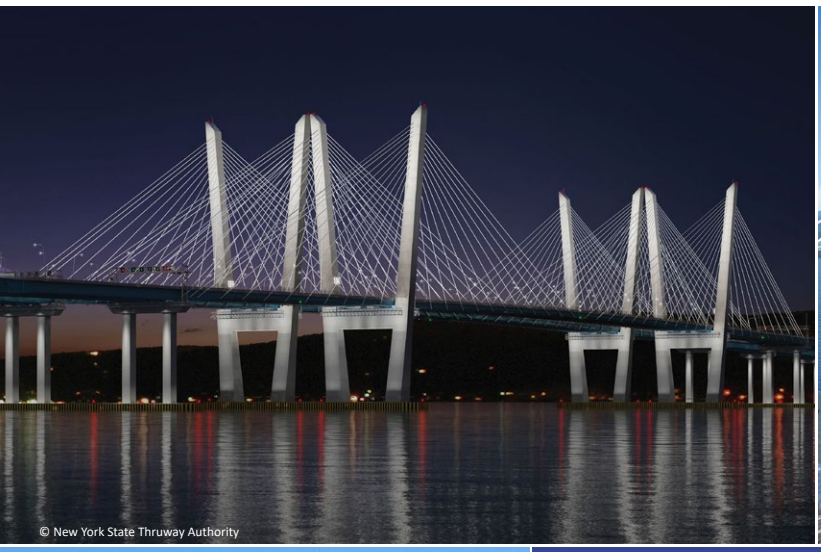
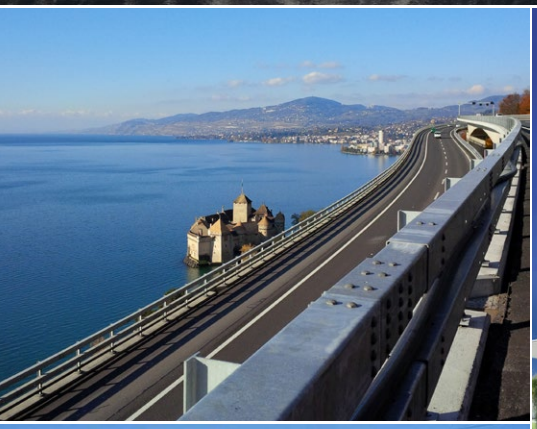
Infrastructure products

Seismic reference projects – worldwide





Index reference projects – worldwide

Project	Location/Country	mageba's completion	Bearings	Expansion joints	Seismic devices	Monitoring & Services	Page
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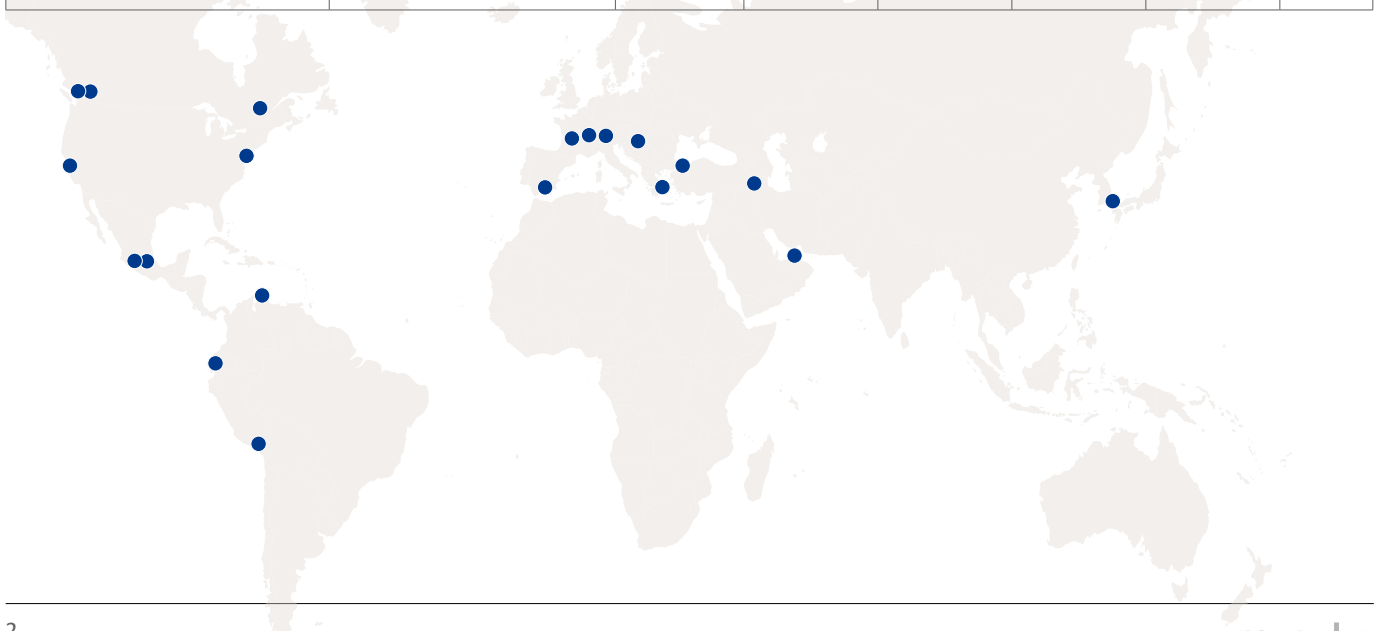


Tappan Zee Bridge (New York)

Project description

The New Tappan Zee Bridge, also known as the New NY Bridge and officially named the Governor Mario M. Cuomo Bridge after the late former governor Mario Cuomo, is a twin cable-stayed bridge built to replace the original Tappan Zee Bridge over New York's Hudson River. The $4.0 billion bridge structure, completed in June 2018, contains a total of eight lanes for vehicular traffic as well as a shared-use bicycle and pedestrian path.

Additionally, an allowance has been made for the future construction, between the two structures, of a rail line to assist with trans-Hudson public transportation.

The Tappan Zee Bridge is a critically important transportation link in the New York Metropolitan Area, with over 138,000 vehicles crossing it each day.

mageba scope

mageba North America Corp. supplied all 23 of the TENSA®MODULAR (type LR) expansion joints required for the new Tappan Zee Bridge, in fully continuous lengths, the longest of which is 105 feet (32 meters). The largest joints are type LR18, each with 18 individual movement gaps which accommodate total longitudinal movements of up to 54 inches (1.4 meters).

mageba also supplied 16 RESTON®STU shock transmission units (STU, also known as lock-up devices), with lock-up capacities of 800 kips (3,550 kN) and pressure release valves rated for 1,600 kips (7,100 kN). Each STU weighs 13,500 lbs (6,150 kg), and have been individually tested to ensure that the performance meets the required design criteria.

