bytom in southern Poland, to carry a railway line over the A1 motorway. The new construction of the motorway in this area necessitated the building of a bridge to enable road and rail traffic to flow freely at the crossing point.

The bridge consists of two reinforced concrete structures, side by side – one for each of the two railway tracks. Noise reduction measures were necessitated by the presence of a residential area close to the bridge.

## mageba scope

mageba supplied TENSA®MODULAR expansion joints for the construction of this bridge. Four joints were required, one for each end of each structure. The joints are of type LR8-RW, the suffix “RW” standing for “railway”. They are designed for the particular challenges presented by railway bridges, such as the ballast stones that would block the gaps of a normal modular joint and must be prevented from entering the gaps, and the high axle loads and vibrations from rail traffic.

The joints also feature ROBO®MUTE noise-reducing mats underneath, to reduce noise under traffic.

## Highlights & facts

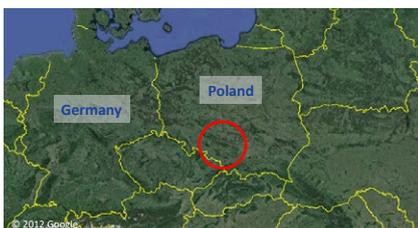
### mageba products:

Type:	TENSA®MODULAR expansion joints (type LR8-RW)
Features:	Railway bridge joints, ROBO®MUTE noise-reducing mats
Installation:	2011

### Structure:

City:	Bytom
Country:	Poland
Completed:	2011
Type:	Railway bridge

The bridge crosses the A1 motorway near the city of Bytom in southern Poland



Lifting of a TENSA®MODULAR type LR8-RW joint into position on the bridge



A TENSA®MODULAR joint of type LR8-RW (railway bridge joint) during installation



# Ganga Rail-Road Bridge, Patna (India)



## Project description

A new bridge is currently being built over the River Ganga (or Ganges) near the city of Patna in north-eastern India. The river is of enormous importance to the people who live in the substantial part of India through which it flows, but its exceptional width presents a great obstacle to transportation and commerce.

The main bridge, with a length of 4,556 m and spans of 123 m, will carry both rail and road traffic on separate levels. The total length of structure being constructed as part of the overall project, including approaches, is approximately 20 km.

## mageba scope

mageba supplied a large number of bearings and expansion joints for the main bridge and its approach structures.

The bearings included 464 RESTON®POT bearings for loads of up to 18,000 kN, and RESTON®FORCE guide bearings designed to resist horizontal forces of up to 5,400 kN but carry no vertical loads. Temporary erection bearings were also supplied.

The expansion joints included 37 TENSA®MODULAR expansion joints of type LR2 for the road deck of the main structure, and 216 metres of TENSA®GRIP single gap joint for the approach structures.

## Highlights & facts

### mageba Products:

Type: RESTON®FORCE and RESTON®POT bearings, TENSA®MODULAR (LR2) and TENSA®GRIP joints

Installation: 2007–2014

### Structure:

City: Patna  
 Country: India  
 Built: 2015  
 Type: K-truss bridge  
 Length: 4.56 km  
 Contractor: Ircon International Ltd.  
 Owner: East Central Railway

The bridge crosses the River Ganges near the city of Patna in north-eastern India.



A RESTON®POT bearing with capacity of 18,000 kN as fabricated and ready for delivery to site.



A RESTON®FORCE bearing, designed to resist only transverse horizontal forces.





# Ganga Rail-Road Bridge, Munger (India)



## Project description

The mighty Ganga (or Ganges) River, a symbol of India and so much more for the country's people, makes its way from the western Himalayas to the Bay of Bengal, a journey of 2,500 km. Its river basin is one of the most fertile and densely populated regions in the world and covers an area of 1,000,000 square kilometres.

A new bridge, currently being built across the river close to the city of Munger, will carry road and rail traffic on different levels.

With 25 main spans of 125 m and a total length of 3190 m, it will be one of the longest bridges in India when it opens in 2015.

