



Expansion joints

Infrastructure | Buildings | Industrial structures

mageba modular expansion joints – the benchmark for large movements



TENSA[®] MODULAR Type LR

proven, versatile, durable



mageba



Product characteristics

Principle

TENSA®MODULAR expansion joints are based on the following concept: The movement gap at the end of a bridge deck is divided into smaller individual gaps by horizontal lamella beams. This enables deck movements of well over 2'000 mm to be accommodated. Rotations about every axis can also be facilitated.

The individual gaps are sealed watertight by elastomeric profiles, enabling the joint to be completely drained at the deck surface. The movements of the lamella beams relative to each other are regulated, elastically and constraint-free, by a control system.

mageba TENSA®MODULAR expansion joints are typically used in bridges with movements of over 80 mm.

TENSA®MODULAR expansion joints of the latest generation are distinguished by their consistently modular design. This enables optimized quality of the modular joints with considerably reduced processing and production time.

Characteristics

Expansion joints are subjected to considerable demands and must satisfy these over a service life of many years. The design of the watertight TENSA®MODULAR expansion joint, which was invented by mageba, has been continually developed in recent decades. The current 5th generation of the system fully accommodates these high demands.

The TENSA®MODULAR expansion joint was developed, as the name suggests, as a modular system, with joints for specific needs built up from proven components. The principle variable in this process is the movement range which must be accommodated.

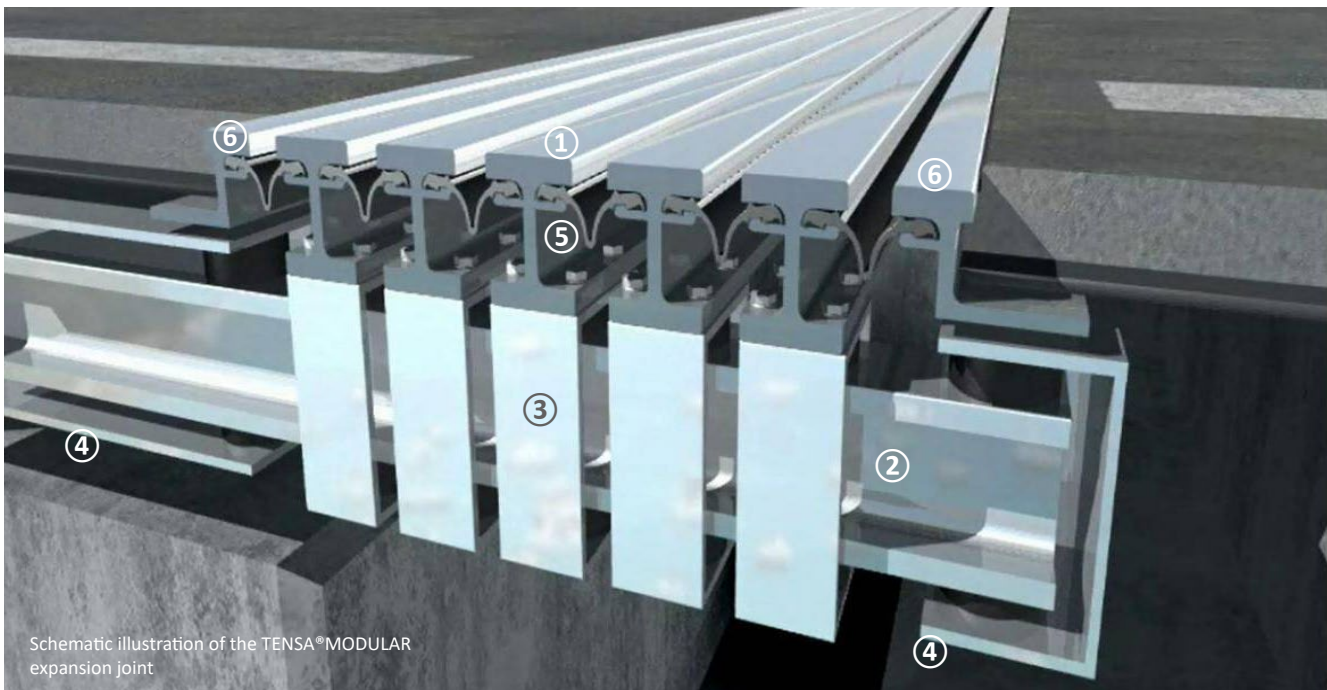
Each individual gap of the joint, and its sealing profile, allows maximum gap openings of between 60 and 100 mm, depending on the relevant norm. For special load cases such as earthquakes, yet larger movements can be facilitated. The maximum joint movement is used to determine the number of gaps and lamella beams that the joint will require.