Highlights & Facts

mageba products:

Type:	23 TENSA®MODULAR LR expansion joints
	16 RESTON®STU shock transmission units
Installation:	2015–2018

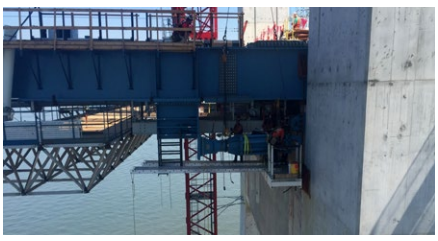
Structure:

City:	New York
Country:	USA
Type:	Cable stay Bridge
Completed:	2018
Length:	3.0 miles (4,800 m)
Builder:	Fluor Corporation, American Bridge Copany, Granite Construction Northeast & Traylor Bros

The Tappan Zee Bridge is located close to New York City

Installation of a TENSA®MODULAR expansion joint type LR8

Installed shock transmission unit



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

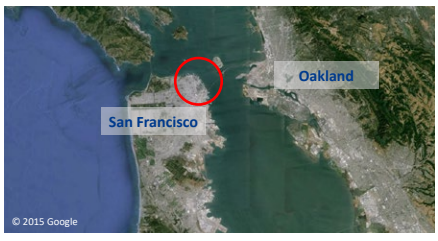
mageba products:

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:

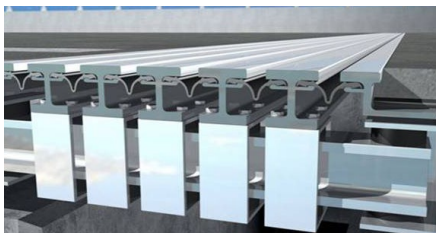
City:	San Francisco, CA
Country:	USA
Type:	Transit Center
Owner:	TJPA
Builder:	Shimmick, Greenlite, MCM

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



Highway A20/A73 Interchange (Canada)

Project description

A new highway viaduct was constructed in 2013, serving the city of Levis in Quebec, Canada. The viaduct, at an interchange between Highways 20 and 73, was constructed adjacent to an existing structure in order to increase highway capacity.

The viaduct has steel girder deck and six spans which range between 131 ft (40 m) and 197 ft (60 m), and has a total length of 984 ft (300 m). With a horizontal radius of 886 ft (270 m), the structure exhibits a prominent curve which increases the risk of serious damage during an earthquake and thus increases the need for its deck to be seismically isolated from its supports. A planning phase lasting several years was needed to identify the best solution for integrating the new bridge into the protected and sensitive local environment with minimal impact. The new 5.7 mi (9.3 km) bypass shortened the old route by 7.9 mi (12.8 km).

mageba scope

While the end spans of the deck are supported by conventional pot bearings, the central spans, which are more prone to damage from movements, are supported by mageba LASTO®LRB Lead Rubber Bearings (LRB). These LRBs will protect the structure during an earthquake by isolating it from destructive ground movements.

Each interior pier carries six LRBs, one supporting each of the deck's main girders. Each LRB has a vertical load capacity of approximately 3,200 kN. Due to the structure's location, the LRBs were designed for extreme temperatures from 104 °F (40 °C) to –22 °F (–30 °C).

Highlights & Facts

mageba products:

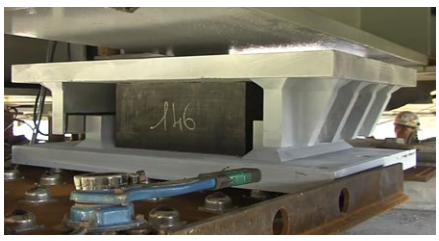
Type:	LRB seismic isolators
Features:	For temperatures as low as –30 °C (–22 °F)
Installed:	2013

Structure:

City:	Levis, Quebec
Country:	Canada
Built:	2013
Type:	Steel girder deck
Length:	317 m

The highway viaduct serves the city of Levis, Quebec

Lead rubber bearing installed in the bridge – guided type, allowing longitudinal movements



Lead rubber bearing installed in the bridge – multi-directional type, allowing all movements

Port Mann Bridge (Canada)

Project descripton

The Port Mann Bridge is one of British Columbia's most significant bridge structures, carrying the Trans-Canada Highway (Canada's Highway 1) across the Fraser River to the west of Vancouver. As part of the major Port Mann Highway 1 project, which also includes the widening and upgrading of 23 miles (37 km) of highway, the bridge has been replaced with a new structure, and was opened to traffic at the end of 2012.

The new bridge is designed for 10 lanes of traffic, and with its main span of 1,542 ft (470 m), it is the second longest cable-stayed span in North America. At 164 ft (50 m) wide, the new bridge is also the widest span bridge of any type in the world.

mageba scope

mageba has delivered the modular expansion joints required for the entire bridge including both approaches. The joints have up to 11 movement gaps and thus can facilitate movements of up to 35 inches (880 mm). In noise-sensitive areas, several joints are equipped with noise-reducing "sinus plates" on the surface.

mageba also supplied, in cooperation with R.J. Watson Inc., disc bearings for the bridge. These are designed for loads of up to 19,000 kN and a number feature "double discs" to achieve this load capacity.

Highlights & Facts

mageba products:

Type:	Modular expansion joints and disc bearings*
Features:	Expansion joints with movements of up to 35 in (880 mm), some featuring "sinus plates"
Installation:	2012

Structure:

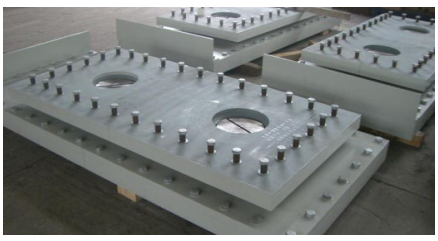
City:	Vancouver
Country:	Canada
Built:	2008–2012
Type:	Cable stayed bridge
Length:	1.37 mi (2,200 m)
Maintained:	Transportation Invesment Corporation
Contractor:	Kiewit Flatiron General Partnership

* in cooperation with R.J. Watson Inc.

Location of the bridge in British Columbia

A modular expansion joint featuring noise-reducing "sinus plates" on its surface

Disc bearings (with double discs per bearing) ready for delivery



Golden Ears Bridge (Canada)

Project description

The Golden Ears Bridge, near Vancouver, British Columbia, creates an important new transportation link across the Fraser River. The bridge, with three main spans each 242 m (795 ft) long, features an unusual hybrid cable stayed system designed to ensure a specified performance in the case of defined earthquake events. The bearings and expansion joints for the bridge are also subjected to such demands, making their design and fabrication an interesting challenge.

mageba scope

Main Span Bearings:

mageba supplied four custom-designed uplift bearings, pre-compressed for frequent load reversal. Each bearing weighs a massive 17 tons and can accommodate a wide range of loads from 4,170 kN to –2,790 kN (uplift), longitudinal movements of 3,100 mm (122 in), transverse movements of 50 mm (2 in) and rotations of 0.039 radians about the x-axis and 0.010 radians about the y-axis.

