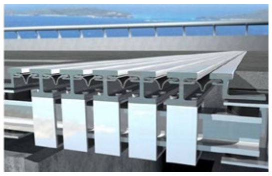
Infrastructure | Buildings | Industrial structures

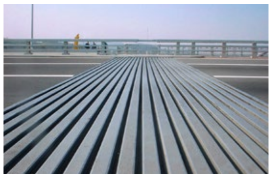
Expansion Joints

mageba modular expansion joints – the benchmark for large movements

TENSA®MODULAR Types LR and LR-LS

proven, versatile, low-noise





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 80 inches (about 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 3.1 inches (80 mm).

The fitting of so-called "sinusoidal plates" to the joint's surface enables noise from passing traffic to be reduced by up to 80 %.

Characteristics

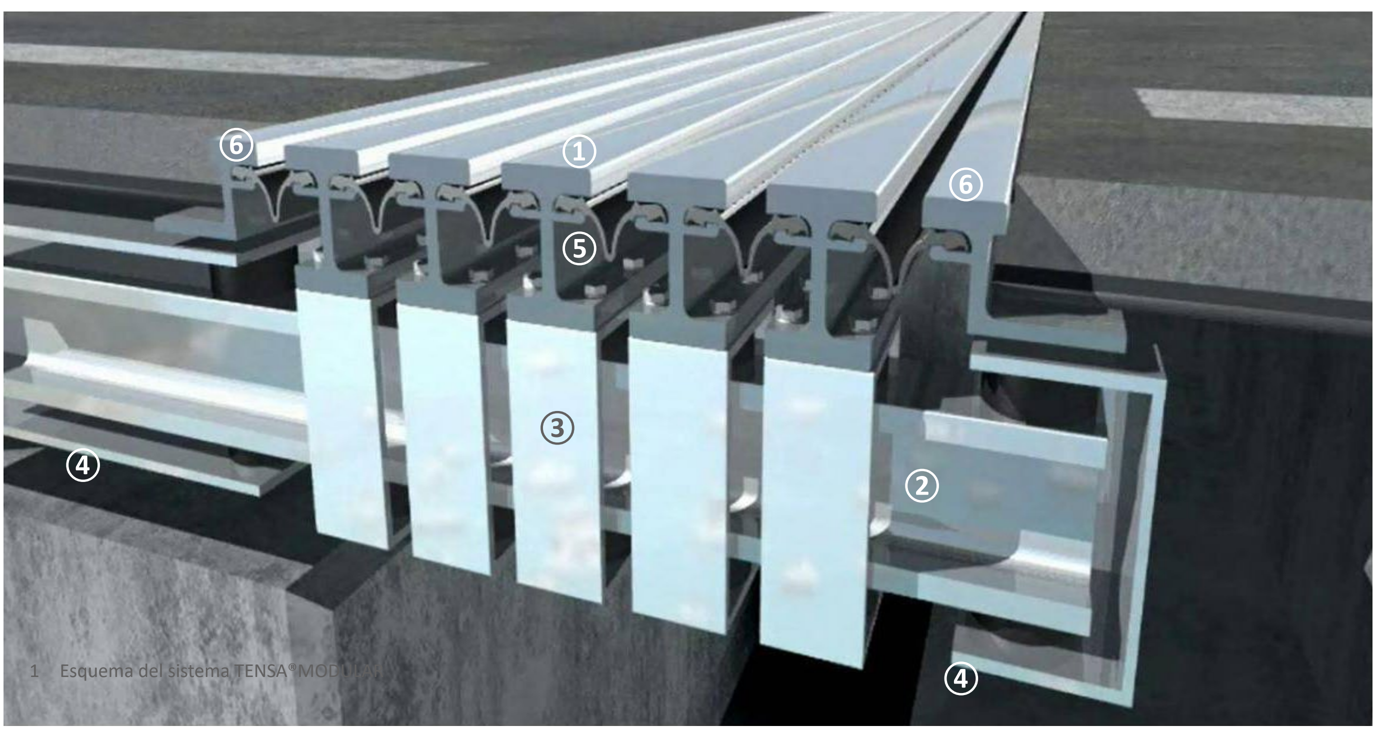
Expansion joints are subjected to considerable demands and must satisfy these over a service life of many years. The design of the watertight TENSA®MODULAR expansion joint, which was invented by mageba, has been continually developed in recent decades. The current 4th generation of the system fully accommodates 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 2.4 and 3.1 inches (60 and 80 mm), depending on the relevant norm. However, if noise-reducing sinusoidal plates are bolted to the upper surface of the lamella beams and edge profiles, the movement accommodated by each gap increases to 3.9 inches (100 mm). For special load cases such as earthquakes, 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.