Parts and components

The joint's individual lamella beams ① rest on and slide along support bars ②, and are connected to these by stirrups ③ through which the support bars pass. The support bars span between support bar boxes ④ in the deck structures at each side of the movement gap. Both support bars and lamella beams are supported by high-quality polymer elements and prestressed by elastomeric components. The movements of the lamella beams relative to each other and along the support bars are regulated by control springs. Sealing profiles ⑤, which connect the lamella beams to each other and to the joint's edge profiles ⑥, make the system enduringly watertight.

Durability

A long service life of the products installed in bridges is of crucial importance in terms of life cycle costs. According to the ETA-24/0357 assessment, the new generation of mageba modular joints is designed for a service life of at least fifty years. Thereby, the environmental impact of premature replacement can be reduced and the follow-up costs associated with replacement can be minimised.





Client benefits

Highlights

- Allows free movements in all directions and rotations about every axis
- Completely watertight system with drainage at the bridge surface
- Versatile and freely adaptable to suit client's wishes
- Can be used on all types of bridges
- Based on well-proven and thoroughly tested components and parts

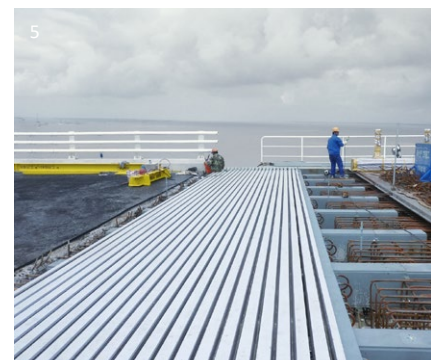
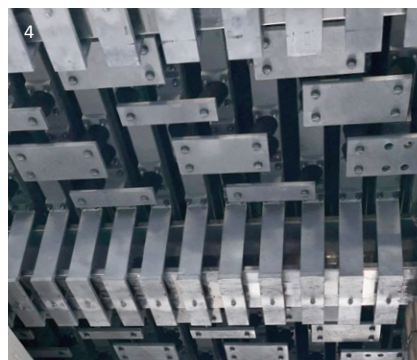
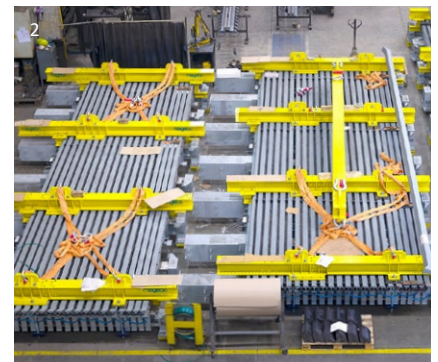
Design

- Welding is avoided in all highly stressed connections, increasing durability.
- All of the joint's well-proven wear parts are bolted in place, and can be replaced if necessary with little effort and without disrupting traffic.
- For the installation of the joint, only relatively small recesses are required in the bridge structure at each side. Thanks to its asymmetric design, it can be easily adapted to suit specific circumstances.
- The orientation of the support bars, in the direction of the deck's span, simplifies the placing of the connecting deck reinforcement.