## mageba scope

To support the deck of this exceptionally long bridge and its approach structures, mageba supplied 304 RESTON®POT bearings for vertical loads of up to 15,000 kN, and RESTON®FORCE horizontal force bearings to resist purely horizontal forces while allowing movement along one axis.

To provide a trafficable surface at the superstructure's movement gaps, mageba also supplied 29 TENSA®MODULAR expansion joints of type LR2 for the road traffic level of the main bridge, and 180 m of TENSA®GRIP single gap joint for the approach road viaducts.

## Highlights & facts

### mageba products:

Type: RESTON®FORCE and RESTON®POT bearings, TENSA®MODULAR (LR2) and TENSA®GRIP joints

Installation: 2007–2014

### Structure:

City: Munger  
Country: India  
Completed: 2015  
Type: Rail and road bridge  
Length: 3.19 km  
Crosses: Ganga (Ganges) River  
Contractor: Gammon India Ltd.

The bridge crosses the River Ganges near the city of Munger in north-eastern India.



A RESTON®FORCE horizontal force bearing, as fabricated.



A RESTON®POT bearing as installed, during erection of the bridge deck on top of it.



# Ventabren TGV Railway Viaduct (France)



## Project description

The Ventabren railway viaduct, built between 1996 and 1998, forms part of the TGV Méditerranée high speed rail connection between Paris and France's Mediterranean coast at Marseilles. The bridge has a length of 1730 m, enabling it to cross a canal and a number of roads including the A8 motorway.

The main motorway crossing has a haunched girder deck with a span of 100 m, which was constructed parallel to the road and then rotated into position about a vertical axis. The remainder of the viaduct, with a prestressed concrete box girder deck, was launched incrementally.

## mageba scope

mageba supplied eight RESTON®SA hydraulic dampers, each with a force capacity of 3,000 kN and allowing movements of up to 650 mm, to control the longitudinal movements of the viaduct's deck. These are velocity-dependent devices, consisting primarily of a piston in a fluid-filled cylinder. They allow free movements of a structure during service conditions, but control displacements and dissipate energy during sudden movements caused, for example, by earthquakes or exceptional traffic forces. They thus reduce the impact of the forces on the structure, enabling its design to be optimised.

## Highlights & facts

### mageba products:

Type: RESTON®SA hydraulic dampers  
Installation: 1998

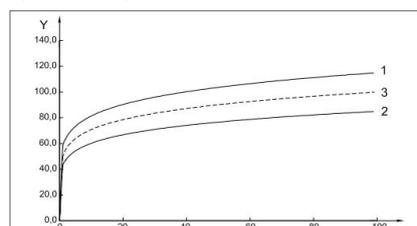
### Structure:

City: Ventabren  
Country: France  
Type: Box girder bridge  
Haunched girder bridge  
Completed: 1998  
Length: 1730 m  
Main span: 100 m

The viaduct is on the TGV line from Paris to Marseilles, where it passes the city of Ventabren



Force-Velocity diagram of a typical RESTON®SA hydraulic damper



An installed RESTON®SA hydraulic damper





# Transbay Transit Center (USA)



## Project description

The new Transbay Transit Center has replaced the former Transbay Terminal that was built in 1939 in downtown San Francisco. This modern transit hub serves 11 transportation systems and contains more than one million square feet. The highlights are a 5.4 acre (22 000 square meters) rooftop public park, Grade Hall, dramatic Light Column, and stay cable pedestrian bridge. The construction was completed in 2018.

## mageba scope

mageba USA worked on different sections of this landmark project. On one side, mageba supplied eight RESTON®PENDULUM Mono bearings with load capacities of 2,500 kips (11,120 kN) and 2,000 kips (8,900 kN) for the terminal superstructure and eight RESTON®SPHERICAL bearings able to withstand blast forces of 171 kips and with 41.5" of max. sliding capacity for the glass roof structure.

On the other side, mageba also supplied two TENSA®MODULAR expansion joints designed with 8 and 11 gaps to accommodate 24 in and 33 in of movement respectively at the bus storage facility ramp.