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
- Low-noise when fitted with sinusoidal plates

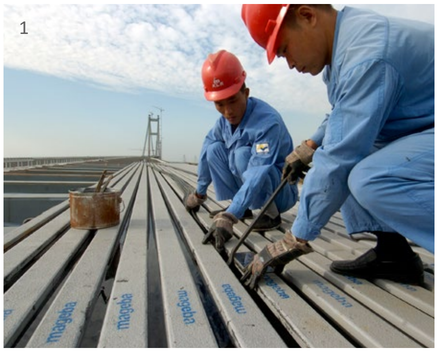
Design

- 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.
- Sinusoidal plates, which can optionally be fitted to the surface of the joint, reduce noise from over-rolling traffic by up to 80%, making the joint suitable for use in noise-sensitive areas.

1 Installation works on the Run Yang Bridge
2 TENSA®MODULAR joint featuring sinusoidal plates – in service
3 Installed 24-gap joint allowing 75.6 inches (1,920 mm) of movement and weighing 90,390 lb
4 Control system with control springs and connection plates
5 Recesses prior to concreting

1


2


3


4


5


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.

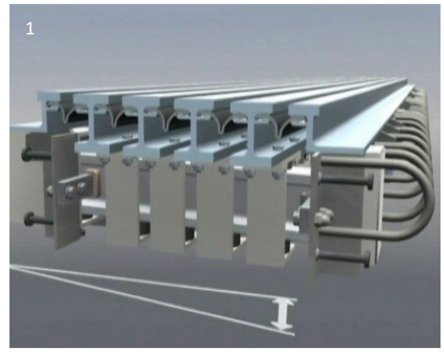
If necessary, the joint's support bar boxes can be designed with a trapezoidal shape to increase the joint's transverse movement capacity to match its longitudinal movement capacity.

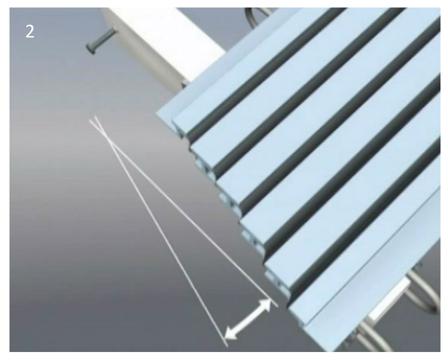
In this case, the support bars of the joint can rotate until they are orientated at 45 degrees to the bridge axis. This simple geometric adaptation represents one significant advantage of the TENSA®MODULAR joint: the functionality and construction of the overall system remains the same for small or large 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. However, 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 (without sinusoidal plates)				Type LR-LS (with sinusoidal plates)			
		Max. longitudinal movement		Max. transverse movement		Max. longitudinal movement		Max. transverse movement*	
		[in]	[mm]	[in]	[mm]	[in]	[mm]	[in]	[mm]
LR 2	2	6.3	160	± 3.1	± 80	7.9	200	± 0	± 0
LR 3	3	9.4	240	± 4.7	± 120	11.8	300	± 0	± 0
LR 4	4	12.6	320	± 6.3	± 160	15.7	400	± 0	± 0
LR 5	5	15.7	400	± 7.9	±200	19.7	500	± 0.2	± 4
LR 6	6	18.9	480	± 9.4	± 240	23.6	600	± 0.4	± 9
LR 7	7	22.0	560	± 11.0	± 280	27.6	700	± 0.5	± 13
LR 8	8	25.2	640	± 12.6	± 320	31.5	800	± 0.7	± 17
LR 9	9	28.3	720	± 14.2	± 360	35.4	900	± 0.9	± 22
LR 10	10	31.5	800	± 15.7	± 400	39.4	1,000	± 1.0	± 26
LR 11	11	34.6	880	± 17.3	± 440	43.3	1,100	± 1.2	± 30
LR 12	12	37.8	960	± 18.9	± 480	47.2	1,200	± 1.3	± 34
LR 13	13	40.9	1,040	± 20.5	± 520	51.2	1,300	± 1.5	± 39
LR 14	14	44.1	1,120	± 22.0	± 560	55.1	1,400	± 1.7	± 43
LR 15	15	47.2	1,200	± 23.6	± 600	59.1	1,500	± 1.9	± 47

(Details relating to other sizes, for larger movements, available on request)

**) Values significantly increased at reduced longitudinal movements*

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

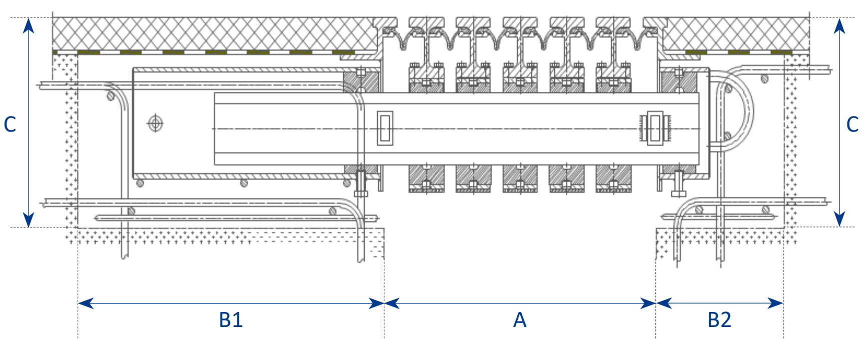
The main dimensions of the recesses (blockouts) required in the bridge structure for the installation of various sizes of expansion joint, and the weight of joint per meter, are provided in the table below.