Functionality

- All parts of the joint are elastically prestressed, making them highly resistant to fatigue.
- The elastic gap control system increases the service life of the entire joint by damping the impact loading from over-rolling traffic.
- The joint's prestressed connections damp impacts and vibrations, while facilitating large transverse movements, vertical displacements and rotations.

- 1 Installation works
- 2 Ready-to-transport LR joints in the factory
- 3 Installed 24-gap joint allowing 1'920 mm of movement and weighing 41'000 kg
- 4 Control system with control springs and connection plates
- 5 Recesses prior to concreting





Movement capacity

Movements of the joint

mageba TENSA®MODULAR expansion joints allow movements in every direction and, at the same time, rotations about every axis. Their elastic control system can accommodate large transverse and vertical movements without developing constraint forces.

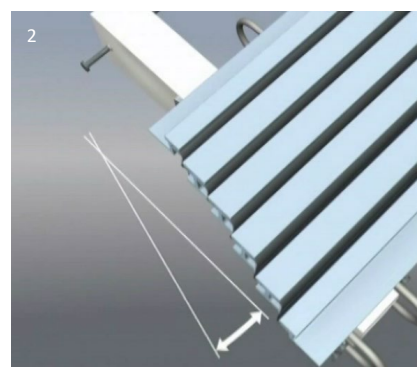
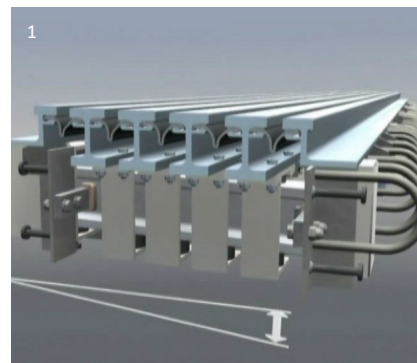
If necessary, the joint's support bar boxes can be designed with a trapezoidal shape to increase the joint's transverse movement capacity to match its longitudinal movement capacity.

In this case, the support bars of the joint can rotate until they are orientated at 45 degrees to the bridge axis. This simple geometric adaptation represents one significant advantage of the TENSA®MODULAR joint: the functionality and construction of the overall system remains the same for small or large transverse movements.

The table below presents the maximum movement capacities of various sizes of TENSA®MODULAR expansion joint, in the longitudinal and transverse directions. Transverse movements are considered with all gaps fully closed.

Skewed orientation and movements

Expansion joints are typically installed perpendicular to the bridge's axis, with their longitudinal movements parallel to the same axis. But it is also possible to design modular joints for installation with a different orientation (i.e. not perpendicular to the bridge axis), or for longitudinal movements which are not parallel to the bridge axis. In such cases, the support bar boxes can be orientated either parallel to the bridge axis or perpendicular to the joint's axis.



1 Vertical movement capacity of the joint
2 Transverse movement capacity of the joint

Type	Number of gaps	Type LR (max. individual gap width 80 mm)		Type LR (max. individual gap width 100 mm)	
		Max. longitudinal movement	Max. transverse movement	Max. longitudinal movement	Max. transverse movement*
[-]	[-]	[mm]	[mm]	[mm]	[mm]
LR 2	2	160	± 24	200	± 24
LR 3	3	240	± 22	300	± 22
LR 4	4	320	± 35	400	± 35
LR 5	5	400	± 29	500	± 29
LR 6	6	480	± 36	600	± 36
LR 7	7	560	± 42	700	± 42
LR 8	8	640	± 76	800	± 76
LR 9	9	720	± 85	900	± 85
LR 10	10	800	± 60	1,000	± 60
LR 11	11	880	± 67	1,100	± 67
LR 12	12	960	± 74	1,200	± 74
LR 13	13	1,040	± 80	1,300	± 80
LR 14	14	1 120	± 87	1,400	± 87
LR 15	15	1 200	± 118	1,500	± 118
LR 16	16	1 280	± 126	1,600	± 126
LR 17	17	1,360	± 99	1,700	± 99
LR 18	18	1,440	± 107	1,800	± 107

Dimensions for larger and intermediate movements on request

Design details

Support and connection system

The joint's lamella beams are connected to the support bars beneath by stirrups through which the support bars pass. In the same way, the support bars are enclosed by support bar boxes at the edges of the joint. In this way, the whole system is supported and connected elastically and securely, while still allowing movements as desired.

