Expansion joints

Infrastructure | Buildings | Industrial structures

mageba plug expansion joint – the new generation

TENSA®POLYFLEX®RapidCure RC

Fast-curing, maintenance-free, watertight

mageba

Product characteristics

Principle and development

Flexible plug expansion joints have a very wide range of applications and offer significant advantages over other types of expansion joint – including, for example, superior ride comfort, very low noise emissions (not exceeding noise from the adjacent road surface), watertightness, and the ability to be easily installed in stages.

However, the bituminous-based materials traditionally used have some disadvantages, such as deformation or rutting. If a very stable material is used to minimise such problems, the resulting very high restoring forces can cause debonding from the adjacent road surface, especially in winter, leading to further deterioration and loss of watertightness.

TENSA®POLYFLEX® expansion joints of synthetic materials set a completely new standard for plug-type expansion joints, in terms of quality and service life. Based on 15 years of experience with plug-type expansion joints of polyurethane (PU), and thanks also to the well-proven expertise of our specialists and engineers, mageba has developed a new addition to the TENSA®POLYFLEX® plug-type expansion joint product line: The **TENSA®POLYFLEX® RapidCure RC** expansion joint.

The new PMMA-based synthetic material used in the new expansion joint was developed in close cooperation with chemical industry leaders, and **offers particularly advantageous characteristics in relation to curing time, requiring only three hours until it can be fully loaded**. Therefore, the new TENSA®POLYFLEX®RapidCure plug-type expansion joint can be **particularly recommended for time-critical projects** such as overnight installations.

The new material has been proven to reduce the above-mentioned restoring values, while continuing to offer the typical advantages – such as the easy installation process – of the TENSA®POLYFLEX® plug-type expansion joint system.

Characteristics

The joint uses a durable, fully elastic material with high tear resistance and exceptionally low restoring forces. Perforated steel angles, fully enclosed within the synthetic material, help to reduce the loading at the interface with the road surfacing from braking and restoring forces.

The material is exceptionally resistant to aging while also resisting environmental and chemical influences, and it is extremely wear-resistant. In most cases, its service life is substantially longer than that of the adjacent roadway surface materials.

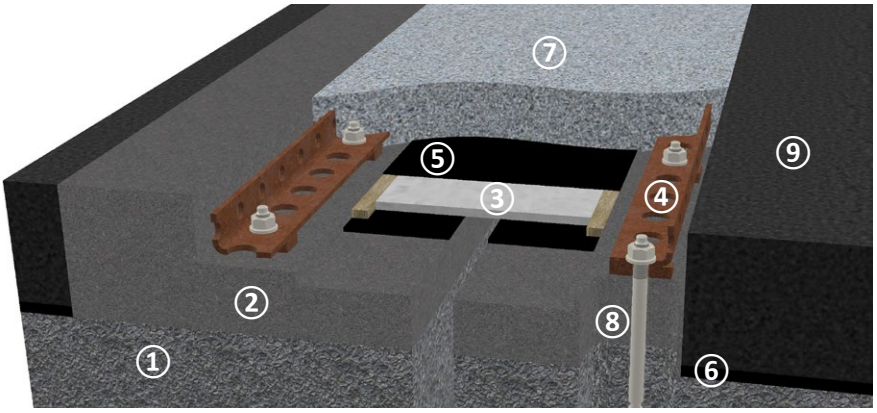
The material can be cast to form virtually any expansion joint shape (e.g. upstands, skewed angles, T-shaped and X-shaped junctions, etc.) – quickly and reliably.

The three-component material is mixed in complete packaging units at ambient temperature, thus avoiding on-site mixing errors. The material can be worked with at temperatures between 5 °C and 35 °C, virtually independent of the humidity. After just three hours of curing time, the material can be subjected to full traffic loading. The joint is fully functional at temperatures from –50 °C to +70 °C (–58 °F to +158 °F) – a far wider temperature range than applies for typical bituminous plug-type joints.

An essential advantage offered by TENSA®POLYFLEX® expansion joints is the ability for each joint to be individually tailored to the unique requirements of any particular bridge. The thickness and width of each joint can be defined to suit the most efficient and economical solution possible, without being limited by standard dimensions.

