MAURER
Girder Grid Joints
Expansion joints have the task of bridging structural gaps by complying with the following requirements:

1. Accommodation of loads and movements by
   - safe transmission of traffic loads
   - rigid and shallow anchorage in the structural components
   - low detriment to carriageway surface
   - continuous adaption to deformations in the structure
   - low resistance to deformation

2. Durability of joint system and its adjoining components due to
   - absolute watertightness
   - high fatigue strength
   - resilience, i.e. unrestrained and damped support of all movable components
   - use of materials resistant to aging, corrosion and wear
   - maintenance-free design

3. Low noise emission under traffic due to
   - avoidance of surface irregularities
   - sealing elements, which are not subjected to traffic loads
   - preloaded bearing components made of high-grade synthetics.

4. Efficiency

Stress optical investigation into the connection centre beam – support bar at the technical university of Innsbruck
### Design Principles and Main Components

Continuous in-house and field quality control, the use of high-grade materials and a quality assurance system in keeping with ISO 9001 and EN 29001 ensure the high standard of MAURER Girder Grid Joints.

All design elements of MAURER expansion joints are engineered in high-quality materials. All synthetics used feature excellent resistance to aging, wear and the environment. Relaxation of the control and bearing elements is insignificant even after decades of service. The sealing elements are insensitive to physical stress.

National regulations are to be taken into account in the choice of the corrosion protection system. We recommend using two-part zinc-rich paint as the primer and epoxy-based micaeous iron as the finish.

<table>
<thead>
<tr>
<th>Designation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Supporting Elements</strong></td>
<td></td>
</tr>
<tr>
<td>1 Edge Beam</td>
<td>Hot-rolled section of steel grade S 235 JR G2 precision tolerances combining good weldability with notch toughness. Can be both shop and site butt-welded.</td>
</tr>
<tr>
<td>2 Centre Beam</td>
<td>Hot-rolled section of steel grade S 355 J2 G3 precision tolerances combining good weldability with notch toughness. Can be both shop and site butt-welded by patented system.</td>
</tr>
<tr>
<td>3 Support Bar</td>
<td>Steel grade S 355 J2 G3, machined for precision tolerances.</td>
</tr>
<tr>
<td><strong>Supports</strong></td>
<td></td>
</tr>
<tr>
<td>4 Sliding Plate</td>
<td>Stainless steel in bridge bearing quality. Sliding surfaces ground and polished. Material no. 1.4401.</td>
</tr>
<tr>
<td>5 Sliding Spring</td>
<td>Natural rubber steel laminated, vulcanized in place. Sliding surfaces of PTFE.</td>
</tr>
<tr>
<td>6 Sliding Bearing</td>
<td>Chloroprene rubber with steel spherical inlay vulcanized in place to handle tilt loading. Sliding surfaces of PTFE.</td>
</tr>
<tr>
<td><strong>Control Elements</strong></td>
<td></td>
</tr>
<tr>
<td>7 Control Spring</td>
<td>Cellular polyurethane of high tear strength, insensitive to oil, gasoline, ozone. High resistance to aging, high self-damping.</td>
</tr>
<tr>
<td><strong>Sealing Elements</strong></td>
<td></td>
</tr>
<tr>
<td>8 Strip Seal 80</td>
<td>Chloroprene rubber or EPDM with high tear strength, resistant to salt water, oil and aging, available in any length. Can be vulcanized in place on site.</td>
</tr>
<tr>
<td><strong>Anchorage</strong></td>
<td></td>
</tr>
<tr>
<td>9 Carriageway Anchor</td>
<td>Steel plate and loop from S 235 JR G2.</td>
</tr>
<tr>
<td>10 Anchor Stud</td>
<td>St 37K</td>
</tr>
<tr>
<td>11 Support Box</td>
<td>To accommodate the sliding bearings, sliding springs, control springs and support bars.</td>
</tr>
</tbody>
</table>
Load Transmission, Fatigue Strength, Riding Comfort and Traffic Safety

Safe Load Transmission

Vehicles travelling over the expansion joint transmit vertical and horizontal loads to the centre beams. The section forces resulting from the eccentric wheel loads are transmitted to the support bars by means of the centre beam. This beam acts as a continuous girder. From there they are diverted into the edges of the structure via the supporting elements and control springs.