ROBO®SLIDE sliding material

Where sliding components are subjected to demanding loading or movements, mageba uses ROBO®SLIDE, a highly developed modern alternative to the traditionally used PTFE. This material consists of modified ultra-high molecular weight polyethylene, and offers very high bearing strength, low friction and exceptional resistance to wear. The increased service life of components which feature this material considerably reduces maintenance effort.

Recess dimensions

The main dimensions of the recesses (block-outs) required in the bridge structure for the installation of various sizes of expansion joint, and the weight of joint per meter, are

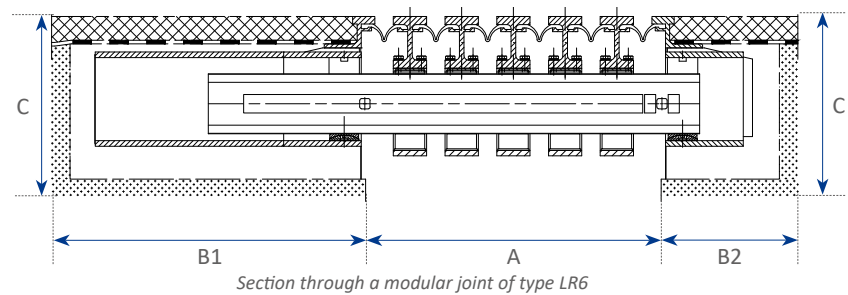
provided in the table below. The values for B1 and B2 are valid for an expansion joint with both a moving side and a fixed side as shown in the cross section. Alternatively, expansion joints can be designed to allow movement at both sides. In such cases, the total longitudinal movement can be split as desired between the two sides, with B1 reduced and B2 increased accordingly. Exact values can be provided on request.

Control system

Elastomeric springs control the movements of the individual lamella beams and make them work as a single kinematic system. The movements of each lamella beam relative to its neighbours are regulated by

control sets, which are rigidly connected to that beam by steel and to the neighbouring beams by control springs. At each edge of the joint, the control set is connected to the bridge structure by so-called control boxes. The entire movement range of the joint is thus distributed among the individual gaps, and braking and acceleration forces from traffic are elastically damped and resisted.

The elasticity of the control system prevents damage to the joint should individual gaps become blocked by stones or debris. The system is designed to ensure that the control springs are not stressed in the transverse direction when the joint is in its central position. This minimises fatigue and thus increases service life.