## Highlights & Facts

### mageba products:

Type: RESTON®PENDULUM Mono bearings  
 RESTON®SPHERICAL bearings  
 TENSA®MODULAR expansion joints of type LR8 and LR11

Features: Table hysteretic behavior

Installation: 2016–2018

### Structure:

City: San Francisco, CA  
 Country: USA  
 Type: Transit Center  
 Owner: TJPA  
 Builder: Shimmick, Greenlite, MCM

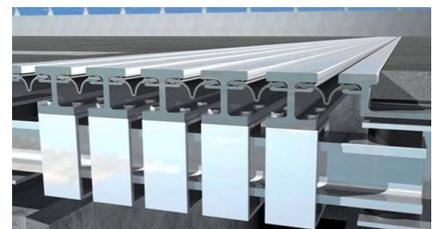
The Transbay Transit Center is located next to the San Francisco – Oakland Bay Bridge



Installation of RESTON®PENDULUM Mono on terminal superstructure



Movements at the Bus storage facility ramp will be facilitated by modular joints



# Zurich Central Train Station (Switzerland)



## Project description

Zurich Central Train Station is regarded as the world's most frequented station in terms of numbers of trains per day. Over 2'915 trains operate here per day, which means that a train arrives or leaves approximately every 25 seconds.

The construction material used for the structure is exposed to external impact such as temperature and humidity. Thanks to the application of expansion joints, the resulting movement forces (so-called „Restrains“) will be balanced and damages such as cracks in the structural components can be avoided. The joints, that were installed in the underground pedestrian area in 1990, had to be replaced. As a consequence, the Swiss Federal Railway (SBB) decided to install a solution without any future maintenance requirements as well as increasing comfort for the public.

## mageba scope

mageba was selected to install +150 m of its flexible plug expansion joint system POLYFLEX®ADVANCED PU over night and within less than seven hours. This remarkably flexible installation had hence no effect on the hustle and bustle of the main station.

The application of a jointless passage represents an extensive reduction of effort for the contractor. In contrast to conventional joint systems, the particular plug expansion joint POLYFLEX®ADVANCED PU offers a new alternative especially in relation to agility, aesthetics and zero maintenance.

As well as for pedestrian zones and railway station buildings, this joint type is also ideal for use in multilevel car parks, airport buildings, shopping malls, hospitals and bridges.

## Highlights & Facts

### mageba products:

Type: POLYFLEX®ADVANCED PU FSJ of type PA40 for buildings

Features: Movements of +26/-14 mm

Installation: 2015

### Structure:

City: Zurich

Country: Switzerland

Type: New renaissance building complex

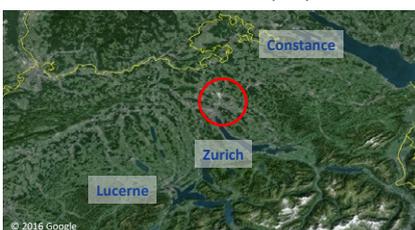
Completion: 1847

Owner: City of Zurich

Contractor: Swiss Federal Railway (SBB)

Architects: Jakob Friedrich Wanner (origin building)  
T. and R. Haussmann (interior work)

More than 437'000 passengers pass through Zurich's central train station every day



Over-night-installation in the station's pedestrian area within less than seven hours



The result offers more comfort for pedestrians and an extensive reduction of effort for the contractor





# Tocumen Airport Access Road (Panama)



## Project description

Panama City's Tocumen International Airport is currently being extended with the addition of a new terminal. Designed by Foster & Partners, it will increase floor space by over 800,000 square feet, with 20 new boarding gates, a duty free area, a new control tower and a third runway.

Access to the new terminal from the Corredor Sur highway that bypasses the airport is provided by a four-lane road, part of which is elevated. The non-continuous elevated structure of each carriageway is supported by ten piers, requiring a bearing solution.

## mageba scope

To support the structures' decks, mageba supplied 80 RESTON®POT HP bearings with uplift resistance. These bearings are based on the standard RESTON®POT bearing which has been a most popular bearing in mageba's range for many years, having proven its worth in countless applications. The recently developed version of the bearing, with "HP" standing for "High Performance", represents a major advance in the bearing's technology. Durability is much increased, thanks to the use of improved materials, and the increased strength enabled the bearings to be made small enough to suit the main structure's design.