The edge beam is rigidly anchored in the structure. For fatigue reasons the traffic loads are transmitted via anchor plates into the adjacent reinforced concrete construction. The support boxes are equipped with anchor studs for rigid connection to the adjacent concrete. In the case of steel bridges the edge construction is supported on consoles or supporting girders parallel to the end cross girder.

Riding Comfort and Traffic Safety

Due to the relatively small expansion joint surface exposed to traffic compared to the movements to be accommodated, the riding comfort is excellent.

The steel surface of the joint divided into small gaps requires no additional treatment to make it skid-proof.

Tests have shown that no significant increase of the impact effect by the tyre occurs up to a single gap width of 80 mm for modular expansion joints. However, it is particularly important that a flush interface is provided between the road surface and the expansion joint.

High Fatigue Strength

Expansion joints are subject to high dynamic stresses due to vehicle loads.

Whilst demonstrating the safe load carrying capacity by structural analysis gives a theoretical indication of the suitability of an expansion joint. Proving its fatigue strength is mandatory in estimating its lifetime. Expansion joints are subjected to intensive axle loading.

In field tests the precise load deformation behaviour was measured for various test situations (braking, starting, driving over) and under normal traffic conditions, from which reliable static systems were established to find out how components are stressed under wheel loads.

To regulate the various notch categories the fatigue behaviour was determined on all components of the system in the lab using load combinations approximating to that of actual conditions.
Versatility

Designing an expansion joint is governed by the magnitude and direction of the main movement of the structure in the plane of the carriageway, this being determined in a girder grid joint by the number of expansion gaps and the arrangement of the support bars running parallel to this direction, whereas the edge and centre beams are located parallel to the edges of the structure.

In addition to the normal anticipated movements in the plane of the carriageway, a multitude of secondary movements can occur. E.g., rotations $\varphi_z$ due to irregular increases in temperature, movements $u_y$ due to abutment settings and the resilience of neoprene bearings, movements $u_z$ resulting from cantilever bridge ends. Also to be taken into account are movements $u_y$ resulting from jacking up the superstructure, for instance, when replacing bridge bearings and from the difference between the longitudinal inclination of the carriageway and the horizontal arrangement of the bearings.

The MAURER Girder Grid Joint is capable of handling all such movements safely.

Designing and dimensioning expansion joints in Germany is dictated by the TL/TP-FÜ (Technical Delivery Instructions and Test Specifications) of the Federal Ministry of Transport. MAURER Girder Grid Joints are approved accordingly and are subjected to independent periodic inspection.

To determine movements accord to German Standard DIN 1072 consideration has to be given to a combination of the following factors:

- thermal effects
- prestress
- shrinkage and creep
- superstructure deformations
- substructure deformations

The following extreme temperature ranges govern the design of expansion joints in addition to normal bridge design consideration:

1. For steel and steel/concrete bridges $+75^\circ \text{C} / -50^\circ \text{C}$
2. For concrete bridges and bridges with rolled beams concreted in place $+50^\circ \text{C} / -40^\circ \text{C}$

The functional range of the strip seals is 0 thru 80 mm perpendicular to the joint ($u_x$) and −40 mm thru +40 mm parallel to the joint ($u_y$).

All MAURER expansion joints are designed to take movements of 80 mm per joint gap and thus the type designation results as a multiple of 80. According to the requirements of ZTV-K (Additional Technical Contract Provisions for Engineering Structures) a movement range of 5 to 70 mm, thus 65 mm, is allowed in Germany. This limiting value applies measured perpendicular to the joint axis.
Concrete Bridge
typical cross-section and plan view for anchorage in reinforced concrete

Cross-section

Plan view

Anchoring in concrete structures is governed by the design data as tabulated beside. For steel structures our engineering offices formulate solutions tailored to individual requirements. Salient design features can be seen from the following figures:

*) Due to static reasons the guide bar is partly positioned to the centre. The necessary recess and thickness of the lower placed cantilever concrete (≥ 150 mm) must be observed.

Steel Bridge
Design alternatives for connection to steel decks

Support on single cantilever

Support on continuous girder
Cross-section thru carriageway at support box

Cross-section thru carriageway between support boxes

Cross-section thru footway (alternative 1)

Cross-section thru footway (alternative 2)

Cross-section thru footway with strip seal 80 G without footway cover plate

Cross-section thru footway with cover plate

Cross-section thru footway guide unit (alternative 1)

Cross-section thru footway guide unit (alternative 2)
Design and Product Data

The form of reinforcement shown is merely a proposal. For reinforcement in the area of the carriageway and footways we recommend a hoop-shaped reinforcement of weldable 16 mm dia. rebar on a centrespacing of 200 mm in conjunction with longitudinal reinforcement of the joint and a mesh reinforcement of the gap beneath the joist boxes.