Typical applications

- Bridge structures for all traffic types (road, pedestrian and railway bridges)
- New construction projects and refurbishment projects (including replacement of conventional steel joints)
- Commercial/residential buildings and industrial structures
- Railway stations (buildings and platforms)
- Multi-story parking structures and parking decks
- Airport buildings, hangars and runways
- Acid- and alkali-resistant joints for the chemical industry
- Sterile joints for clinics, hospitals and laboratories and the pharmaceutical industry
- The food processing industry
- Flooring for air cushion vehicles
- Heavy industrial applications



1 Superstructure or abutment
2 Polymer concrete base
3 Gap-covering plate
4 Perforated, coated steel angle
5 EPDM sliding sheet
6 Bridge waterproofing membrane
7 TENSA®POLYFLEX®RapidCure compound
8 Anchoring
9 Road surfacing of asphalt or concrete

Client benefits

Advantages & properties

- **Can be driven across just three hours after installation**
- **Simplified and fast installation**
- Can be installed with minimal impact on traffic, e.g. lane-by-lane in night-time shifts
- Reduction of joint widths compared to conventional systems of the same movement capacity
- Exceptionally long service life (typically longer than the adjacent road surface)
- Highest possible driver comfort
- No additional noise from crossing traffic since the surface is continuous and flush with the connecting road
- The joint remains absolutely watertight
- Maintenance-free; cleaning as required by conventional steel joints is not necessary
- Installation within a wide temperature range (5 °C to 35 °C / 41 °F to 95 °F)
- Highly aging-resistant and durable – does not contain any mechanical wear parts
- No rutting and excellent resistance to abrasion, so can also be used in deceleration lanes, mountain areas, etc.)
- Local damage to the joint (e. g. scraping by snow ploughs etc.) can be easily repaired by reactivation of the material
- No recesses required for anchoring to the main structure
- Road surfacing (asphalt or concrete) can be placed, continuously across the expansion joint location, before the joint is installed
- Any kerb / sidewalk detail possible
- No noise emission to adjacent structural elements
- Not susceptible to vibrations
- Low restoring forces on the main structure
- Cold processing, easy material handling with pre-set, constant mixing ratio, so mixing errors easily avoidable
- Resistant to environmental influences and chemicals
- Resistant to alkalis, acids and salts
- Fungus- and germ-resistant
- Available in grey or black colour
- Smooth surface ideal for pedestrian areas of airports or railway stations
- Excellent characteristics in the event of earthquakes

Damage repair & partial installations

Road maintenance vehicles, snow ploughs or traffic accidents can cause significant damage to expansion joints, resulting in high repair costs.

Local damage to TENSA®POLYFLEX® expansion joint can be repaired easily, quickly and cost-efficiently by cutting out the affected area from the surface and chemically reactivating the previously cured material. For this, the prepared area is filled with new material.

A similar procedure of chemically reactivating the previously cured material is applied where an expansion joint is installed in stages, e.g. lane-by-lane, resulting in a single, continuous expansion joint.

System types

High traffic loading ①

TENSA®POLYFLEX®RapidCure RC Type H: Suitable for new bridges with high loading and large movements (e.g. highways, freeways, etc.), as an expansion joint solution for integral bridges or for refurbishments.

Lower loading ②

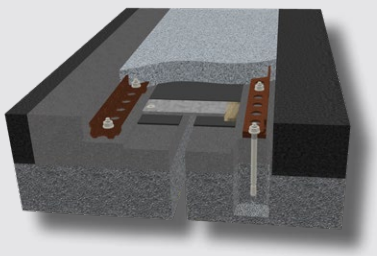
TENSA®POLYFLEX®RapidCure RC Type S: This version with reduced dimensions and without anchoring of the gap cover plate is used for lower loading on city streets and rural roads.

For movements of 90 mm or greater, a wave-shaped gap-covering plate design is applied, regardless of application.

Sidewalk detail ③

The expansion joint's design enables a perfect result to be achieved where footpaths areas, kerbs or upstands are required.

1



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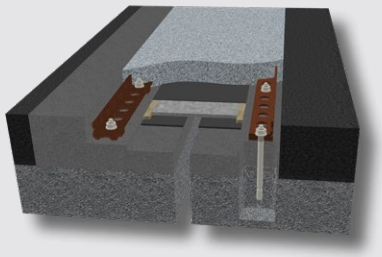


3

Dimensions

Design principles

The TENSA®POLYFLEX®RapidCure RC material provides excellent adhesion to the supporting structure and to the connecting road surfacing, and is therefore capable of transferring horizontal loads safely to the structure.

Additionally, coated perforated steel angles, which are fully embedded within the joint material and are anchored to the structure, can transfer even the highest loads (e. g. from a heavy vehicle braking on the joint on a downward slope).

These steel angles also support the adjacent surfacing, preventing asphalt etc. from being pushed into the sides of the joint material.