## Highlights & facts

### mageba products:

Type: RESTON®POT HP (high performance) bearings  
Features: Uplift resistance  
Installation: 2014

### Structure:

City: Panama City  
Country: Panama  
Completed: 2014  
Type: Airport access viaduct  
Contractor: Construtora Norberto Odebrecht

The new viaduct provides access to Tocumen International Airport, Panama City, Panama



Exploded view of a typical RESTON®POT bearing, showing elastomeric pad at its core



A typical RESTON®POT bearing featuring uplift resisting clamps at sides, as fabricated



# Car Park P6 Zurich Airport (Switzerland)



## Project description

Along with the project 'The Circle', which has the purpose to establish Zurich Airport as a service destination from 2018 on, the parking area had to be optimised and adjusted to the passenger increase expected in the next years. Therefore, the car parks P40 and P45 were dismantled and replaced by the expansion of car park P6 to the south.

The new car park features 12 floors and parking levels hence now offering sufficient space for 1,300 additional cars. The floors are accessible via a central spindle.

## mageba scope

In order to meet the requirements in terms of seismic protection, the expansion features space of approximately 43 m to the existing building.

mageba was chosen to find a solution for a suitable passage construction. Besides seismic protection, adequate load and movement capacity had to be assured. mageba hence developed the special joint TENSA®SEISMIC RS-Fuse. 66 units of a total length of 450.5 m as well as steel cover plates of a total length of 2,013 m were delivered and installed.

Thanks to mageba's long-term experience in the infrastructure and building sector, the entire order processing to the point of installation was reliably carried out from one source and on schedule.

## Highlights & Facts

### mageba products:

Type: TENSA®SEISMIC special joint RS-Fuse  
 Features: seismic isolation with movements of +/- 300 mm  
 Installation: 2013–2016

### Structure:

City: Zurich  
 Country: Switzerland  
 Type: Steel-concrete-compound construction  
 Construction: 2013  
 Owner: Flughafen Zürich AG  
 Architect: Stutz + Bolt + Partner Architekten AG

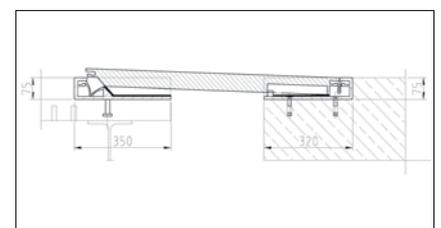
Zurich Airport annually manages over 25 million passengers and is classified as Switzerland's logistic intersection



The installed joints assure seismic isolation as well as load and movement capacity



Principle of a joint for seismic protection, pictured by means of a drawing





# Amsterdam Airport Schiphol (Netherlands)



## Project description

Amsterdam Airport Schiphol (AMS) is the international passenger airport of the Dutch capital city Amsterdam. With the first airplane landing there in 1916, the airport has been classified as the oldest international airport with a never changing location.

The airport is located 10 km south of the city centre in the Schiphol suburbs and has been awarded as Europe's fourth biggest airport, accommodating approximately 55 million passengers in 2014 (after London Heathrow, UK, Paris-Charles-de-Gaulle, FR, and Frankfurt on the Main, DE).

Up to 2003, a variety of expansion projects were implemented on a surrounding area of around 2,787 ha. These projects comprised a new terminal with three halls and eight piers as well as six start and landing runways.

## mageba scope

Due to water leak, the joints on the ramp and access road to the departure hall had to be replaced. mageba installed its 100 % watertight flexible plug expansion joint POLYFLEX®ADVANCED PU, type PA30, that assures a movement capacity of +20/-10 mm.

In order to allow arriving passengers to comfortable move their baggage, mat joints TENSA®MAT have been chosen. This specific joint construction forms a closed, compact and integrated surface with the mat hence allowing passenger's baggage such as cases and trolleys being moved without any blockages. A further advantage of this specific joint is the considerable waste reduction as no foreign substances can be accumulated in the joint range.

