



Expansion joints

Infrastructure | Buildings | Industrial structures

mageba modular expansion joints – the benchmark for large movements



TENSA[®] MODULAR Types LR and LR-LS

proven, versatile, low-noise



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.

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

Characteristics

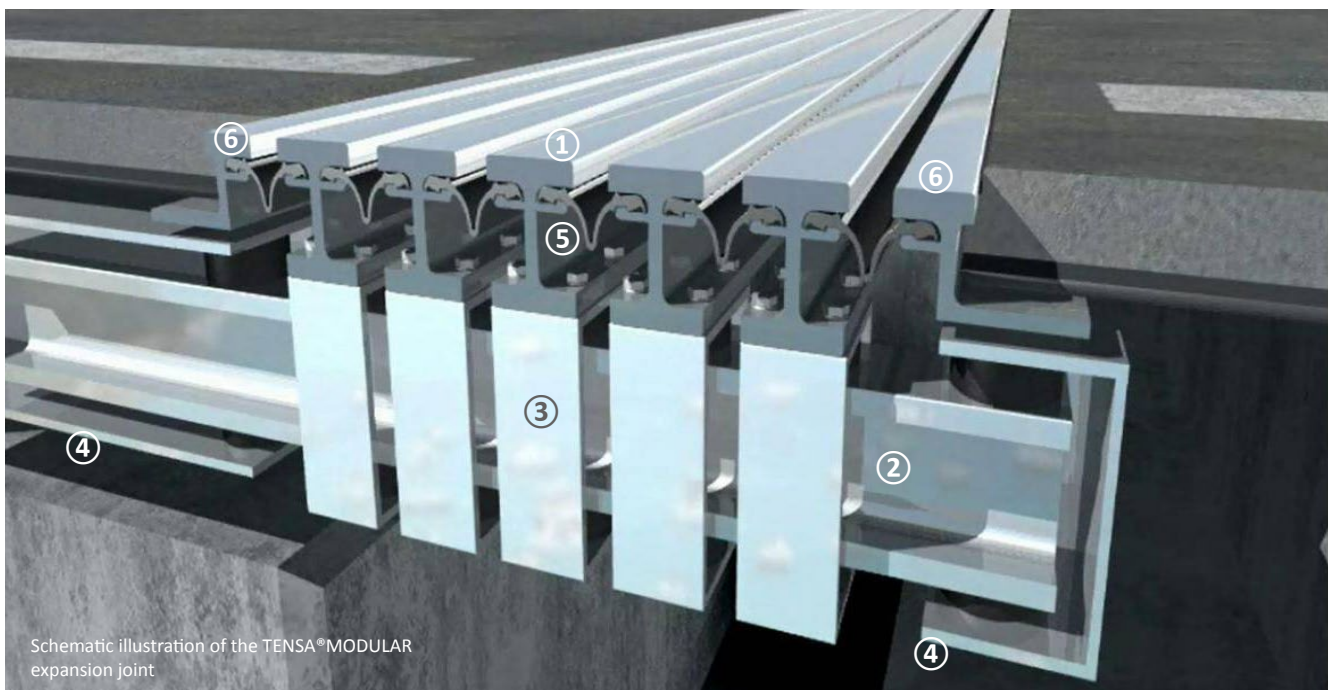
Expansion joints are subjected to considerable demands and must satisfy these over a service life of many years. The design of the watertight TENSA®MODULAR expansion joint, which was invented by mageba, has been continually developed in recent decades. The current 4th generation of the system fully accommodates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



Schematic illustration of the TENSA®MODULAR expansion joint



Expansion joints

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 sinus plates

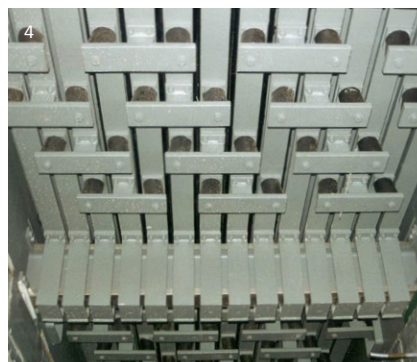
Design

- 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.
- Sinus 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 sinus plates – in service
- 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.