It is recommended to strengthen adjacent bituminous road surfacing by means of a strip of a special polymer concrete, or an asphalt with a void content of <6 %, along the side of the joint.

An embedded cover plate bridges the structure's movement gap, and is designed to withstand all traffic loading. The joint's unique design avoids the need for additional components (springs, stabilising elements, etc.) to avoid exceeding vertical deformation limits. These values are derived from EAD 120011-01-0107 of October 2019, ensuring traffic safety and high driver comfort.

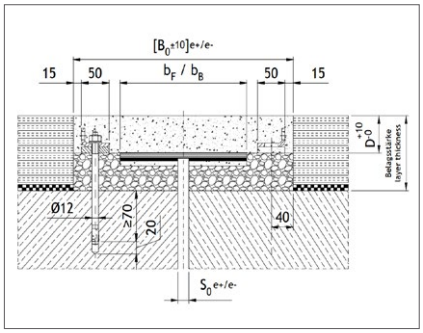
The structure's waterproofing membrane is integrated into the joint's poured flexible material or the polymer concrete base material beneath, making the whole system completely watertight. Watertightness can also be achieved by a butt joint.

Type selection

The tables below show examples of expansion joint dimensions for a preliminary design. Since plug-type expansion joints cannot be preset to suit the gap width at the time of installation, the temperature of the main structure during installation is extremely important for expansion joint performance. It is therefore recommended to discuss with the manufacturer as early as possible, and agree how to address this challenge. In the final design, the width and thickness of the joint are determined according to the expansion/contraction movements that will actually arise. All joint types can accommodate vertical movements of ±10 mm, e.g. to facilitate replacement of bridge bearings.

System types RC40 – RC105

	RC 40 [mm]	RC 60 [mm]	RC 75 [mm]	RC 90 [mm]	RC 105 [mm]
Total movement e	40	60	75	90	105
Expansion movement e+	27	40	50	60	70
Contraction movement e-	13	20	25	30	35
Thickness D	60	60	60	65	65
Joint width in neutral position B_0	360	400	500	600	730
Movement gap in neutral position S_0	19 – 58	25 – 50	25 – 90	35 – 100	40 – 100
Width of gap cover plate b_B	170	205	260	400	440
Width of sliding sheet b_F	190	230	290	370	440
Steel angle	50 × 40 × 6				



Note: Achievable movements at the Serviceability Limit State (SLS), considering permissible vertical deflections. At the Ultimate Limit State (ULS), significantly larger movements can be accommodated. Please contact our specialists for further details. For expansion joint replacement projects, the actual width of the structure's movement gap must be considered in the joint's detailed design.

Material

Material characteristics

At the Austrian Research and Testing Institute (OFI), the newly developed elastic material and its components have been successfully subjected to comprehensive testing, including:

- Artificial weathering and aging tests
- Spectroscopy (IR) testing
- Thermal analysis (TGA) testing
- Hardness testing
- Tensile strength testing
- Dynamic-mechanical analysis of fully reacted material

Materials

The TENSA®POLYFLEX®RapidCure RC joint is based on an elastic, solvent-free three-component compound system that was specially developed for use in flexible plug expansion joints.

The polymer concrete recommended for use to form a sub-base where required is a cold-processed compound that was adapted to optimally suit TENSA®POLYFLEX® plug-type expansion joints in terms of workability and endurance.

Detailed information about the materials can be found in the appropriate technical and safety data sheets. We will be happy to provide the documents on request.

1 Marking and cutting of the previously installed road surfacing (installed right across the joint's location)
2 Prepared substructure with support strips along each side of the joint
3 Placing of gap cover plate, on an EPDM sliding sheet, on a polymer-concrete base
4 Drilling/fixing of anchor bolts
5 Formation of a joint for installation in stages
6 Fully installed expansion joint

Testing and verification

Since February 2023, mageba has been granted the European Technical Approval ETA-22/0692 for the product system TENSA®POLYFLEX®RapidCure RC.

To obtain certification, the product has to undergo a thorough approval procedure in which various tests must be carried out at certified and renowned testing institutes such as MAPAG-Gumpoltshofen (Austria), Technical University of Munich (Germany), BAM (Germany) and OFI–Vienna (Austria). The European Technical Assessment is issued in accordance with Regulation (EU) No. 305/2011 on the basis of:

- EAD 120011-01-0107 (“Flexible asphaltic plug expansion joints for road bridges with flexible filling based on a synthetic polymer as binder“) and EAD 120093-00-0107
- ETAG 032-1 “Guideline for European Technical Approval – Expansion joints for road bridges – Part 1: General”, edition May 2013, used as a European Assessment Document

The following tests were performed as part of the approval process:

Wheel tracking test and PVT test

A wheel tracking test in accordance with EN 12697-22 was performed by the MAPAG testing institute in Austria. The standard’s requirement for 30,000 load cycles was met, and then a further 60,000 load cycles were successfully applied at the request of the Austrian motorway management company (ASFINAG).