## Highlights & facts

### mageba products:

Product: POLYFLEX®ADVANCED PU flexible plug joints type PA30  
TENSA®MAT mat joints

Features: Flexible plug joints with movements of +20/-10 mm  
Mat joints with movements of up to 160 mm

Installation: 2013

### Structure:

Location: Amsterdam  
Country: Netherlands  
Opening: 1916  
Owner: Schiphol Group  
Contractor: Heijmans NV  
Architects: Bentheim Crouwel Architects

Location of Amsterdam Airport Schiphol



View of a mat joint TENSA®MAT with crossover



A car crossing the installed flexible plug joint POLYFLEX®ADVANCED PU





Reference projects

# Muscat International Airport (Oman)



## Project description

The new Muscat International Airport expansion will be completed in 2016 and has the capacity to handle 12 million passengers annually.

Further expansions planned in three subsequent phases will ultimately boost the airports' capacity to 24, 36 and 48 million passengers when the demand is required. The Total Gross Floor Area Terminal Building would be 335,000 m<sup>2</sup>.

## mageba scope

In order to assure safety in the Passengers Terminal Building (PTB) mageba delivered a variety of bearings and joints: In total 90 units of RESTON®POT bearings and 153 RESTON®SPHERICAL bearings for internal steel bridges, steel roofs as well as the tower and lift buildings. The 19 TENSA®MODULAR expansion joints with a

total length of 388 m will be installed in traffic forecourt bridges and in the traffic concourse (passenger arrival and departure).

mageba's supply for building products comprises:

772 units of high-quality point bearings LASTO®FLONPAD GP9, and 182 units of high-quality knuckle and sliding point bearings LASTO®FLONBLOCK, each made in Switzerland.

The process had challenges in terms of maximum available space below and above in several positions and also due to the fact that in other positions the bearings would be visible from the ground floor. mageba's input was hence extremely critical for the designing team because it had to adjust their details to the dimensions and heights of the bearings.

## Highlights & facts

### mageba products:

Type: 90 RESTON®POT bearings  
135 RESTON®SPHERICAL bearings,  
19 TENSA®MODULAR expansion joints,  
772 LASTO®FLONPAD GP9 point bearings,  
182 LASTO®FLONBLOCK sliding bearings

Installation: 2012–2016

### Structure:

City: Muscat  
Country: Oman  
Type: Airport Center  
Contractor: JV "Bechtel – ENKA"  
Architect: Larsen A&CE  
Client: OAMC (Oman Airports Management Company)

The Muscat airport is the largest one of the two international airports in Oman



A spherical bearing supporting the steel roof of this impressive building



On-site check of a spherical bearing that features patented ROBO®SLIDE sliding material





# Teleférico de Mérida (Venezuela)



## Project description

The Teleférico de Mérida (Mérida Cable Car) is located in Venezuela, and connects the city of Mérida (at an altitude of 1,640 metres) to Espejo Peak in the adjacent mountains (at an altitude of 4,765 metres). Climbing over three kilometres along its route of 12.5 km, it is one of the longest and highest cable car systems in the world. It was opened in 1960, and closed in 2008, having reached the end of its service life.

The construction of a new cable car system to replace the old one is currently underway, with completion expected in 2016.

## mageba scope

Two RESTON®SA shock absorbers were supplied, complete with connection brackets. They were designed for a maximum load of 480 kN and maximum stroke of +/- 50 mm. One shock absorber was subjected to a low velocity test, a constitutive law test and a damping efficiency test, while each unit was subjected to pressure and stroke verification tests.

A TENSA®COMPRESS expansion joint, accommodating movements of up to 45 mm, was also required for the associated station infrastructure.