Expansion Joints:

In addition to the bearings, 12 TENSA®MODULAR LR expansion joints were supplied by mageba. The largest, type LR17 with 17 individual gaps, will allow longitudinal movements of 1,350 mm (53 in). The joints are also equipped with 'Fuse-Box' earthquake protection devices which prevent serious damage to the joint, and the connecting bridge structure, in the event of an earthquake. The 'Fuse-Box' also enables the modular expansion joint to continue to allow passage of emergency vehicles after a seismic event.

Highlights & Facts

mageba products:

Type:	12 TENSA®MODULAR expansion joints, with up to 17 gaps, and 4 special uplift bearings
Features:	Uplift bearings
Installation:	2009

Structure:

City:	Vancouver
Country:	Canada
Type:	Hybrid cable stay design
Completed:	2009
Length:	2,410 m 1.45 mi with 3 main spans each 242 m (794 ft) long
Contractor:	GCCJV (Bilfinger Berger and others)
Owner:	TransLink

The bridge crosses the Fraser River near Vancouver, Canada

Preparing the special bearings for transport

Installation of LR17 expansion joint featuring "Fuse-Box" seismic protection

Hotel Via Vallejo (Mexico)

Project description

This building will be housing two different Marriot hotels, the Courtyard and the Fairfield. The whole building will be constructed on top of a large new mall called Via Vallejo, located in the centre of Mexico City.

The 10-floor building will has been designed to not only withstand the effects of the severe earthquakes in Mexico City, but also to ensure the serviceability of the hotel during and after the seismic event. To do this, the engineers have chosen to use seismic isolation as a protective strategy.

mageba scope

To improve the seismic response of the building, the engineers in charge of the structural design performed complex dynamic analysis, which confirmed that the best strategy was to seismically isolate the hotel from the large mall. Therefore, it was decided that 18 mageba LASTO®LRB (Lead Rubber Bearings) will be supporting the entire hotel. These devices will isolate the structure, which is rather flexible, from the much stiffer mall's structure.

This strategy has been confirmed after extensive three-dimensional dynamic analysis of the structure seismic response.

Highlights & facts

mageba products:

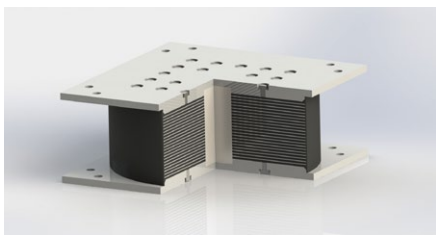
Type:	LASTO®LRB Lead Rubber Bearings (isolators)
Installation:	2014–2015

Structure:

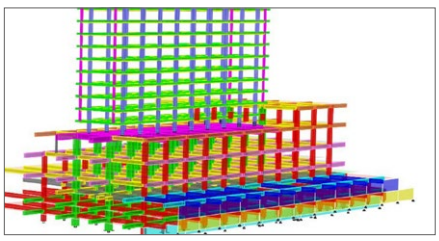
City:	Mexico City
Country:	Mexico
Completed:	2014
Type:	Gallegos Consultores
Contractor:	SIESA

The structure is located in Mexico City, Mexico

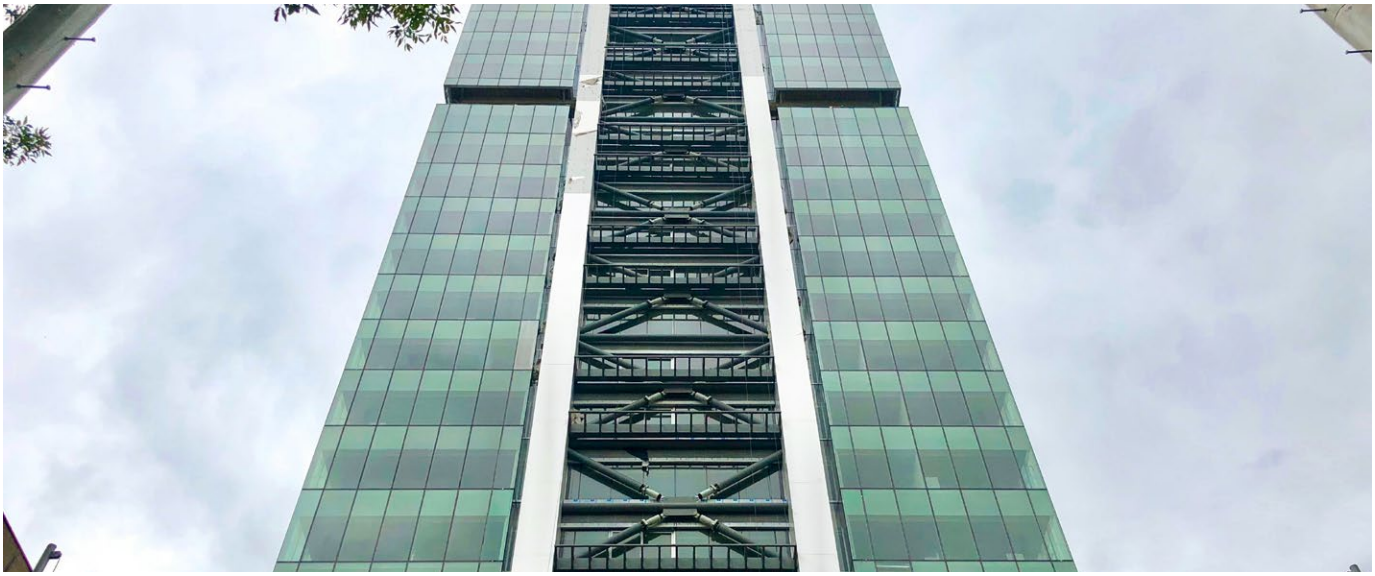
3D-View of one of the LASTO®LRB (seismic isolators) to be installed in the building



Three-dimensional model of the hotel including the mageba LASTO®LRB supporting the hotel



Ministry of Economy (Mexico)



Project description

The Mexican Ministry of Economy's Executive Tower in Mexico City, a 27-storey building dating from 1976, was constructed to a seismic protection standard that no longer applies.

In order to strengthen the building, and ensure that it will continue to survive earthquakes of the type that strike Mexico city from time to time, it was decided to install an array of shock absorbers (viscous dampers), complete with steel bracing, in each face of the building.

mageba scope

mageba RESTON®SA shock absorbers were selected for use.

With a pair of these dampers per face at each of 25 levels, each damper in a pair acting in a different direction, the total number of dampers required was 200.

These were designed for loads of up to 800 kN and seismic displacements of +/- 50 mm.

The manufacturing process involved a high degree of complexity, considering in particular the very low alpha-value of 0.1 (far more demanding to achieve than typical values of about 0.3).

To provide complete confidence in the actual seismic performance of the dampers, full-scale, full-speed testing was carried out, simulating exactly what would happen in an earthquake.