Type	Type LR (max. individual gap width 80 mm)						Type LR (max. individual gap width 100 mm)					
	A _{min}	A _{max}	B1	B2	C*	Weight	A _{min}	A _{max}	B1	B2	C*	Weight
[-]	[mm]	[mm]	[mm]	[mm]	[mm]	[kg/m]	[mm]	[mm]	[mm]	[mm]	[mm]	[kg/m]
LR 2	100	300	360	320	400	230	140	340	400	320	400	230
LR 3	170	470	440	320	400	300	230	530	500	320	400	310
LR 4	240	640	520	320	420	380	320	720	600	320	420	390
LR 5	310	810	600	320	440	450	410	910	700	320	440	470
LR 6	380	980	680	320	440	540	500	1,100	800	320	440	560
LR 7	450	1,150	760	320	440	620	590	1,290	900	320	440	640
LR 8	520	1,320	840	320	465	740	680	1,480	1,000	320	465	760
LR 9	590	1,490	920	320	465	820	770	1,670	1,100	320	465	850
LR 10	660	1,660	1,000	320	485	940	860	1,860	1,200	320	485	970
LR 11	730	1,830	1,080	320	485	1,020	950	2,050	1,300	320	485	1,050
LR 12	800	2,000	1,160	320	485	1,100	1,040	2,240	1,400	320	485	1,140
LR 13	870	2,170	1,270	320	515	1,240	1,130	2,430	1,530	320	515	1,290
LR 14	940	2,340	1,350	320	515	1,330	1,220	2,620	1,630	320	515	1,380
LR 15	1,010	2,510	1,430	320	535	1,500	1,310	2,810	1,730	320	535	1,560
LR 16	1,080	2,680	1,510	320	535	1,590	1,400	3,000	1,830	320	535	1,660
LR 17	1,150	2,850	1,590	320	565	1,810	1,490	3,190	1,930	320	565	1,890
LR 18	1,220	3,220	1,670	320	565	1,910	1,580	3,580	2,030	320	565	1,990

Dimensions for larger and intermediate movements on request

*) The minimum value of the recess refers to an asphalt thickness of 74 mm



Testing & optional features

Laboratory testing

The TENSA®MODULAR expansion joint has proven its worth in testing by independent institutions on many occasions. For example, the durability of the joint was verified in testing with 6×10^6 load changes, after which no signs of fatigue could be established.

All critical components and their materials, such as elastomers and sliding surfaces, were also subjected to individual testing.

In an Opening Movement & Vibration (OMV) test as defined by American standards, the joint proved its suitability in a programme which simulated a 100-year service life – and specifically, the thermal opening and closing movements, and the vibrations from traffic, to which a joint of this type would be subjected during that period.

Furthermore, an LR7 joint was subjected to intensive seismic testing, which exceeded the requirements of American standards and additionally simulated an actual earthquake – the Northridge earthquake which, with its magnitude of 6.7 and ground movements of 1.2 m/s, destroyed infrastructure across parts of California in 1994. The joint withstood this testing without any damage, demonstrating in impressive fashion its ability to accommodate multidimensional movements and rotations.

Videos of the testing can be viewed at mageba-group.com.

National approvals

TENSA®MODULAR expansion joints and associated components have undergone extensive testing and verification of their suitability. In accordance with the world's most comprehensive specification EAD 120113-00-0107, the system has been awarded the ETA-24/0357 approval.

Approvals are being processed in numerous countries in accordance with the German test specification TL/TP-FÜ and the current version of the Austrian ÖNorm B4031 and B4032.

Fuse-Element

Ensuring the functionality of expansion joints in seismically active regions is of crucial importance. Especially after an earthquake, it must be ensured that the expansion joints remain passable so that rescue vehicles can pass the bridge. Therefore, the modular joint and the adjacent bridge structure must be protected against earthquake damage.

To address these particular needs, the design of the TENSA®MODULAR expansion joint featuring one or more Fuse-Elements was developed. The system is based on the integration of a trapezoidal steel element into the surface of the joint. In normal service, the Fuse-Element forms a rigid connection between the sections of the joint. However, in the event of an earthquake, the Fuse-Element is pushed upwards and out of the expansion joint so that the joint can accommodate extreme closing movements.

Fuse-Box

The Fuse-Box system has the same objective, namely to protect the joint and adjacent structure, but is based on a different design. The Fuse-Box prevents damage by enabling the joint's connection to the structure at one side to fail in a controlled, designed manner. Due to the inclination of its failure plane, the joint can slip back into its original position after an earthquake.

The use of Fuse-Box enables the design of a particular joint for exceptional load cases to be optimized, resulting in more economical solutions.