Comparison of service lives:	
Conventional asphaltic plug expansion joint (picture ①)	0
BT 16 HS LKS (common asphaltic road surfacing)	1
TENSA®POLYFLEX®RapidCure RC (picture ②)	**≥ 2**

In practice, this means that the expected service life of TENSA®POLYFLEX®RapidCure RC flexible plug expansion joints is typically more than twice that of the adjacent road surfacing.

Furthermore, measurements were carried out, using a pendulum device, to determine the skid resistance (roadway and sidewalk) in accordance with EN 13036-4 and ETAG 032 Part 1, in both dry and wet conditions.

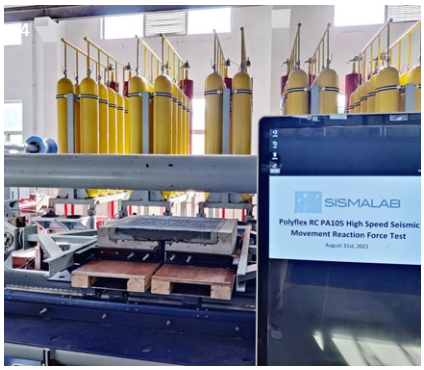
Load resistance and fatigue resistance

At the testing facility of the Technical University of Munich, Germany (Prüfamt für Verkehrswegebau, TU München) testing of the TENSA®POLYFLEX®RapidCure RC60 expansion joint’s load resistance and fatigue resistance was carried out. The testing was based on test specifications according to EAD 120093-00-0107, ETAG 032-3 and ÖNORM B4031 and B4032, and included the following:

Test method a) was carried out at an ambient temperature of 23 ±2 °C (73.4 ±3.6 °F) using a mean contact pressure of 0.94 MPa, applied with a vertical force of 150 kN through a load distribution pad of dimensions 400 × 400 mm simulating the wheel print defined in ETAG 032, Part 1 Annex G. During the test, the specimen was subjected to an opening movement of 100 % of the declared value for the tested type, RC60.

After applying the load for five minutes, the elastic deformations and the recovery during the following hour were recorded. The recordings showed a maximum elastic deformation of 0.5 mm directly after unloading, and a full recovery after one hour.

Because these results were so impressive the test was then carried out again, but this time with the load distribution pad halved in size, resulting in a wheel print of just 400 × 200 mm and a doubled mean contact pressure of 1.88 MPa. Even under these extreme testing conditions, the maximum elastic deformation was just 1.4 mm, and the remaining deformation after one hour, directly under the load distribution pad, was just 0.5 mm. Finally, the test was performed with a load distribution pad of size 300 × 250 mm and a resulting contact pressure of 2.0 MPa.



1 Conventional bituminous plug joint after 100 over-roll cycles at 60 °C (140 °F)
2 TENSA®POLYFLEX® expansion joint after 30,000 over-roll cycles at 60 °C (140 °F)
3 Measurements to determine skid resistance
4 Seismic testing at SISMALAB in Shanghai

Testing and verification

Test method b) "Resistance to repeated vertical dynamic loads" was carried out on a second test specimen as a "classic" over-rolling test.

The test specimen was heated for this purpose so that the temperature inside the expansion joint reached +45 °C. Standard twin truck tyres of dimension 7.50R15 were used, inflated to a pressure of 10 bar (145 psi) and vertically loaded with a force of 45 kN. This resulted in a mean contact pressure of around 1.0 MPa – more than twice the required value of 0.46 MPa as per ETAG 032.

The over-rolling speed was set at 0.2 m/s, and a lateral shifting of the wheel tracks in a range of ±2 cm was simulated. During the test, the specimen was subjected to an opening movement of 60 % of the nominal value for the tested type, RC60. Next, 3000 over-roll cycles were carried out under vertical loading, followed by another 30 cycles with a simulated braking force of 10 % of the vertical load.

The number of load cycles applied was 50 % higher than the 2000 cycles required according to ETAG 032, Part 3. The surface profile was recorded after every 500 cycles to show the effects of any possible wheel tracking or rutting.

The recorded elastic deformations were negligibly small, and no lasting wheel tracking was observed.