Highlights & facts

mageba Products:

Type:	RESTON®SA shock absorbers
Features:	Very low alpha-value of 0.1
Installed:	2017

Structure:

City:	Mexico City
Country:	Mexico
Built:	1976
Type:	Office building
Owner:	Secretaría de Economía
Contractor:	Grupo Copris

The building is located in Colonia Hipodromo Condesa in Mexico City, Mexico

Labelling of viscous dampers at mageba's Shanghai factory following fabrication

View of one section of retrofitted bracing, with two RESTON®SA shock absorbers

Chilina Bridge (Peru)

Project description

The Chilina Bridge in the Peruvian city of Arequipa, opening 2014, is a segmental continuous pre-stressed concrete viaduct. With an overall length of 562 m, it is the longest urban bridge in the country, with spans of up to 157 m. Its two 11.3 m-wide decks are box girders with variable depths. These were constructed by the balanced cantilever method with 5.1 m-long insitu segments built using form travellers. It is in a highly seismic area, requiring large seismic movements to be allowed for in the design.

mageba scope

The bridge is equipped with 4 TENSA®MODULAR expansion joints - two at each end, one per structure. These are of type LR7 (with 7 individual movement gaps), allowing service movements of up to 560 mm (80 mm per gap). The joints feature Fuse-Box seismic protection, designed to ensure that the expansion joint will break free of the deck in a controlled manner during an earthquake, avoiding serious damage to the deck or the joint itself. This will enable the bridge to be used in the immediate aftermath of an earthquake, when it might be needed most for emergency purposes.

Highlights & facts

mageba products:

Type:	TENSA®MODULAR expansion joints (LR7)
Features:	Fuse-Box (seismic)
Installation:	2014

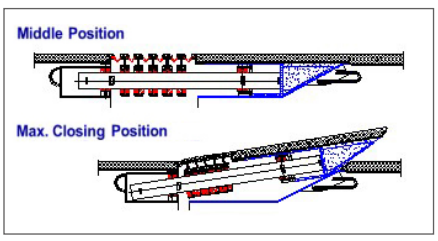
Structure:

City:	Arequipa
Country:	Peru
Completed:	2014
Type:	Concrete viaduct
Length:	562 m
Contractor:	Consorcio Constructor Puente Chilina

Arequipa is Peru's second most populous city, with a population 10 % that of the capital, Lima

Sectional view of a TENSA®MODULAR expansion joint with 5 gaps (Type LR5)

The joints feature Fuse-Boxes, enabling them to break free from the deck during an earthquake



Sky Building, Guayaquil (Ecuador)

Project description

The Sky Building in Guayaquil Ecuador will be part of a commercial complex called Aerocity located near the Guayaquil International Airport.

This 15-floor building consists of 4 parking levels and 11 office floors. Sky Building has been designed with the latest advances in terms of seismic protection by the leading structural engineering company in Ecuador. The structure has been conceived to withstand severe earthquake without suffering damages that could jeopardize the serviceability of the building at any time.

mageba scope

The seismic protection strategy chosen for this building is based on the seismic isolation principle. 64 mageba LASTO®LRB (Lead Rubber Bearings) will be installed on top of the parking levels in order to isolate the severe movement at the ground level, this will provide a comfortable movement on the structure, and most importantly the protection against any seismic damage during the earthquake.

There were considered three different types of seismic isolator for different loading conditions. Additionally, 44 sliders will also contribute with the isolation system.

Highlights & facts

mageba products:

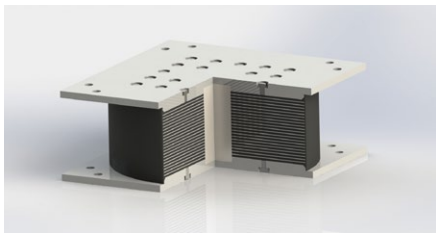
Type:	LASTO®LRB Lead Rubber Bearings (Isolators)
	RESTON®SPHERICAL structural bearings (seismic sliders)
Installation:	2014-2015

Structure:

City:	Guayaquil
Country:	Ecuador
Completed:	2014
Engineer:	Consulsismica
Contractor:	Construdipro S.A.

The building is located in Guayaquil, Ecuador

3D-View of one of the LASTO®LRB (seismic isolators) to be installed in the Sky Building



Full-Scale Sample LASTO®LRB prepared to be tested under actual seismic conditions in Italy

Oil refinery seismic isolation (Venezuela)

Project description

In the process of making an oil refinery in a seismically active part of Venezuela safe from the destructive effects of earthquakes, heat exchange tanks were seismically isolated from ground movements in 2012. The ongoing operation of such refineries is of great importance to the Venezuelan economy, with revenue from petroleum exports accounting for over 50 % of the country's GDP and roughly 95 % of total exports. Venezuela has the world's largest proven oil reserves (20 % of global reserves), and is one of the top four suppliers of foreign oil to the United States.

mageba scope

mageba supplied six LASTO®LRB lead rubber bearings with a diameter of 220 mm and height of 165 mm including 20 mm steel connection plates. Each bearing is designed for a vertical service load of 780 kN and to allow seismic displacements of up to 100 mm. The lead core at the bearing's vertical axis has a diameter of 44 mm and provides dissipation of seismic energy, while the natural rubber (NR) elastomer around it provides the desired re-centering after the earthquake. To ensure proper installation and functioning, mageba also supervised the installation.

Highlights & facts

mageba products:

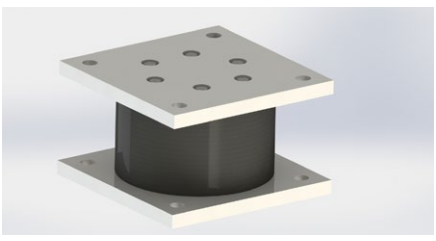
Type:	LASTO®LRB isolators
Installation:	2012
Supervision:	Installation supervised by mageba

Structure:

Location:	Falcón State
Country:	Venezuela
Type:	Oil refinery
Client:	PDVSA

The refinery is located in Falcón State, one of Venezuela's 23 states, in northern Venezuela

A LASTO®LRB lead rubber bearing of the type supplied – with 220 mm diameter



The LASTO®LRBs protect heat exchange tanks from ground vibrations during earthquakes

AlpTransit Viaduct 781 (Switzerland)

Project description

The construction of the new AlpTransit / NEAT railway connection through the Alps mountains is one of the biggest building projects currently being undertaken in Switzerland. Its tunnels and viaducts will reduce the travel time between Zurich and Milan by a full hour, to just 2.5 hours. The new route is scheduled to open to rail traffic in 2019.

A railway viaduct on the north side, known as Lotto 781, connects the new Ceneri base tunnel to the existing railway line between Bellinzona and Locarno. It has a length of 1012 m and is curved with a radius of 850 m.

mageba scope

mageba is supplying large pot bearings and massive shear keys to support the viaduct's deck. These were designed to withstand the large acceleration and braking forces of railway traffic and the centrifugal forces resulting from the viaduct's curvature, and the fatigue loading resulting from deck deflections. They must also be designed to facilitate the ground settlements of up to 120 mm that are expected due to local soil conditions. The shear keys (which prevent horizontal forces but carry no vertical loads) are designed for forces of up to 9,850 kN, and the pot bearings resist up to 31,000 kN.

