

# Minimising noise from expansion joints

Presented by Adel Yousfi, mageba SA

07.02.2024



**mageba**  
engineering connections®

## Overview

### 1. Introduction

### 2. Mechanical noise reduced expansion joints

- Latest developments in noise reduced expansion joints
- Evaluating the effectiveness of noise reducing measures
- Evaluation of enclosing the space beneath an expansion joint
- Case Study – Queensferry Crossing

### 3. Flexible plug low-noise expansion joints

### 4. Conclusion

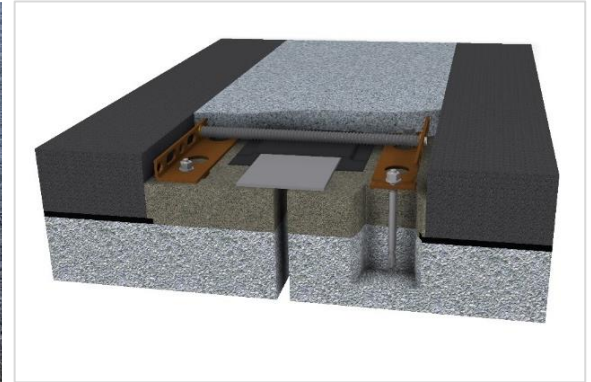
# Common types of expansion joint



Noising joints



Mat joints



Plug joints



Modular joints



Cantilever finger joints

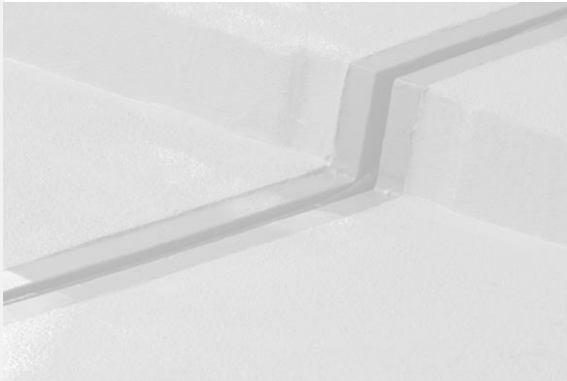


Sliding finger joints

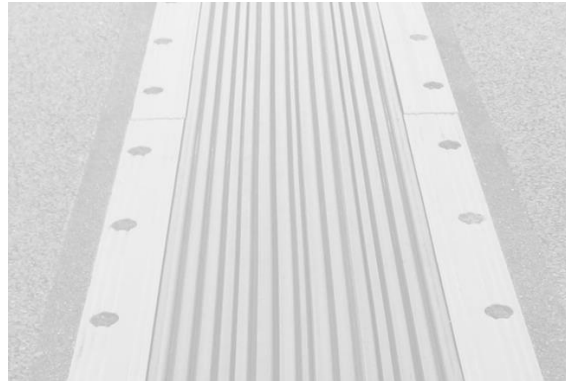
Some types of expansion joints emit more noise than others