The total movement "u" in the main direction of movement can be resolved into the two components \( u_x \) and \( u_y \) perpendicular and parallel to the direction of the joint respectively. Selecting the size of joint is governed by the component \( u_x \) and the maximum permissible gap width.

To assist dimensioning, the salient design data is listed in the table, whereby departures are possible within certain limits where space availability is restricted. All dimensions are nominal and will be determined according to project. These dimensions are measured at a right angle to the axis of the joint and for angles \( \alpha \) of 45° to 90° between this axis and the direction of movement. Dimensions for smaller angles or larger movements are available on request.

<table>
<thead>
<tr>
<th>MAURER expansion joint</th>
<th>admissible movement</th>
<th>design data</th>
<th>concrete recess dimensions</th>
<th>concrete gap dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>n type ( \alpha )</td>
<td>( u_x ) ( u_y )</td>
<td>( u_z ) a b c d h t t_{lc} t_{sc} f_{max} f_{min} l_f l_c</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 D160 90°–45°</td>
<td>160 ±10 ±20</td>
<td>150 217 216 255</td>
<td>340 350 335 335</td>
<td>150 200 850 820</td>
</tr>
<tr>
<td>3 D240 90°–60°</td>
<td>240 ±15 ±30</td>
<td>270 297 226 255</td>
<td>350 430 355 355</td>
<td>240 320 1100 950</td>
</tr>
<tr>
<td>4 D320 90°–60°</td>
<td>320 ±20 ±40</td>
<td>390 377 246 275</td>
<td>370 520 365 365</td>
<td>350 440 1390 1080</td>
</tr>
<tr>
<td>5 D400 90°–60°</td>
<td>400 ±20 ±50</td>
<td>510 509 266 275</td>
<td>390 650 375 375</td>
<td>460 560 1760 1210</td>
</tr>
<tr>
<td>6 D480 90°–60°</td>
<td>480 ±20 ±60</td>
<td>630 588 286 285</td>
<td>410 745 385 400</td>
<td>570 680 2060 1340</td>
</tr>
<tr>
<td>7 D560 90°–50°</td>
<td>560 ±20 ±70</td>
<td>750 682 306 285</td>
<td>430 800 395 450</td>
<td>680 800 2280 1470</td>
</tr>
<tr>
<td>8 D640 90°–60°</td>
<td>640 ±20 ±80</td>
<td>870 749 306 285</td>
<td>450 890 405 500</td>
<td>790 920 2570 1600</td>
</tr>
</tbody>
</table>

n... number of sealing elements
\( u_m \)... moving direction at superstructure
\( u_{mx} \)... movement rectangular to the joint axis
\( u_{my} \)... movement in joint direction \( (\leq \pm n \cdot 40 \text{ mm}) \)
\( u_{mz} \)... vertical adjustment of the edge beams in direction z
\( u_{mq} \)... crosswise movement rectangular to \( u \)
\( \alpha \)... angle between joint axis y and moving direction

- all dimensions are rectangular to the joint axis y
- \( a, f \) and \( l \) apply to an adjustment dimension \( e = 30 \text{ mm} \) for every joint gap and must be adjusted by \( n \times \Delta e \) in case of deviating dimension
- recesses for footway joists and pipe passages must be considered individually
- smaller gap dimensions by specific structural design
- the gap recess \( t \) can be reduced by installing the joint at one edge asymmetrically to the joint

<table>
<thead>
<tr>
<th>type</th>
<th>weight (kg/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D 160</td>
<td>200</td>
</tr>
<tr>
<td>D 240</td>
<td>290</td>
</tr>
<tr>
<td>D 320</td>
<td>400</td>
</tr>
<tr>
<td>D 400</td>
<td>530</td>
</tr>
<tr>
<td>D 480</td>
<td>680</td>
</tr>
<tr>
<td>D 560</td>
<td>830</td>
</tr>
<tr>
<td>D 640</td>
<td>1040</td>
</tr>
</tbody>
</table>
Resilient Control

MAURER Girder Grid Joints adapt continually to deformations in the structure. The control springs provided between the support bars ensure a uniform distribution of the total movement to the individual joint gaps. Steel stops are provided at the support bars to prevent an opening of the individual gap of more than 80 mm.