18 RESTON®STU shock transmission units are also being supplied, designed for forces of up to 5000 kN.

Highlights & facts

mageba products:

Type:	RESTON®POT bearings RESTON®FORCE shear keys, RESTON®STU shock transmission units
Features:	Shear keys designed for fatigue loading
Installation:	2012–2019

Structure:

Project:	AlpTransit / NEAT
Country:	Switzerland
Completed:	2019 (projected)
Type:	Railway viaduct
Length:	1012 m

The viaduct is to the north of the new Ceneri Base Tunnel on the AlpTransit (NEAT) route

The support of one pier (shear key at centre and a pot bearing at each side) during installation

Installation of a RESTON®STU shock transmission unit in the viaduct's deck

Viaduc de Chillon (Switzerland)

Project description

The Viaduc de Chillon is an important viaduct on the A9 highway near the Swiss city of Montreux. When constructed between 1966 and 1969, the structure was designed in accordance with the standards of the day, but significant advances have been made in these standards in the intervening period – most notably in relation to seismic safety. This project involved the retrofitting of seismic isolation to the viaduct, to ensure that the structure will survive a strong earthquake. The viaduct has a length of 2100 m, and consists of two structures, side by side, with 23 spans of prefabricated concrete.

mageba scope

In order to improve the ability of the structure to withstand a serious earthquake, it was decided to retrofit seismic isolators to form the connections between the deck and the abutments and selected piers. Lead rubber bearings (LRB) were selected – a type of isolator often preferred for use in highway bridge structures due to its simplicity and its combining of the important isolation and energy dissipation functions in a single compact unit.

The project also involved adaptations to the viaduct's piers to enable hydraulic jacks to be used to lift the deck during installation works.

Highlights & Facts

mageba products:

Type:	LASTO®LRB seismic isolators
Installation:	2013, under mageba guidance

Structure details:

City:	Montreux
Country:	Switzerland
Completed:	1969
Type:	RC Highway viaduct
Length:	2100 m
Contractor:	Walo Bertschinger

The viaduct is at the east end of Lake Geneva in Switzerland, near the town of Montreux

An installed LASTO®LRB (Lead Rubber Bearing) seismic isolator

Lifting of deck at one pier using hydraulic jacks on specially constructed plinths at each side

Drava Highway Bridge (Croatia)

Project description

This bridge carries the Croatian A5 highway (part of European route E73) across the Drava River, a tributary of the Danube, near the town of Osijek in eastern Croatia.

It has a total length of 2485 m, including the approaches at each side of the river which raise the highway above the river's flood plains.

The main cable stayed structure has a length of 420 m, including a main span of 220 m, with its composite deck supported by two A-shaped pylons of 75 m height.

The approach structures are of precast prestressed concrete, with span widths of 35 m.

mageba scope

To control the longitudinal movements of the bridge's long deck under the action of sudden forces, the bridge was equipped with eight RESTON®STU shock transmission units.

These are designed to allow free movement during normal service conditions, but to lock up and thus transmit very large forces to the supporting structure, at the preferred location, when high-speed movements occur – for example, as typically might arise during an earthquake or as a result of exceptional traffic braking forces.

The devices supplied were designed for forces of up to 3000 kN and movements of +/- 160 mm.

Highlights & facts

mageba products:

Type:	RESTON®STU shock transmission units
Force:	3000 kN
Stroke:	+/- 160 mm
Installation:	2014

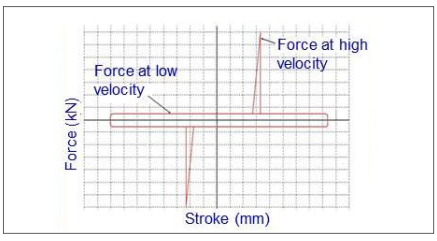
Structure:

City:	Osijek
Country:	Croatia
Type:	Cable-stayed bridge
Completed:	2015
Length:	2485 m incl. approaches (main structure: 420 m)
Contractor:	Viadukt dd

The bridge carries the Croatian A5 motorway across the River Drava in eastern Croatia

A RESTON®STU shock transmission unit, not showing pins or connecting fittings at its ends

Typical performance diagram of a RESTON®STU, relating force, speed and stroke



Angouleme Multimedia Library (France)

Project description

The city of Angouleme in south-western France is home to an impressive new multimedia library, designed by the architect Françoise Raynaud.

The design of the building is based on the concept of an assembly kit game with five stacked boxes, each one corresponding to a different “universe”.

The first three are inspired by the words Imagine, Understand and Create. The fourth, devoted to entertainment, culture and relaxation, allows the media to be crossed and the worlds to be linked, while the last houses administrative and logistics functions.

Due to the building’s highly unconventional shape, it was particularly important to ensure the correct interaction between the structure’s various “building blocks”.

mageba scope

RESTON®SA shock absorbers were used at specific interfaces to secure particular blocks and control their relative movements. The shock absorbers were designed for seismic/dynamic loads of 51 kN each, with a longitudinal movement capacity of +/- 30 mm. They were equipped with spherical bearings at each end to accommodate minor transverse movements.

Due to the relative small loads, an innovative external channel was developed by mageba’s design engineers to ensure precise damping performance. After fabrication, the units were extensively tested in accordance with EN 15129, and the entire solution was certified with the CE label, by Politecnico de Milano.

Highlights & facts

mageba products:

Type:	RESTON®SA shock absorbers
Notable:	Tested at Politecnico di Milano, Italy
Installation:	2014

Structure:

City:	Angouleme
Country:	France
Completed:	2014
Type:	Library building
Floor area:	5,600 square metres
Architect:	Françoise Raynaud (Loci Anima)

The library is located in south-western France, in the city of Angouleme

Two of the RESTON®SA shock absorbers, in a wooden crate for shipping to site

The dampers were tested at Politecnico di Milano, Italy in accordance with EN 15129

Notified Body 1777 – CPR

CERTIFICATE OF CONSTANCY OF PERFORMANCE
1777 - CPR – 14.04

In compliance with the Regulation (UE) No. 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonized conditions for the marketing of construction products and repealing Council Directive 89/106/EEC, it has been stated that the construction product

Fluid Viscous Damper

with trade name

Reston SA Shock Absorber

velocity dependent devices, to use in building and civil engineering works where requirements on individual devices are critical

placed on the market by

Mageba S.A.
Solistrasse 68 , 8180 Bülach , Switzerland

AVE Antequera-Granada railway (Spain)

Project description

Spain's AVE high-speed railway system is currently the longest high-speed rail network in Europe with a length of approximately 3,100 km, and the second longest in the world (after China's). The system's first line commenced service in 1992, and its trains travel at speeds of up to 310 km/h.