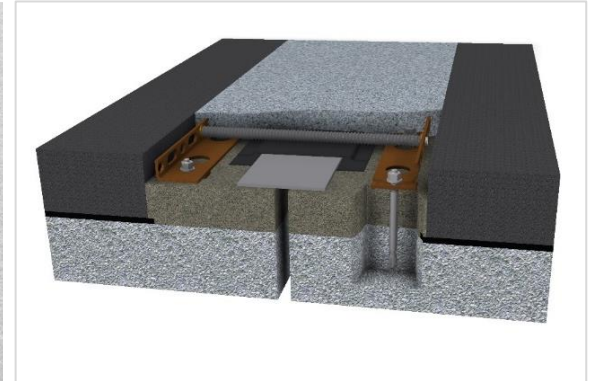
# Common types of expansion joint



Noising joints



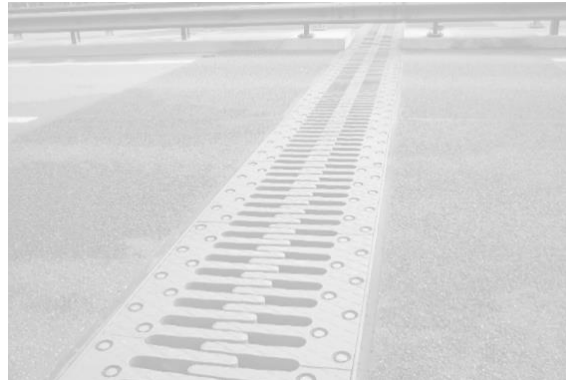
Mat joints



Plug joints



Modular joints



Cantilever finger joints



Sliding finger joints

Some types of expansion joints emit more noise than others

## Noise emissions – Modular Joints

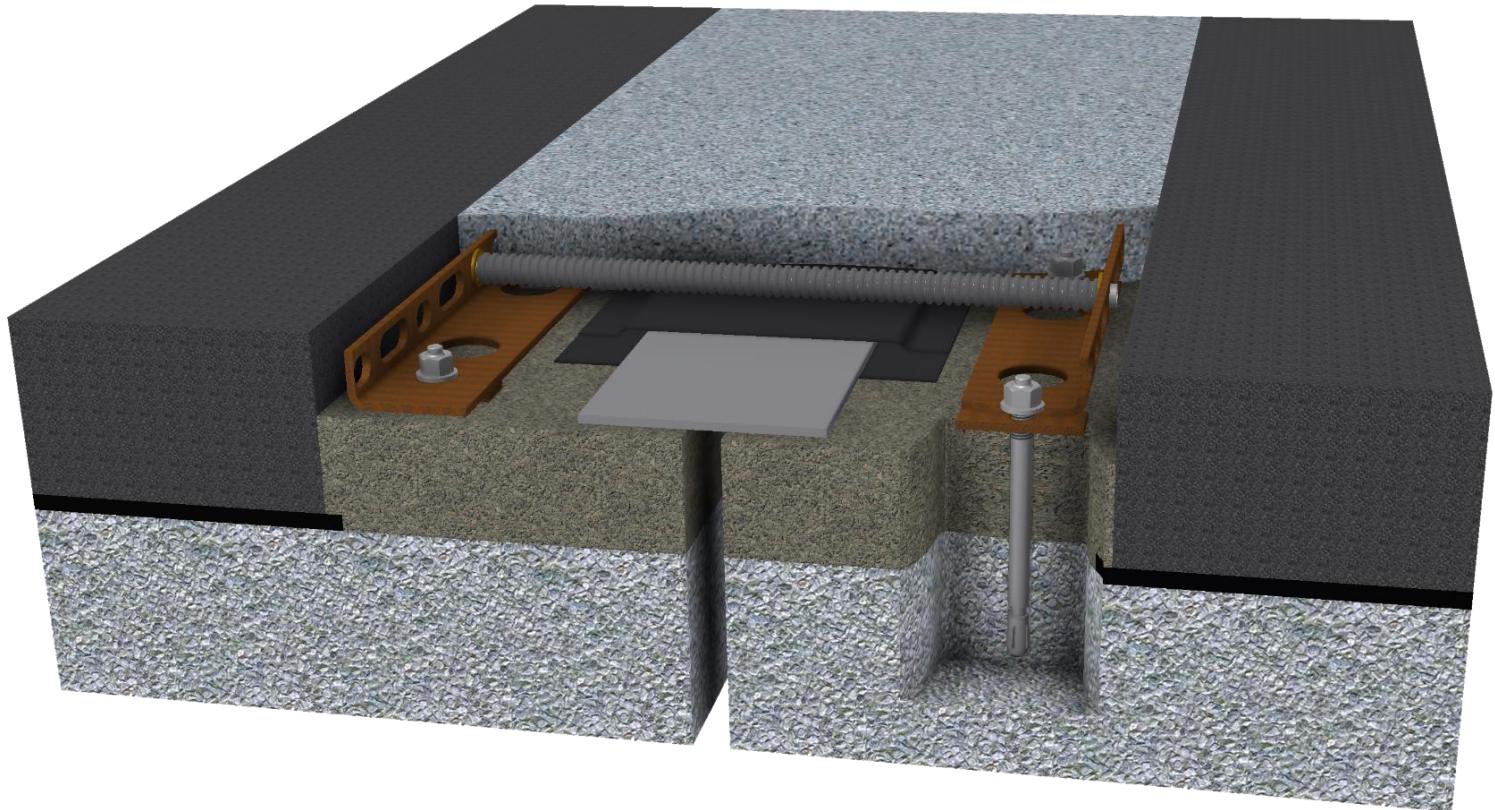


### Noise effects at modular and strip seal joints

- **“Random noise”**: General road surface noise
- **“Hitting noise”**: Tire hitting the steel elements
- **“Plop noise”**: Tire penetrating the gap and pops out air
- **“Bell noise”**: Impact to the joint hitting not damped components
- **“Drum noise”**: Impact transmitted to the bridge and abutment activating structure-borne sound
- **“Echo noise”**: The bridge and abutment acting as resonating box (amplifying low frequencies)

Due to discontinuous surface – noise reduction measures can have great effect

## Small movement joints – flexible plug innovation



**TENSA® POLYFLEX® ADVANCED PU expansion joint able to accommodate movements of up to 135mm**



## Small movement joints – traditional products



The TENSA® POLYFLEX® ADVANCED PU based expansion joint system offers a variety of benefits compared to:

Conventional strip seal joints:

- High noise
- Low traffic comfort
- High maintenance needs

Asphaltic plug joints:

- Short lifespan (2-5 years)
- Highly temperature dependent
- Limited movement range

Mat type joints:

- Short lifespan (2-5 years)
- Low traffic comfort
- Not watertight (damaging for the bridge)

## Overview

### 1. Introduction

### 2. **Mechanical noise reduced expansion joints**

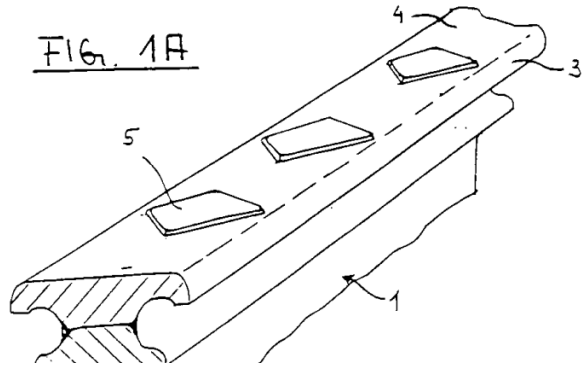
- **Latest developments in noise reduced expansion joints**
- Evaluating the effectiveness of noise reducing measures
- Evaluation of enclosing the space beneath an expansion joint
- Case Study – Queensferry Crossing

### 3. Flexible plug low-noise expansion joints

### 4. Conclusion



## Noise-reduction elements - discontinuous surface joints



First attempts to address noise effects of modular / nosing joints developed 30 years ago.

Patent DE 40 32 958 applied in 1992

**Geräuschminderung durch Sinusplatten der  
Fahrbahnübergänge LR2-LS70 bis LR15-LS70**  
für eine Spaltbreite von 5 bis 70 mm

**Regelprüfung nach TL/TP-FÜ 92**

gemäß Anforderungen des:  
Bundesministeriums für Verkehr,  
Bau- und Wohnungswesen  
Abteilung Strassenbau / Referat S 25  
Robert-Schuman-Platz 1  
D-53175 Bonn - Bad Godesberg