- 1 Over-rolling test of an LR joint
- 2 Seismic testing of an LR joint
- 3 Full size movement test on TENSA®MODULAR expansion joints with 18 gaps for 1,800 mm longitudinal movement capacity
- 4 Modular expansion joint with a Fuse-Element

Materials & installation

Materials

The following high-quality materials in particular are used as standard for the manufacturing of TENSA®MODULAR expansion joints:

- Lamella beams and support bars of S355 steel; hybrid lamella beams including stainless steel can be provided on request
- Sealing profiles of EPDM or CR
- Control springs, sliding springs and sliding bearings of elastomer, PTFE and polyamide
- Special high-grade sliding material ROBO®SLIDE for sliding bearings and sliding springs in particularly demanding circumstances

Corrosion protection

The steel profiles are treated with corrosion protection systems based on ISO 12944 as standard, or on applicable national standards (e.g. ZTV-ING, ASTRA, RVS, ACQPA) as required.

Watertightness

The TENSA®MODULAR expansion joint is 100 % waterproof, thanks to the well-proven mageba sealing profile. The profile has provided reliable service in many bridges over a period of several decades. It has a number of special sealing points, which prevents the passage of water through the joint. Should the sealing profile ever become damaged due to external mechanical influences, it can be quickly and inexpensively replaced.

Assembly and transport

mageba TENSA®MODULAR expansion joints are assembled in the factory, and prepared for transport to site. They can generally be transported in the lengths with which they will be installed, but can if necessary be jointed on site. A crane is required on site for unloading and installation.

Installation

In particular, the installation of very large TENSA®MODULAR expansion joints should be supervised by a mageba specialist. Before installation, the bridge gap width and temperature are checked by the contractor, and the joint's presetting value is adjusted as appropriate. The joint is then levelled against both edge profiles.

Footway and edge area

At the edge of the bridge, where a footway or similar may exist, the TENSA®MODULAR joint can be detailed to precisely suit the structure's profile with a kerb block, or fitted with cover plates for the comfort and safety of pedestrians and cyclists.

Connection reinforcement

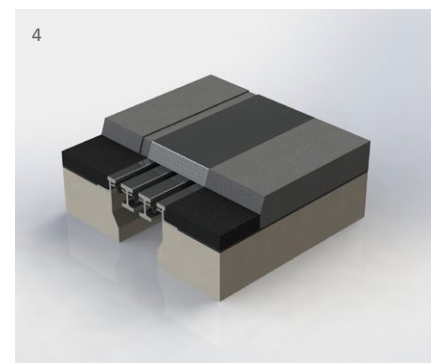
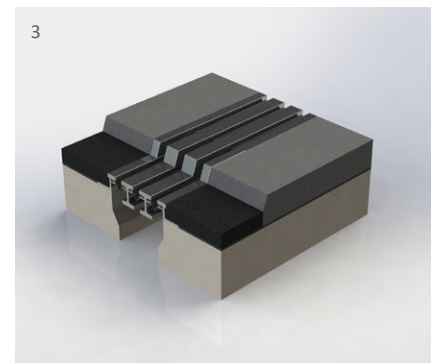
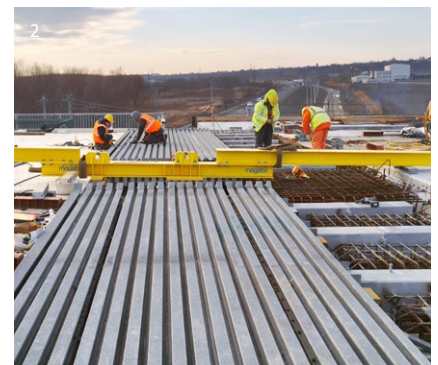
The connection reinforcement in the bridge structure adjacent to the joint is to be designed and implemented in accordance with the relevant reinforced concrete norm. The anchor loops on the edge profiles are normally perpendicular to the joint, but can, on request, be welded at any other angle. Beneath the support bar boxes, additional local reinforcement is needed to prevent tensile cracking.