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 minimizes fatigue and thus increases service life.



Section through a modular joint of type LR6

Type	Type LR (without sinusoidal plates)												Type LR-LS (with sinusoidal plates)											
	A_{min}		A_{max}		B1		B2		C*		Weight		A_{min}		A_{max}		B1		B2		C*		Weight	
	[in]	mm	[in]	[mm]	[in]	[mm]	[in]	[mm]	[in]	[mm]	[lb/ft]	[kg/m]	[in]	[mm]	[in]	[mm]	[in]	[mm]	[in]	[mm]	[in]	[mm]	[lb/ft]	[kg/m]
LR 2	5.5	140	11.8	300	15.7	400	11.8	300	15.7	400	101	150	5.5	140	13.4	340	17.7	450	13.8	350	17.7	450	128	190
LR 3	8.7	220	18.1	460	18.9	480	11.8	300	15.7	400	161	240	8.7	220	20.5	520	21.7	550	13.8	350	17.7	450	208	310
LR 4	11.8	300	24.4	620	22.0	560	11.8	300	15.7	400	222	330	11.8	300	27.6	700	25.6	650	13.8	350	18.5	470	289	430
LR 5	15.0	380	30.7	780	25.2	640	11.8	300	16.5	420	282	420	15.0	380	34.6	880	29.5	750	13.8	350	18.5	470	376	560
LR 6	18.1	460	37.0	940	28.3	720	11.8	300	16.5	420	343	510	18.1	460	41.7	1,060	33.5	850	13.8	350	18.5	470	450	670
LR 7	21.3	540	43.3	1,100	31.5	800	11.8	300	16.5	420	403	600	21.3	540	48.8	1,240	37.4	950	13.8	350	19.3	490	531	790
LR 8	24.4	620	49.6	1,260	34.6	880	11.8	300	17.3	440	464	690	24.4	620	55.9	1,420	41.3	1050	13.8	350	20.1	510	611	910
LR 9	27.6	700	55.9	1,420	37.8	960	11.8	300	18.1	460	531	790	27.6	700	63.0	1,600	45.3	1,150	13.8	350	20.9	530	699	1,040
LR 10	30.7	780	62.2	1,580	40.9	1,040	11.8	300	18.9	480	605	900	30.7	780	70.1	1,780	49.2	1,250	15.7	400	22.0	560	800	1,190
LR 11	33.9	860	68.5	1,740	44.1	1,120	11.8	300	20.1	510	685	1,020	33.9	860	77.2	1,960	53.1	1,350	15.7	400	22.8	580	907	1,350
LR 12	37.0	940	74.8	1,900	47.2	1,200	11.8	300	20.1	510	766	1,140	37.0	940	84.3	2,140	57.1	1,450	15.7	400	22.8	580	1,008	1,500
LR 13	40.2	1,020	86.6	2,200	52.4	1,330	13.8	350	22.0	560	827	1,230	40.2	1,020	91.3	2,320	61.0	1,550	15.7	400	24.0	610	1,115	1,660
LR 14	47.2	1,200	92.9	2,360	55.5	1,410	13.8	350	22.0	560	887	1,320	47.2	1,200	102.4	2,600	65.0	1,650	15.7	400	25.2	640	1,216	1,810
LR 15	52.0	1,320	99.2	2,520	58.7	1,490	13.8	350	23.2	590	941	1,400	52.0	1,320	111.0	2,820	68.9	1,750	15.7	400	25.2	640	1,324	1,970

(Details relating to other sizes, for larger movements, available on request)

**) The minimum value of the recess refers to an asphalt thickness of 2.75 inches (70 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 were observed.

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 program 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 3.9 ft/s (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 **www.mageba-group.com.**

National Approvals

The TENSA®MODULAR expansion joints have been extensively tested for suitability and performance. The system has been awarded national approvals in numerous countries around the world.