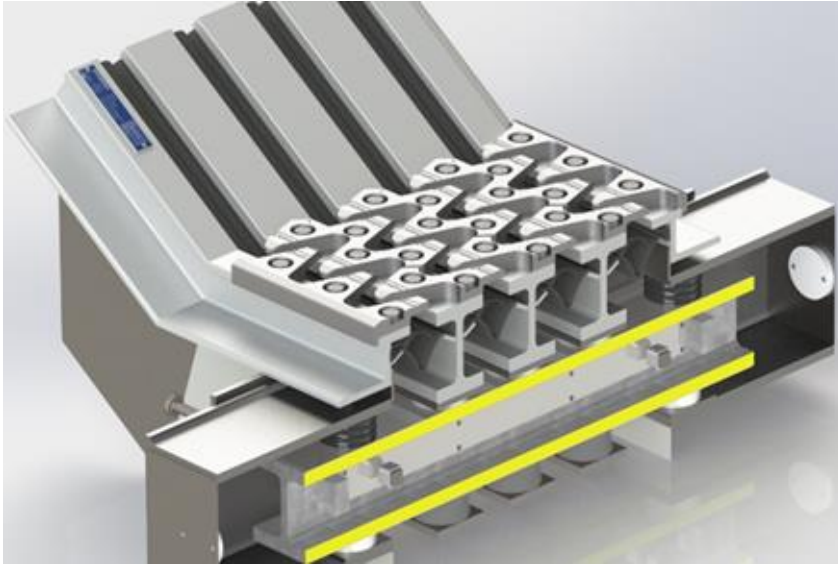


The German Federal Ministry of transportation introduced use of such noise reducing plates in 2002, and by 2009 actively encouraged the application of noise reducing elements.

German general approval still based on TL/TP FÜ 1992

**Noise reducing elements are well-proven state of the art**

## Noise reduction elements at surface level



Modular joint with sinusoidal “sinus” plates

- Sinusoidal “sinus” plates provide a continuous support to vehicle wheels
- It also ensures a smooth and safe ride for bicycles over the expansion joint
- Sinus plates can be designed to accommodate small transversal movements, or joints installed in a skewed angle

# Assessment according to latest specifications



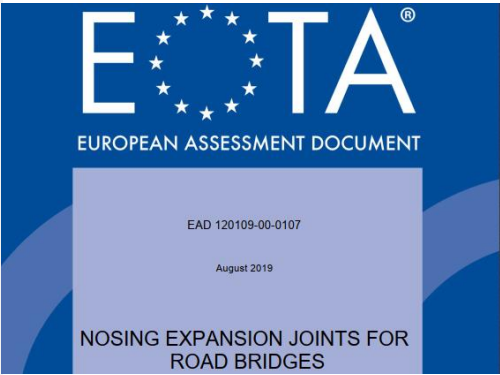
<b>European Technical Assessment</b>		<b>ETA-22/0218</b> of 04.05.2022
General part		
Technical Assessment Body issuing the European Technical Assessment	Austrian Institute of Construction Engineering (OIB)	
Trade name of the construction product	mageba TENSA@GRIP Type RS-LS	
Product family to which the construction product belongs	Nosing expansion joint for road bridges	
Manufacturer	Mageba Services & Technology AG Sollstrasse 68 8180 Bülach Switzerland	



First ETA considering noise reducing elements granted based on an European Assessment Document (EAD) superseding ETAG 032

First with noise reduction elements acc. EAD

mageba sinus plates



Latest European specification

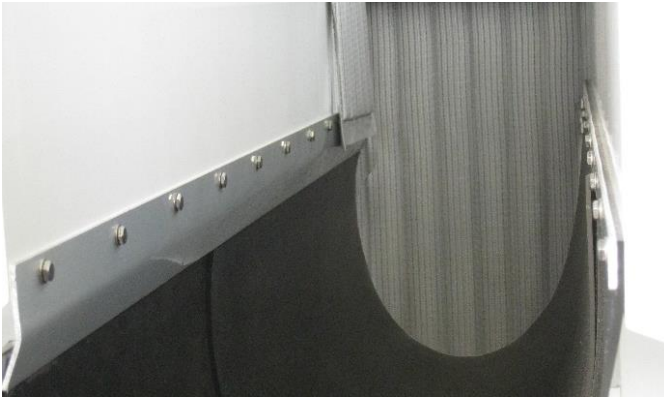


Dynamic assessment

First dynamic assessment of noise reducing elements in full compliance with EAD including stainless steel designs.

**A new era in the assessment of expansion joints has started**

## Noise barriers - discontinuous surface joints



Inside of noise barrier underneath the joint closed



Lower side of noise barrier underneath the joint open

- **Further limit noise possible** by tackling noise emanating from the underside of the joint
- Addressed by enclosing the space **beneath an expansion joint** using flexible, noise-absorbing elements
- **ROBO<sup>®</sup>MUTE** system applied to the underside of the expansion joints proven very effective through testing.