The springs comprise mainly of closed-cell polyurethane, a material which has a proven record of success for spring elements exposed to dynamic and impact stresses. The high permissible deformation (up to 80% compression deformation relative to the original free length) permits the production of elements with high permissible spring deflection for a compact design. The natural damping effect of the material affords vibration and impact damping of dynamically stressed components. The special arrangement of the stops for securing the control springs to the support bars has the effect that the wider the opening of the joint the more the springs are compressed. The springs are compressed in any opening condition of the joint, the precompression being at a minimum when the joint is closed. Advantages of this control system are as follows:

- adaptability to production tolerances
- high reliability
- durability
- insensitive to movement constraints
- noise damping
- single gap increase possible during repair

The reaction forces resulting from the elastic deformations of the strip seals and the control springs are independent of how many of these parts are involved because they function as a series arrangement of springs.

Resilient and Prestressed Support

The support bars of the MAURER Girder Grid Joint are supported by resilient bearing elements i.e. precompressed spring and sliding bearings, located above and below the support bars respectively in the support boxes. This arrangement provides a resilient and sliding support in the direction of the structure movement. Precompression of the sliding springs prevents the supports from lifting off the bearings and also compensates for manufacturing tolerances. The support resilience also serves to eliminate edge pressure in the sliding surfaces.

To compensate for unavoidable differences in height between the edges of the structure, the sliding bearings have been designed to accommodate the resultant inclination of the support bars and to reduce the torsional stiffness.

The Control Principle

Control of MAURER Girder Grid Joints
Watertight Connection

To protect the adjacent structural parts from the penetration of dirt and aggressive surface water MAURER Girder Grid Joints feature watertight strip seals to close the gap between the individual steel beams watertight. The MAURER strip seal has become most popular in modular seals systems.

The strip seal is made of EPDM rubber with a bulbous-shaped edge. This is installed in a claw in the edge beam and centre beams without the need for additional clamping bars. The connection is watertight and secure, with the peeling element set below the road surface level. It is protected against direct wheel or snowplough contact.

Sealing elements can be replaced even when the individual gaps are $\geq 25$ mm. The gap width can be enlarged by moving the centre beams. This operation is carried out using special hydraulic equipment. The bulbous edge section of the sealing element locks it in the steel claw and is capable of withstanding wheel pressure on any impurities (e.g. stones, grit, snow etc.).

The sealing element adapts to different kinds of joint design and bridge cross sections.

For the protection of the structural concrete and the substructures the interface of the edge beams to the waterproofing layer(s) of the bridge must also be watertight. For this purpose the edge beams of MAURER Girder Grid Joints feature an 80 mm wide horizontal steel flange.

Installation

Installation is usually realized by our special fitters and according to the valid work instructions.

High Functional Reliability

Within their anticipated lifetime no malfunction of MAURER expansion joints is expected, but despite this, all synthetic components can be replaced with minimum effort. Touching up the corrosion protection system is required during maintenance as is normal for steel structures.

Low Noise Emission

Carriageway expansion joints also add to this noise, the causes of which have been investigated in extensive research by Maurer Söhne to enable MAURER Girder Grid Joints to be optimized in this respect.

With its preformed articulated section it is possible to move the strip seal in direction $x$ without any appreciable build-up in reaction forces. Movement in direction $z$ causes deformation of the sealing element.

Residents in the vicinity of such expansion joints find the sudden change in the noise pattern particularly disturbing, the criteria for which is not so much the noise level as measured but the magnitude of the fleeting change in frequency and the pulsed element of the noise pattern, whereby a basic distinction is made between noise emitted upwards from the carriageway and the noise projected downwards through the gap between the two structural components.

All supporting elements of MAURER Girder Grid Joints which are exposed to traffic loads are supported by high-quality resilient synthetics which distinguish such designs from those having rigid support. The structural gap can be dammed downwards. Maurer Söhne offers tailored solutions for each and every application.

Noise control to the top is effected by optimizing the road surfacing connection and supporting the wheel when crossing the joint. Angular joint design, finger-type bridging and joint sealing afford relief.
Detail Features

- Watertight design of parapet
- Horizontal bend and kerb units
- Connection of a modular joint to a single seal joint
- Intersection with rail of tram

Special kerb unit