A new line to Granada in southern Spain is to cross a highly seismic area with irregular topography. The project in question relates to the construction of a viaduct on the line - a single continuous pre-stressed concrete deck with 12 spans and a total length of 580 m.

mageba scope

The design of the viaduct requires its deck to be connected to one of its abutments by shock absorbers which generally act as rigid connections but which dissipate energy and protect the structure from overloading during a large earthquake. mageba's innovative solution is a shock absorber featuring a specially developed fused connection. The devices were designed and tested in accordance with EN 15129, with testing carried out at leading testing institutes in both Europe and the United States.

Highlights & facts

mageba products:

Type:	RESTON®SA shock absorber with fuse
Installation:	2014

Structure:

City:	Loja
Country:	Spain
Completed:	2015 (proj.)
Type:	Concrete rail viaduct
Length:	580 m
Contractor:	AZVI
Owner:	AVE Renfe Operadora

The viaduct is on the high-speed rail link serving the city of Granada in southern Spain

A fuse element (without shock absorber) in testing at Politecnico di Milano, Italy

A shock absorber, fully assembled with fuse element and ready for transport to site

Stavros Niarchos Center (Greece)

Project description

The Stavros Niarchos Foundation Cultural Center (SNFCC) in Athens is a multifunctional arts, education and recreation complex. It will include, within its 170,000 m² park, new state-of-the-art facilities for the National Library of Greece and the Greek National Opera. The buildings were designed by Renzo Piano, the internationally acclaimed architect who achieved worldwide fame in the 1970s with the Centre Georges Pompidou in Paris. With a budget of €566 million, the SNFCC is one of the largest construction projects in recent Greek history.

mageba scope

In order to ensure that the building structure can withstand even a severe earthquake of the type Athens has known for thousands of years, the buildings of the National Library of Greece and the Greek National Opera are built on 323 RESTON®PENDULUM Curved Surface Sliders. The 323 seismic isolators allow dynamic movements of +/- 350 mm and carry loads of up to 70,000 kN per unit.

A solar collector roof canopy with an area of 10,000 m² is also equipped with 60 RESTON®SA shock absorbers and 120 RESTON®SP spring devices to resist the strong wind forces arising. These regulate the connections to the 30 column heads, damping all vertical vibrations.

A ROBO®CONTROL structural health monitoring (SHM) system is also linked to all damper and spring devices.

Highlights & facts

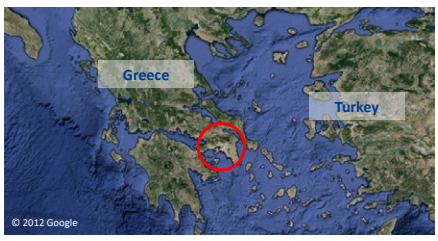
mageba products:

Type:	RESTON®PENDULUM Curved Surface Sliders
	RESTON®SA shock absorbers
	RESTON®SP elastic spring devices
	ROBO®CONTROL SHM
Installation:	2013–2015

Structure:

City:	Athens
Country:	Greece
Completed:	2016 (projected)
Type:	Cultural centre
Owner:	Stavros Niarchos Foundation (to be donated to Greek state)
Contractor:	Impregilo-TERNA JV

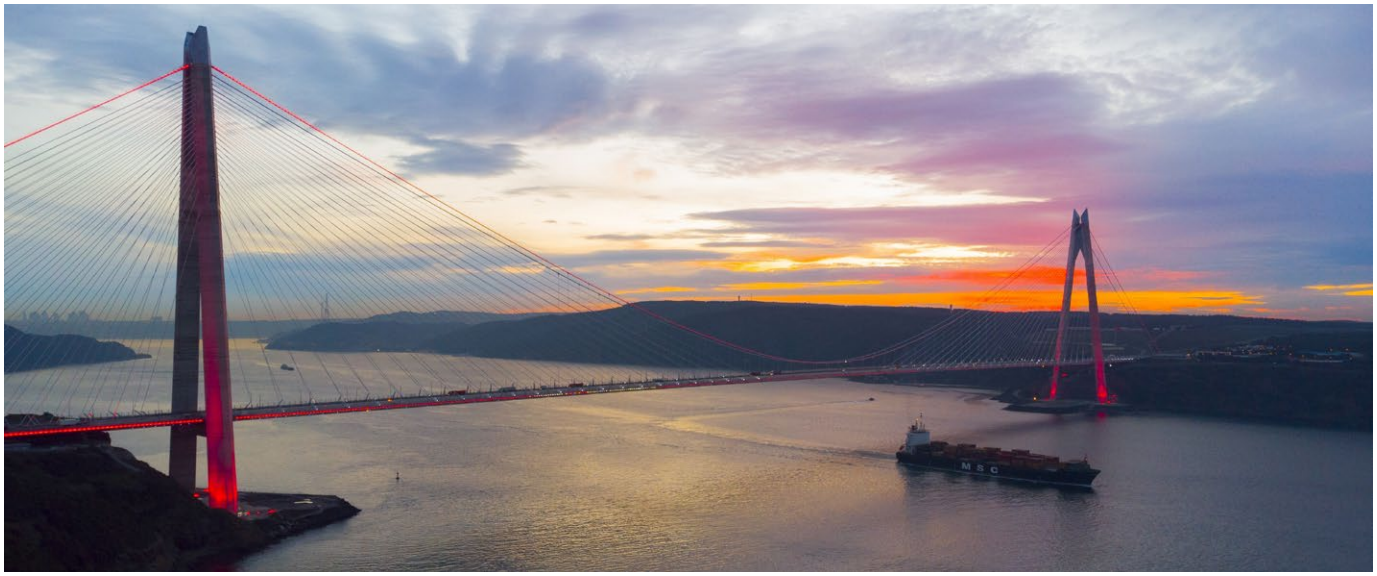
The SNFCC is located 4.5 km south of the centre of Athens, Greece



The RESTON®PENDULUM isolators allow large movements and carry loads of up to 70,000 kN

Testing of one set of four RESTON®SA shock absorbers, arranged as used in roof canopy

Third Bosphorus Bridge (Turkey)



Project description

The Third Bosphorus Bridge, officially named the Yavuz Sultan Selim Bridge, is the third bridge to be built across the Bosphorus Strait which connects the Black Sea to the Mediterranean via the Marmara Sea. Not only does the strait divide Istanbul, it also forms part of the boundary between Europe and Asia. The new structure will be of enormous importance to the region, carrying both road and rail traffic. The hybrid cable-stayed / suspension bridge will have a main span of 1408 metres, 322 m-tall towers and a 58 m-wide deck – three world records for this bridge type. It is expected to open in 2016.

mageba scope

mageba is supplying extraordinary bearings for the construction of the bridge, including specially developed cylindrical pendulum bearings. In relation to load and displacement, the curved sliding plates of these bearings have extremely small radii in order to stabilise the bridge horizontally under railway traffic. The bearings weigh up to 34 tonnes each, designed for vertical loads of up to 120 MN (more than the weight of the Eiffel Tower), while facilitating longitudinal movements of +/– 770 mm. Transverse forces at the pylons are resisted by shear keys, with the loads transmitted by vertically oriented RESTON-POT bearings with up to 78 MN capacity.