Operation and maintenance

TENSA®MODULAR expansion joints are, under normal operating conditions, virtually maintenance-free. The opening and closing movements of the joint, combined with the continual passage of traffic across the surface, results in a self-cleaning effect.

Inspections may therefore simply entail checking for corrosion and confirming watertightness during regular bridge inspections. To ensure early detection of any wear or damage that may arise, however, it is recommended that full inspections be carried out about every five years, on the basis of mageba's relevant Inspection & Maintenance Manual. These inspections can be carried out by mageba if desired, as an additional service.

All wear parts are standard components and can be quickly replaced when required using simple tools, from beneath the joint if access allows and thus without any impact on traffic.



- 1 Transport of a modular expansion joint
- 2 Installation of a modular expansion joint
- 3 Footway in joint with kerb block
- 4 Footway in joint with cover plate



Expansion joints

Quality & support

Related products

The following mageba products can be used in combination with TENSA®MODULAR expansion joints:

- **ROBO®DUR:** Strengthening ribs of special mortar, which reinforce the asphalt adjacent to the joint. These reduce rutting, increasing driver comfort and the durability of the joint
- **ROBO®MUTE:** Noise-protection system, consisting of mats placed beneath and at the ends of the joint to reduce noise emissions
- **ROBO®GRIP:** Anti-skid coating with high coefficient of friction, preventing skidding of over-rolling vehicles in wet conditions
- **ROBO®STATIFLEX:** Strengthening strip of quick-hardening polymer concrete along the side of an expansion joint, which reduces rutting, increasing driver comfort and joint durability
- **ROBO®CONTROL:** Sensor-based electronic monitoring system which can serve many purposes – e.g. continuous measurement and transmission of data relating to an expansion joint's movements and the conditions to which it is subjected

Quality

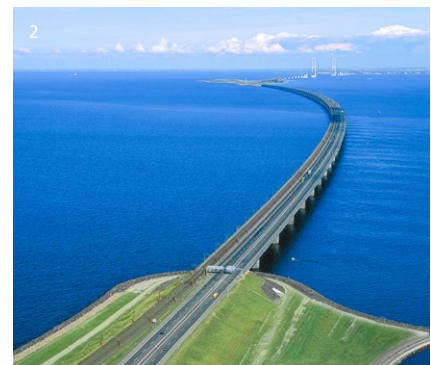
The 100 % watertight modular expansion joint was invented by mageba in the 1960s. For five decades, mageba TENSA®MODULAR expansion joints have proven their worth in thousands of structures under the most demanding conditions. In addition to the product properties, the extensive experience of our well-qualified manufacturing and installation staff also contributes to the product's high quality and durability.

mageba has a process-orientated quality system that is certified in accordance with ISO 9001. Quality is also regularly inspected by independent institutes, such as the University of Stuttgart's materials testing body (MPA) and the University of Innsbruck. mageba factories are certified for welding in accordance with ISO 3834-2, and according to the current steel construction standard EN 1090.

Customer support

Our product specialists will be pleased to advise you in the selection of the optimal solution for your project, and to provide you with a quotation.

On our website, mageba-group.com, you will find further product information, including reference lists and tender documentation.



- 1 Tsing Ma Bridge, Hong Kong
Equipped with TENSA®MODULAR expansion joints of type LR25
Providing reliable service since 1996
- 2 Storebaelt West Bridge, Denmark
Equipped with TENSA®MODULAR expansion joints of type LR15
Providing reliable service since 1994

Reference projects TENSA®MODULAR Type LR expansion joints



Golden Ears Bridge (CA)



Incheon Bridge (KR)



Ba Lin He Bridge (CN)



Talübergang Lavant (AT)



Braila Bridge (RO)



Ganter Bridge (CH)

mageba expansion joint types



Single gap joints



Cantilever finger joint



Sliding finger joints



Modular expansion joints

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