FUSE-BOX

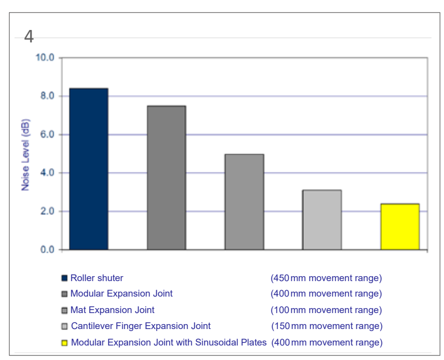
The optional FUSE-BOX feature protects the modular expansion joint and adjacent bridge structure from seismic damage. If a standard joint (without FUSE-BOX) closes more than geometrically allowed during an earthquake, the joint and bridge structure will be damaged or could even fail. The FUSE-BOX prevents such 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, enabling emergency vehicles to cross the bridge in the earthquake's aftermath.

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

Sinusoidal Plates

The use of "sinusoidal plates" reduces the noise from passing traffic by up to 80 % by covering the straight transverse gaps in the roadway. The wheels of passing vehicles thus maintain constant contact with the expansion joint's surface, eliminating the noise caused by impacts with the gap edges. The special shape of the sinusoidal plates also enables motorcycles and bicycles to cross the joint safely. TENSA®GRIP expansion joints featuring sinusoidal plates are ideal for use on bridges near residential areas or in other noise-sensitive zones.

The bolting (rather than welding) of the sinusoidal plates to surface of the joint enables the sealing profiles beneath to be easily and quickly replaced if necessary.



1 Fatigue testing of an LR joint
2 Seismic testing of an LR joint
3 FUSE-BOX during an earthquake
4 Comparison of noise levels generated by traffic crossing joints of different types (yellow: a modular joint featuring sinusoidal plates)

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 ASTM A709 Grade 50 steel
- Hybrid lamella beams including stainless steel can be provided on request
- Sinusoidal plates of ASTM A709 Grade 50 steel
- Sealing profiles of EPDM or CR (Neoprene)
- 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 edge profiles are treated with corrosion protection systems based on hot dip galvanizing ASTM A-123 / AASTHO M111, or any applicable painting systems approved by the responsible Department of Transportation (D.O.T.).

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 the site. They can generally be transported in the lengths at 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 leveled against both edge profiles.

Sidewalk and Edge Area

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

Connection Reinforcement

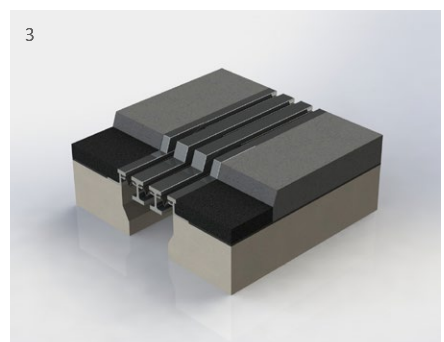
The connection reinforcement in the bridge structure adjacent to the joint is to be designed and implemented in accordance with the relevant reinforced concrete norm. The anchor loops on the edge profiles are normally perpendicular to the joint, but can, on request, be welded at any other angle. Beneath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

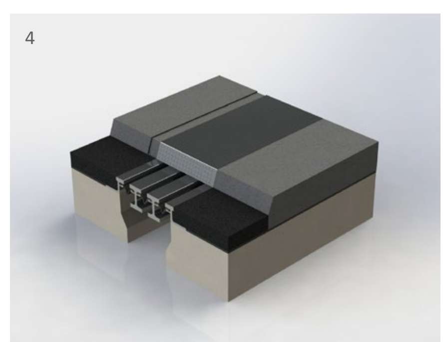
Operation and Maintenance

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 Sidewalk in joint with curb block
4 Sidewalk in joint with cover plate

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 passing vehicles in wet conditions
- **STATIFLEX®:** Strengthening strip of quick-hardening polymer concrete along the side of the 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. In addition, its quality is regularly inspected by independent testing institutes. mageba factories are AISC certified for Major Bridges (CPT, STD, SPE) and also maintain AWS certifications for D1.1 and D1.5.

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.

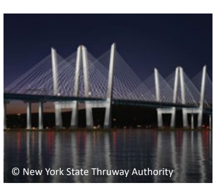
On our website, **mageba-group.com**, you will find further product information, including reference lists and tender documentation.

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 with TENSA®MODULAR Type LR Expansion Joints

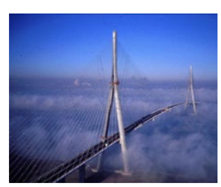

Golden Ears Bridge (CA)



Tappan Zee Bridge (CA)


Ba Lin He Bridge (CN)

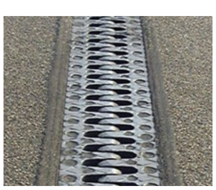

Incheon Bridge (KR)


Pont de Normandie (FR)


Ganter Bridge (CH)

mageba Expansion Joint Types


Single Gap Joints


Cantilever Finger Joint


Sliding Finger Joints


Modular Expansion Joints

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