Highlights & facts

mageba products:

Type:	Special cylindrical RESTON®PENDULUM bearings, RESTON®POT bearings, temporary elastomeric bearings
Features:	For loads up to 120 MN
Installation:	2014–2016

Structure:

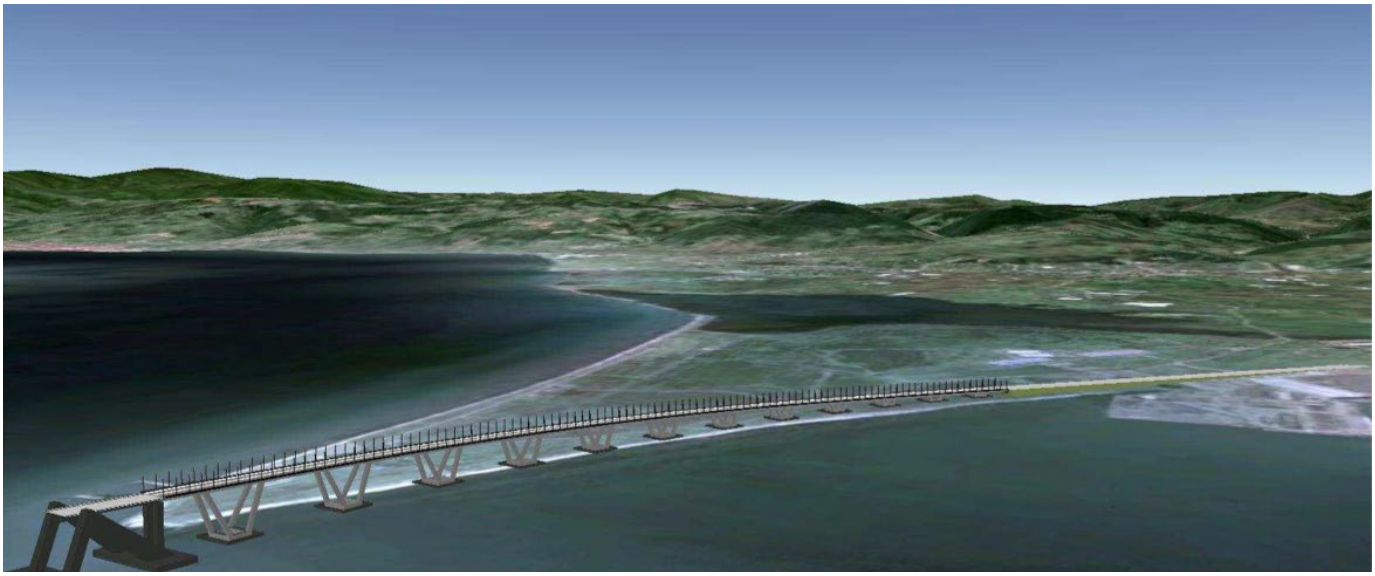
City:	Istanbul
Country:	Turkey
Completed:	2016
Type:	Hybrid cable-stayed / suspension bridge

The bridge will cross the Bosphorus Strait, connecting Istanbul's European and Asian parts

A special cylindrical RESTON®PENDULUM bearing as fabricated, prior to delivery to site

Installation of a RESTON®POT bearing, vertically oriented for use on a shear key

Izmit Bay South Approach Viaduct (Turkey)



Project description

The Izmit Bay Bridge near Istanbul, currently under construction with a main span of 1550 m, will carry six lanes of highway across the bay, greatly improving road connectivity between Istanbul and south-western Turkey. The bridge is in an area of high seismic activity, with the Anatolian fault running perpendicular to the bridge alignment. It is predicted that this fault will rupture during the next seismic event, causing severe ground movements. The design of the bridge and its approach viaducts to resist and survive such seismic events is thus of critical importance.

mageba's scope

The seismic protection system selected for the south approach viaduct consists of 22 isolation units, each comprising two LASTO®LRB lead rubber bearings (with capacity up to 42 MN each) placed side by side, together with 108 RESTON®SA shock absorbers (with stroke of up to 1175 mm) working in both the longitudinal and transverse directions.

RESTON®SPHERICAL bearings and specially designed uplift resisting devices are also required at each end of the structure. The bearings are each designed to carry loads of 20 MN and to allow longitudinal sliding movements of +/- 1470 mm.

Highlights & facts

mageba products:

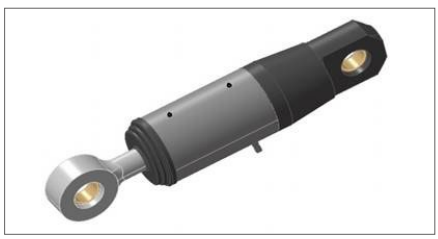
Type:	LASTO®LRB seismic isolators,
	RESTON®SA shock absorbers,
	RESTON®SPHERICAL bearings,
	uplift devices
Installation:	2014–2015

Structure:

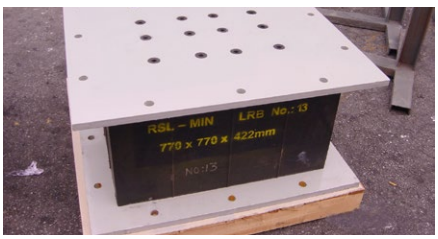
Country:	Turkey
Completed:	2016
Type:	Bridge viaduct
Engineer:	COWI A/S

The suspension bridge will cross Izmit Bay in the Sea of Marmara, 50 km south-east of Istanbul

The seismic safety of the structure is partially ensured by 108 RESTON®SA shock absorbers



A LASTO®LRB lead rubber bearing. The LRBs for this project can carry up to 42 MN each



Louvre Abu Dhabi (United Arab Emirates)

Louvre Abu Dhabi's exterior with Abu Dhabi's skyline (night)
© Louvre Abu Dhabi, Photography: Mohamed Som

Project description

The Louvre Abu Dhabi Museum, an affiliate of the renowned Louvre Museum in Paris, is located on the Saadiyat Island. In November 2017 the museum opened its doors to the public after ten years of planning and construction time. Designed by the French architect Jean Nouvel, the museum building is a fitting venue for the world-class art collections to be hosted in the years to come.

The building's most striking feature is its roof, a beautifully designed dome with a diameter of 180 m and a weight of approximately 8000 tonnes. The web-patterned dome allows the sun to filter through, much like rays of sunlight passing through palm branches in an oasis.

mageba scope

mageba supplied four large RESTON®PENDULUM bearings (type Mono) to support the museum's enormous roof. These bearings are designed to carry vertical loads of up to 33,000 kN each and to allow horizontal sliding movements of up to +/- 315 mm.