In addition to the tests required by the approval procedure, mageba also conducted further testing to evaluate the joint's behaviour during an earthquake. These optional tests were carried out at SISMALAB Shanghai. All the tests had excellent results – for example, the test at a velocity of 1m/sec after overstraining to 200 % in which no damage to the joint was detected.

Testing of movement capacity and of material characteristics

At the Federal Institute for Materials Research and Testing (BAM) in Berlin, Germany, movement capacity tests in accordance with ETAG 032, Part 3, Annex 3 N were carried out on a test specimen of a TENSA®POLYFLEX®RapidCure RC60 expansion joint.

Test method a) "Movement capacity under slow occurring movements": Starting from an initial gap width of 50 mm at a temperature of +15 °C, the maximum expansion of +40 mm was applied at a temperature of -40 °C, and the maximum contraction of -20 mm was applied at a temperature of +60 °C – in each case at a constant deformation rate of 0.2 mm/h. On completion of this stress test, the watertightness was tested after expanding again to +40 mm.

Test method b) "Movement capacity under fast occurring movements": This test was performed with 7.5 x 10^6 load cycles at 15 °C and a further 300,000 cycles at -40 °C. The dynamic amplitude chosen was 2 mm at a vibration frequency of 5 Hz in sinusoidal form. After the end of the loading, the watertightness was tested again after a further expansion of +40 mm at room temperature.

All tests were successful and provided the respective restoring forces. All requirements of ETAG 032 were met without any concerns.

Further tests have also been successfully completed, such as artificial weathering and aging, spectroscopy analysis (IR), thermal analysis (TGA), hardness testing, tensile testing, dynamic-mechanical analysis, and bonding tests.

All of the tested values are far better than comparable values of conventional bituminous plug expansion joints. This again emphasises the extraordinary capabilities of the TENSA®POLYFLEX®RapidCure RC plug-type expansion joint system.

1 Over-rolling test using truck tyres
2 Movement capacity test on a TENSA®POLYFLEX®RapidCure specimen of type RC60

Installation and Support

Installation

For new bridge structures with bituminous surfacing, the road surfacing can – and preferably should – be laid in advance, continuously across the expansion joint location (e.g. using a paving machine). In the case of concrete surfacing or concrete edge details, adequate recesses must be provided.

If the TENSA®POLYFLEX® expansion joint is installed directly on structural concrete, this must have a nominal compressive strength of at least 25 N/mm² and meet the requirements of the relevant standards in terms of quality.

To ensure watertightness of the whole system, the main structure's waterproofing membrane should be applied as far as the bridge gap. During installation of the TENSA®POLYFLEX® joint, the waterproofing membrane is cut and integrated into the poured compound of the expansion joint or the polymer concrete bedding. The system can also be installed on steel structures.

Digital installation supervision

In keeping with the company's spirit of innovation, mageba introduced remote supervision of installation work in 2021. The use of the latest communication technology can make the presence of an installation specialist on site unnecessary in most cases. With the help of a head-mounted mini-tablet with video functionalities worn by a colleague on site, transmitting real-time video images, a mageba engineer or installation specialist at another location can efficiently oversee and coordinate the installation work. A new era in terms of cost reduction, flexibility and environmental sustainability.

Technical support

mageba offers full technical support to help determine the optimal expansion joint width and all other details, considering all technical and economic aspects, in order to achieve the optimal, most cost-effective solution.

Our flexible plug expansion joints can be installed either by mageba staff or by the customer's own personnel that have been specially trained and certified by our specialists. On request, we will be happy to provide expert supervision, either directly on site or remotely via real-time video.

Certification in accordance with ISO 9001, strict factory production controls and continuous monitoring by government authorities ensure the high quality level of our products and manufacturing facilities.

Our product specialists are pleased to support you in the selection of the optimal solution for your project and to provide pricing information. Please visit **www.mageba-group.com** for further information.

1 A1 Highway, Salzburg, Austria
Equipped with TENSA®POLYFLEX®RapidCure RC40 expansion joints

2 Delaware Memorial Bridge, USA
Equipped with TENSA®POLYFLEX®RapidCure RC105 (installed with the aid of digital supervision)

Reference projects – TENSA®POLYFLEX® plug expansion joints


König-Ludwig-Bridge (DE)


Älsborgbron Bridge (SE)


Shanghai – G40 Hwy (CN)


Schnellstraße S10 (AT)


Kabutotori Bridge (JP)


Avrasya Tunel (TR)

mageba expansion joint types


Single gap joints


Cantilever finger joints


Sliding finger joints


Modular expansion joints

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