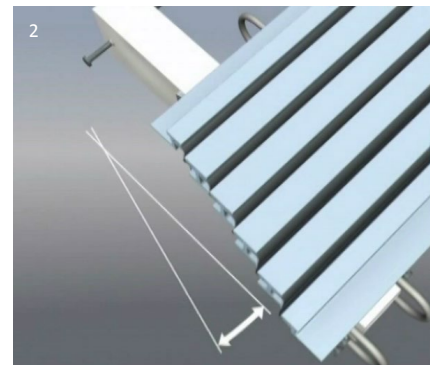
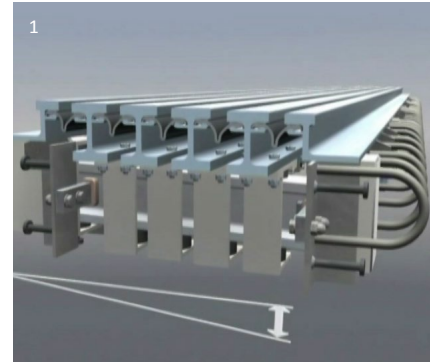
If necessary, the joint's support bar boxes can be designed with a trapezoidal shape to increase the joint's transverse movement capacity to match its longitudinal movement capacity.

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 (without sinus plates) | | Type LR-LS (with sinus plates) | |
|-------|----------------|--------------------------------|--------------------------|--------------------------------|---------------------------|
| | | Max. longitudinal movement | Max. transverse movement | Max. longitudinal movement | Max. transverse movement* |
| [-] | [-] | [mm] | [mm] | [mm] | [mm] |
| LR 2 | 2 | 160 | ± 80 | 200 | ± 0 |
| LR 3 | 3 | 240 | ± 120 | 300 | ± 0 |
| LR 4 | 4 | 320 | ± 160 | 400 | ± 0 |
| LR 5 | 5 | 400 | ±200 | 500 | ± 4 |
| LR 6 | 6 | 480 | ± 240 | 600 | ± 9 |
| LR 7 | 7 | 560 | ± 280 | 700 | ± 13 |
| LR 8 | 8 | 640 | ± 320 | 800 | ± 17 |
| LR 9 | 9 | 720 | ± 360 | 900 | ± 22 |
| LR 10 | 10 | 800 | ± 400 | 1'000 | ± 26 |
| LR 11 | 11 | 880 | ± 440 | 1'100 | ± 30 |
| LR 12 | 12 | 960 | ± 480 | 1'200 | ± 34 |
| LR 13 | 13 | 1'040 | ± 520 | 1'300 | ± 39 |
| LR 14 | 14 | 1'120 | ± 560 | 1'400 | ± 43 |
| LR 15 | 15 | 1'200 | ± 600 | 1'500 | ± 47 |
| LR 20 | 20 | 1'600 | ± 800 | 2'000 | ± 67 |
| LR 25 | 25 | 2'000 | ± 1'000 | 2'500 | ± 87 |
| LR 30 | 30 | 2'400 | ±1'200 | 3'000 | ± 107 |

Dimensions for larger and intermediate movements on request

*) Values significantly increased at reduced longitudinal movements



Expansion joints

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, mägeba 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

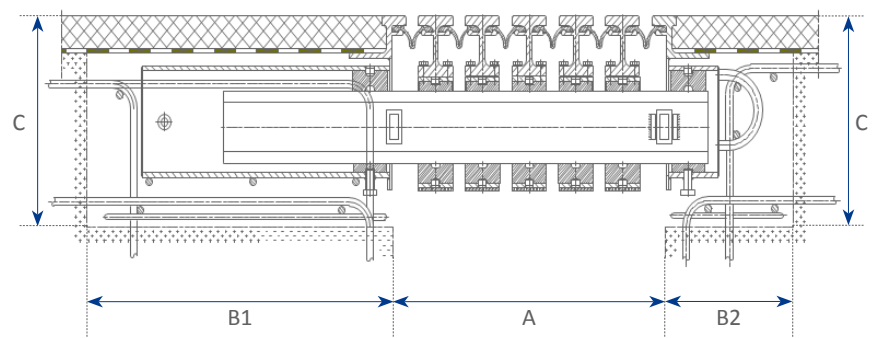
provided in the table below. The values for B1 and B2 are valid for an expansion joint with both a moving side and a fixed side as shown in the cross section. Alternatively, expansion joints can be designed to allow movement at both sides. In such cases, the total longitudinal movement can be split as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