**Noise barriers offer a simple enhancement of installed expansion joints**



## Overview

### 1. Introduction

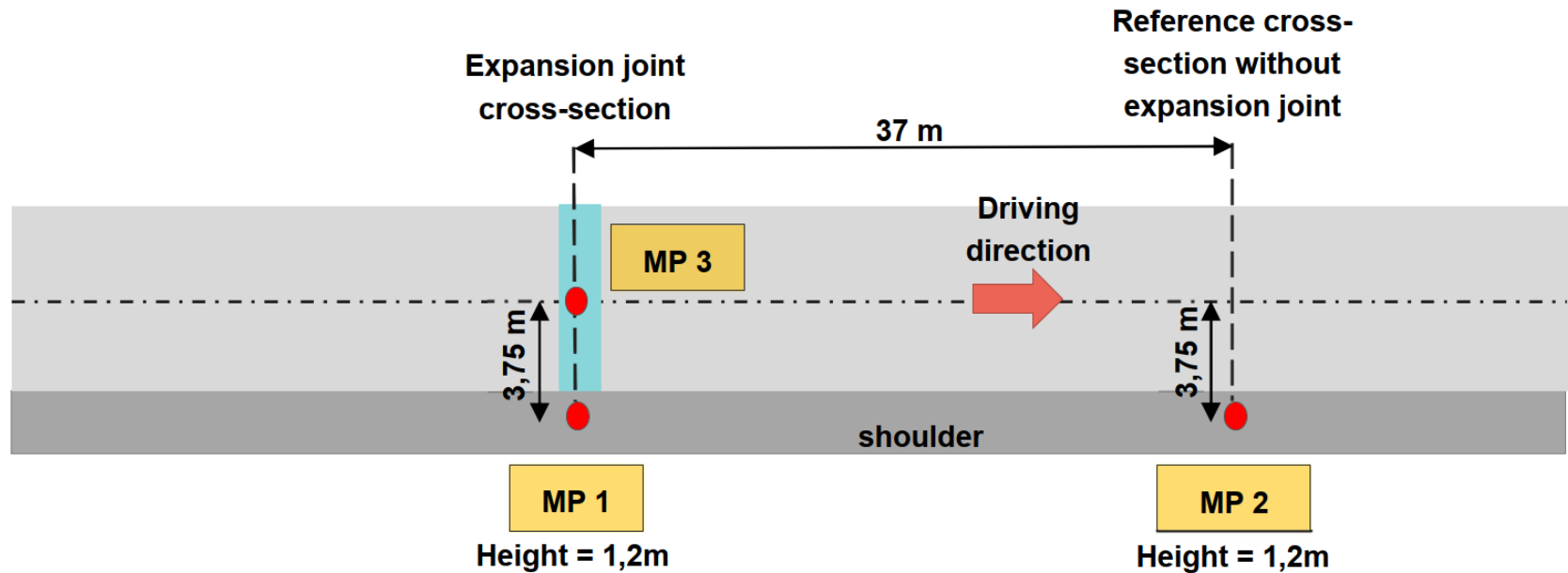
### 2. **Mechanical noise reduced expansion joints**

- Latest developments in noise reduced expansion joints
- **Evaluating the effectiveness of noise reducing measures**
- Evaluation of enclosing the space beneath an expansion joint
- Case Study – Queensferry Crossing

### 3. Flexible plug low-noise expansion joints

### 4. Conclusion

## Test setup according Austrian Code, ÖNorm B 4031



Measurement setup according Önorm B 4031

- ÖNorm B 4031 is the only available code for guidance on qualifying low noise joints
- Reference method only way to evaluate effective noise impact by joints
- Much better reproducibility by cars compared to trucks
- Considers speeds of 60, 90 and 130 km/h
- Preferred at constant condition in specific test site