## Highlights & facts

### mageba products:

Type: RESTON®SA shock absorbers, TENSA®COMPRESS expansion joint

Installation: 2015

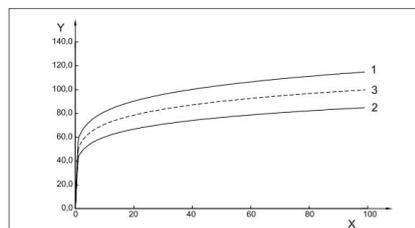
### Structure:

City: Mérida  
Country: Venezuela  
Type: Cable car system  
Built: 1960  
Renovated: 2016  
Length: 12.5 km  
Climb: 3,125 m  
Builder: Garaventa

The city of Mérida is located in the Andes mountains of northwestern Venezuela



Typical Force (y-axis) versus Velocity (X-axis) diagram of a RESTON®SA shock absorber



Two RESTON®SA shock absorbers, packed in a crate for transport to site



# Kai Tak Cruise Terminal (China)



## Project description

The Kai Tak Cruise Terminal is built on the former site of the Kai Tak Airport in Hong Kong. The terminal has the capacity to berth two 360 m-long vessels. On peak days the Cruise Terminal can cater for up to 8,400 passengers and 1,200 crew members

The cruise terminal was designed by Foster + Partners and its roof spans over 70 m. Its multi-functional design allows the terminal to be converted into a venue for exhibitions and other events.

The total area of the Cruise Terminal is 52,000 m<sup>2</sup> and it also encompasses a rooftop garden which is open to the public.

## mageba scope

A total of 1060 LASTO®BLOCK elastomeric bearings were used in the construction of the Kai Tak Cruise Terminal. All mageba elastomeric bearings installed in the Cruise Terminal are made from high-quality elastomer, reinforced by steel plates.

The RESTON®POT bearings used for this project have maximum load carrying capacity of  $V_{max} = 3,800$  kN and ensure the controlled transfer of loads.

mageba RESTON®POT bearings are equipped with a special POM seal which is vulcanised directly into the bearing pad and hence improves the wear resistance of the bearing significantly.

## Highlights & facts

### mageba Products:

Type: RESTON®POT bearings, LASTO®BLOCK elastomeric bearings

Installation: 2012

### Structure:

City: Hong Kong

Country: China

Completed: 2013

Type: Cruise Terminal

Area: 52,000 m<sup>2</sup>

Builder: Dragages Hong Kong

Location of the Kai Tak Cruise Terminal, Hong Kong



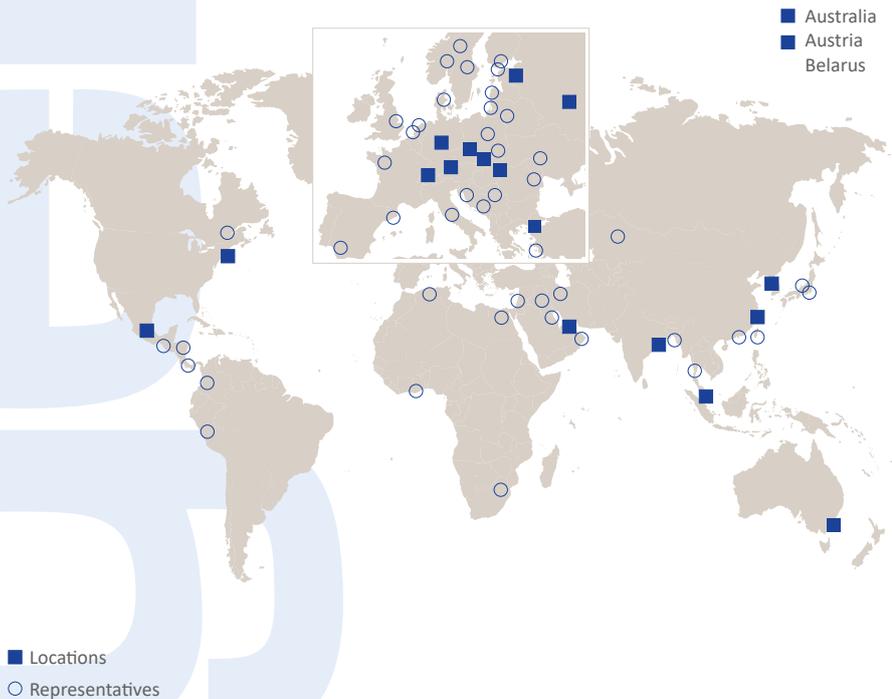
mageba LASTO®BLOCK elastomeric bearings, ready for delivery



The Kai Tak Cruise Terminal during construction



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