Section through a modular joint of type LR6

| Type | Type LR (without sinus plates) | | | | | | Type LR-LS (with sinus plates) | | | | | |
|-------|--------------------------------|------------------|-------|------|------|--------|--------------------------------|------------------|-------|------|------|--------|
| | 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 | 150 | 310 | 400 | 300 | 420 | 150 | 150 | 350 | 450 | 350 | 440 | 190 |
| LR 3 | 240 | 480 | 480 | 300 | 420 | 240 | 240 | 540 | 550 | 350 | 440 | 310 |
| LR 4 | 330 | 650 | 560 | 300 | 420 | 330 | 330 | 730 | 650 | 350 | 460 | 430 |
| LR 5 | 420 | 820 | 640 | 300 | 440 | 420 | 420 | 920 | 750 | 350 | 460 | 560 |
| LR 6 | 510 | 990 | 720 | 300 | 440 | 510 | 510 | 1'110 | 850 | 350 | 460 | 670 |
| LR 7 | 600 | 1'160 | 800 | 300 | 440 | 600 | 600 | 1'300 | 950 | 350 | 480 | 790 |
| LR 8 | 690 | 1'330 | 880 | 300 | 460 | 690 | 690 | 1'490 | 1'050 | 350 | 510 | 910 |
| LR 9 | 780 | 1'500 | 960 | 300 | 480 | 790 | 780 | 1'680 | 1'150 | 350 | 530 | 1'040 |
| LR 10 | 870 | 1'670 | 1'040 | 300 | 500 | 900 | 870 | 1'870 | 1'250 | 400 | 550 | 1'190 |
| LR 11 | 960 | 1'840 | 1'120 | 300 | 530 | 1'020 | 960 | 2'060 | 1'350 | 400 | 550 | 1'350 |
| LR 12 | 1050 | 2'010 | 1'200 | 300 | 530 | 1'140 | 1'050 | 2'250 | 1'450 | 400 | 570 | 1'500 |
| LR 13 | 1'020 | 2'200 | 1'330 | 350 | 560 | 1'230 | 1'020 | 2'320 | 1'550 | 400 | 610 | 1'660 |
| LR 14 | 1'200 | 2'360 | 1'410 | 350 | 560 | 1'320 | 1'200 | 2'600 | 1'650 | 400 | 640 | 1'810 |
| LR 15 | 1'320 | 2'520 | 1'490 | 350 | 590 | 1'400 | 1'320 | 2'820 | 1'750 | 400 | 640 | 1'970 |
| LR 20 | 1'580 | 3'370 | 1'890 | 350 | 650 | 2'250 | 1'870 | 3'870 | 2'290 | 400 | 650 | 2'650 |
| LR 25 | 1'980 | 4'220 | 2'290 | 350 | 690 | 2'900 | 2'345 | 4'845 | 2'790 | 400 | 740 | 3'350 |
| LR 30 | 2'380 | 5'070 | 2'690 | 350 | 720 | 3'500 | 2'820 | 5'820 | 3'290 | 400 | 830 | 4'050 |

Dimensions for larger and intermediate movements on request

*) The minimum value of the recess refers to an asphalt thickness of 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 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 have been subjected to scrutiny, and awarded national approvals, in many countries around the world – for example, in accordance with the German standard TL/TP-FÜ or the latest version of the Austrian standard RVS.