**ÖNorm B 4031 recommended as reference for noise evaluation**

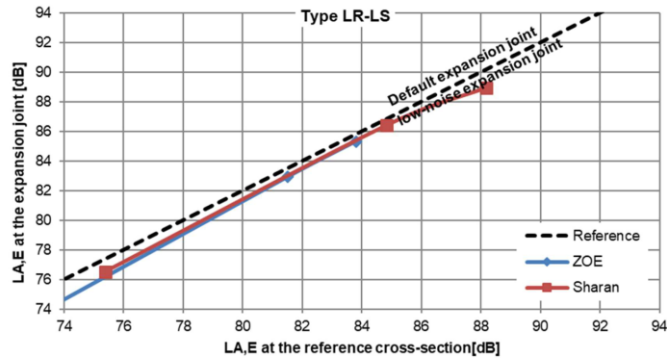
# Results from evaluation per Austrian Code, ÖNorm B 4031



Specially constructed test specimen for noise testing of modular joint

## Results for modular expansion joints (Type LR-LS)

- Sinus plates proven to limit the noise emission increase at the expansion joint to around 1 dB compared to the regular road surface.
- This comfortably fulfils the limit of 2 dB for “low noise expansion joints”.



## Overview

### 1. Introduction

### 2. **Mechanical noise reduced expansion joints**

- Latest developments in noise reduced expansion joints
- Evaluating the effectiveness of noise reducing measures
- **Evaluation of enclosing the space beneath an expansion joint**
- Case Study – Queensferry Crossing

### 3. Flexible plug low-noise expansion joints

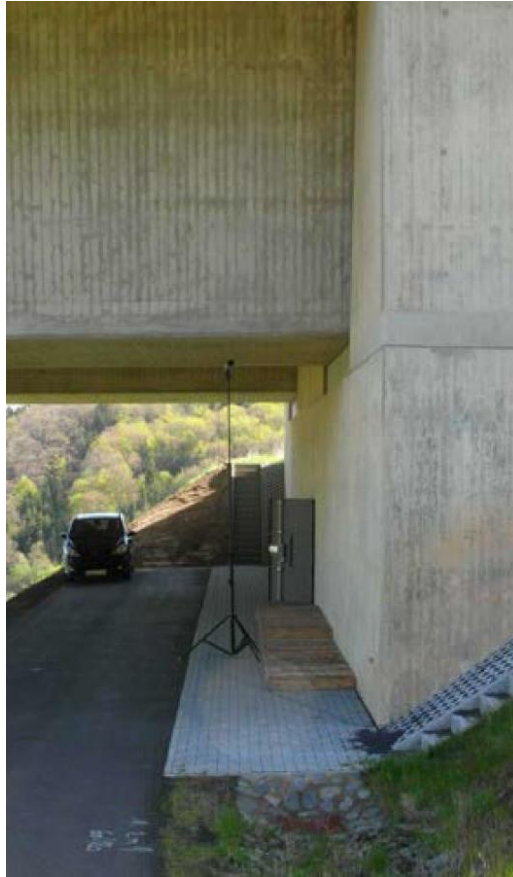
### 4. Conclusion



## Test setup for noise from underneath the expansion joint



Noise measurement below the expansion joint



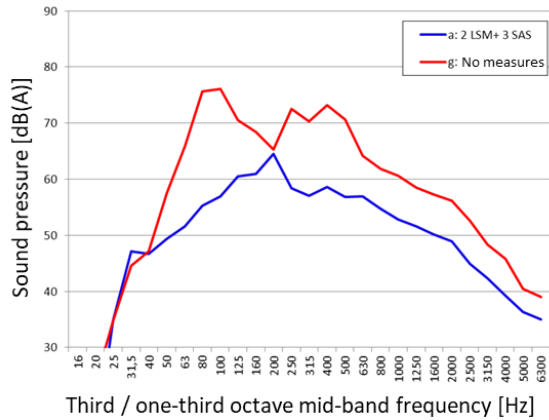
Noise measurement in front of the abutment

Direct effect of system identified through measurement directly below the expansion joint.

Effectiveness for the structure requires measurement outside the abutment.