The contract to supply the bearings included a provision for full-scale testing to be carried out prior to the use of the bearings in the structure. This testing was successfully completed in 2014, at the SRMD testing facility of the University of California, San Diego – one of the world's foremost institutes for testing of this kind.

Highlights & facts

mageba products:

Type:	RESTON®PENDULUM seismic isolators (type Mono) for loads of up to 33,000 kN
Testing:	Caltrans SRMD, USA
Installation:	2015

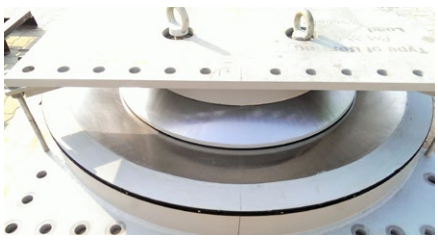
Structure:

City:	Abu Dhabi
Country:	United Arab Emirates
Type:	Art museum
Completed:	2017
Roof span:	180 m
Architect:	Jean Nouvel
Engineer:	Buro Happold

The museum was built in Abu Dhabi, the largest of the seven United Arab Emirates

Testing of an isolator at the SRMD testing facility of the University of California, San Diego

A RESTON®PENDULUM bearing (type Mono) as fabricated, showing its spherical sliding surfaces



Ghotour Bridge (Iran)

Project description

Ghotour Bridge is a railway bridge over the Ghotour River in West Azarbaijan province, north-western Iran. It is a steel arch bridge, and its construction was completed in 1970.

It has an overall length of 443 m, with the longest span being 223 m. In the 1980s it withstood airstrikes during the Iran-Iraq war.

During the planning of seismic retrofitting works to be carried out in 2014–2015, it was decided to add shock absorbers to dampen transverse oscillations.

This type of damper is becoming ever more popular for use on structures in seismically active zones such as Iran.

mageba scope

mageba supplied a total of 20 RESTON®SA shock absorbers for installation on the bridge – 16 on the lower part and 4 for the deck – to control the bridge's transversal movements.

The 16 dampers for the lower part were each designed for a force of 990 kN and a stroke of +/- 100 mm at velocities of up to 880 mm/s, while the 4 dampers for the deck were designed for a force of 680 kN and a stroke of +/- 250 mm at velocities of up to 1600 mm/s.

For the purposes of quality control, factory production control testing was carried out in accordance with the European standard EN 15129.

Highlights & facts

mageba Products:

Type:	RESTON®SA shock absorbers
Features:	Force: Up to 990 kN
	Stroke: Up to +/-250 mm
	Testing: Factory production control, to EN 15129
Installation:	2015

Structure:

Province:	West Azerbaijan
Country:	Iran
Type:	Steel railway bridge
Completed:	1970
Main span:	223 m
Length:	443 m

The bridge crosses the Ghotour River in West Azarbaijan Province, north-western Iran

A RESTON®SA shock absorber, excluding connection fittings at each end

Parts of the RESTON®SA shock absorbers as fabricated, prior to assembly of the dampers

Ulsan Grand Harbor Bridge(South Korea)

Project description

The Ulsan Grand Harbor Bridge is a single span suspension bridge which will span the harbor mouth of Ulsan City in Korea.

The bridge has a main span of 1,150 m. The approaching viaducts have a span of 303 m respectively 355 m to each side of the suspended span.

The viaducts are made of traditional steel box girder and pre-stressed concrete beams.

The bridge will have 4 traffic lanes, and a 300 m wide navigation clearance of at least 60 m height.

When completed in early 2015, Ulsan Grand Harbor Bridge will have the 3rd largest span as a single-span suspension bridge in the world.

mageba scope

mageba TENSA®MODULAR expansion joints with a movement capacity of up to 1,760 mm each were chosen due to its elastic steering system. It ensures kinematic behavior and prevents damage from constraint forces which will occur at Ulsan Grand Harbor single-span suspension bridge.

mageba Hump-Seals will be installed to drastically reduce debris falling between the joint gaps.

mageba RESTON®SA hydraulic shock absorbers were chosen to allow slow movement of the Ulsan Grand Harbor bridge, as well as to damp brisk movements (e.g. from earthquakes or from the braking of heavy road vehicles).

In normal conditions, however, they permit free movement between the structure's parts.

Highlights & Facts

mageba Products:

Type:	4 x TENSA®MODULAR expansion joint LR22
	4 x RESTON®SA shock absorber
Features:	Joints: max. movement 1,760 mm
	Shock absorbers: load 3,000 kN
Installation:	2014

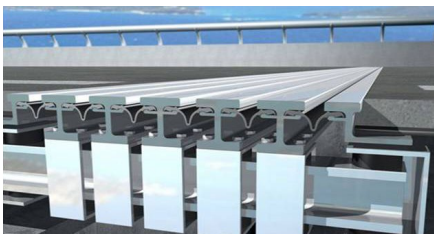
Structure:

City:	Ulsan
Country:	South Korea
Built:	2008–2015
Type:	Suspension bridge
Length:	1,150 m

Location of the bridge in Ulsan, around the Korean South/East Sea

Testing of a RESTON®SA shock absorber in Sismalab, Shanghai

TENSA®MODULAR expansion joints 1,760 mm movement (LR22)



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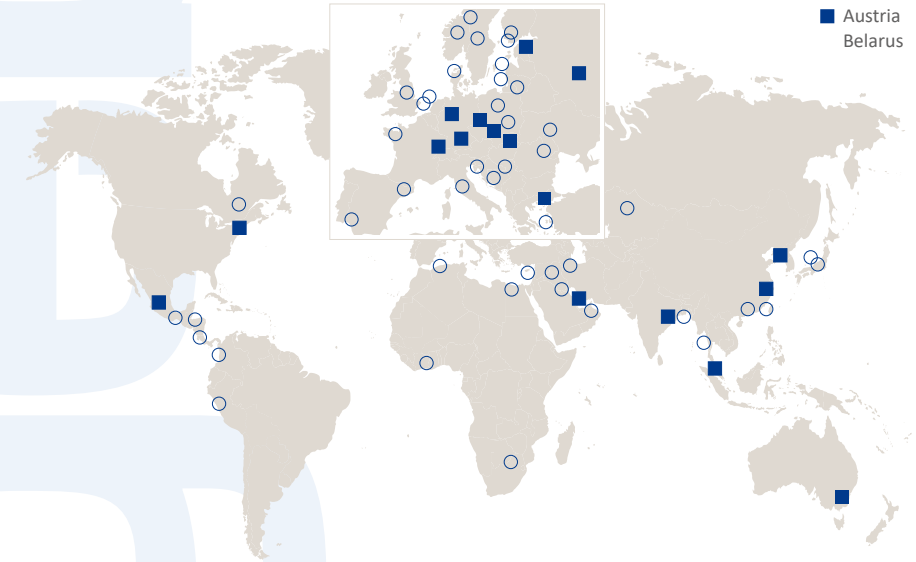

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