FUSE-BOX

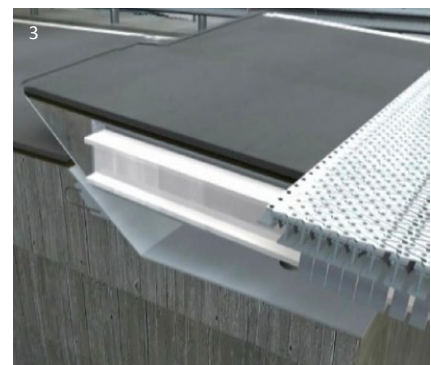
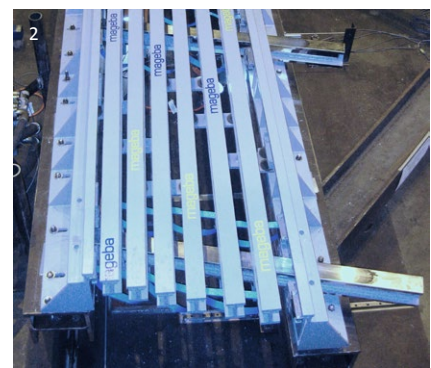
The optional FUSE-BOX feature protects the modular expansion joint and adjacent bridge structure from seismic damage. If a standard joint (without FUSE-BOX) closes more than geometrically allowed during an earthquake, the joint and bridge structure will be damaged or could even fail. The FUSE-BOX prevents 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 optimised, resulting in more economical solutions.

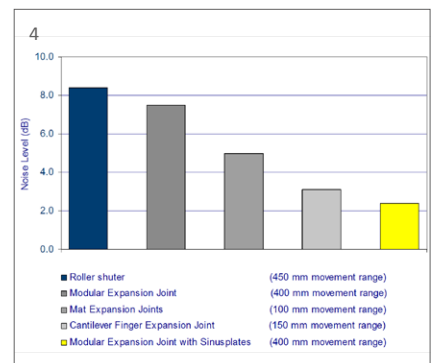
Sinus plates

The use of "sinus plates" reduces the noise from over-rolling traffic by up to 80 % by covering the straight transverse gaps in the carriageway. The wheels of over-rolling 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 sinus plates also enables motorcycles and bicycles to cross the joint safely. TENSA®MODULAR expansion joints featuring sinus plates are ideal for use on bridges near residential areas or in other noise-sensitive zones.

The bolting (rather than welding) of the sinus 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 sinus 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 S355 steel; hybrid lamella beams including stainless steel can be provided on request
- Sinus plates of S355 steel
- 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

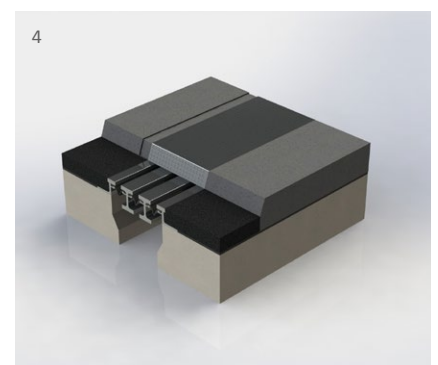
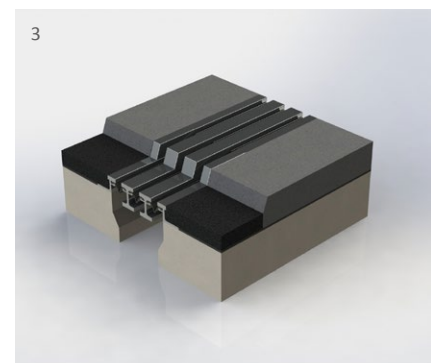
The connection reinforcement in the bridge structure adjacent to the joint is to be designed and implemented in accordance with the relevant reinforced concrete norm. The anchor loops on the edge profiles are normally perpendicular to the joint, but can, on request, be welded at any other angle. Beneath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



Pont de Normandie (FR)

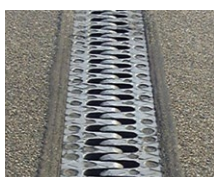


Ganter Bridge (CH)

mageba expansion joint types



Single gap joints



Cantilever finger joint



Sliding finger joints



Modular expansion joints

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