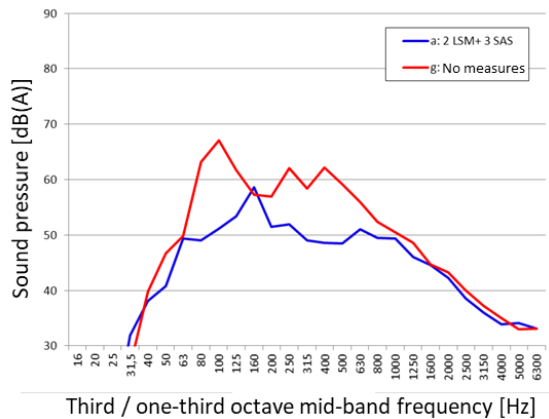
**Effectiveness depends much on the specific structure and conditions**

## Evaluation for truck at high speed



Peak reduction directly underneath the expansion joint ROBO®MUTE 85.1 dB(A) to 71.8 dB(A).

Noise from truck at 90 km/h below expansion joint



Peak reduction in front of the abutment - ROBO®MUTE cut the peak of 72.5 dB(A) to 65.9 dB(A).

Overall sound lower than the reference noise of the road surface in 30m proximity to the expansion joint.

Noise from truck at 90 km/h in front of the abutment

**Highest noise from trucks well reduced by ROBO®MUTE system**

## Overview

### 1. Introduction

### 2. **Mechanical noise reduced expansion joints**

- Latest developments in noise reduced expansion joints
- Evaluating the effectiveness of noise reducing measures
- Evaluation of enclosing the space beneath an expansion joint
- **Case Study – Queensferry Crossing**

### 3. Flexible plug low-noise expansion joints

### 4. Conclusion

## Queensferry Bridge, UK



mageba

**Queensferry Crossing, Scotland**

2.7 km long | two 650 m spans | crosses the Firth of Forth

- **Scope: 2 modular joints equipped with noise reduction systems**
- **Movement capacity up to 2,300 mm**

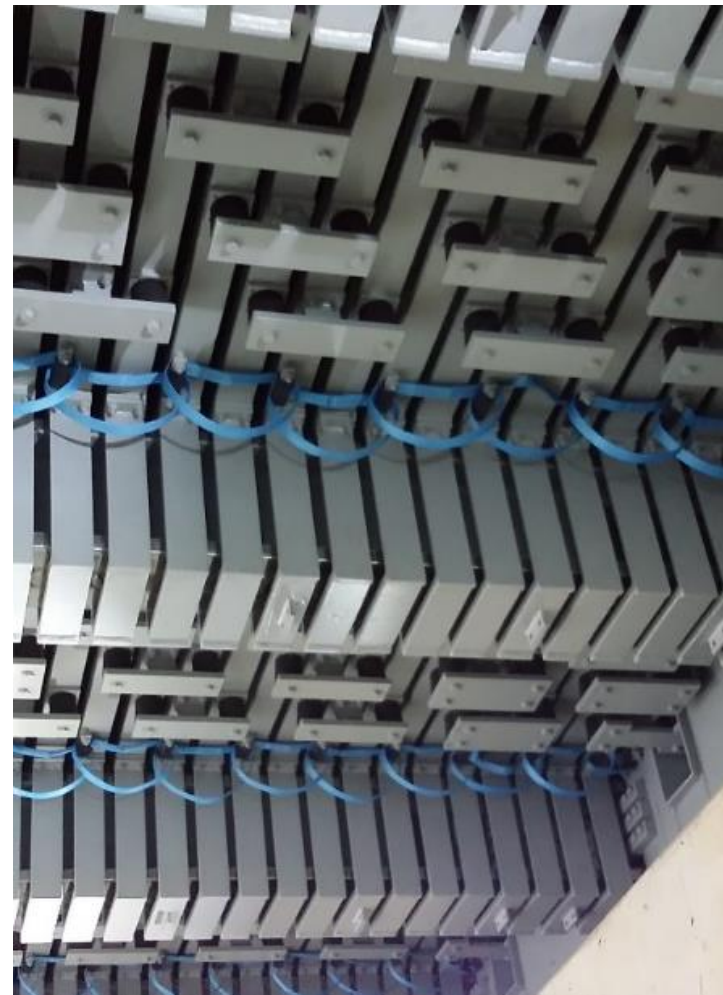


## Queensferry Bridge, UK – Overview



**One of largest expansion joints ever installed with 23 gaps (55 tons)**

## Queensferry Bridge, UK – Overview



**Underside of joint – with and without ROBO® MUTE system**



## Overview

1. Introduction
2. Mechanical noise reduced expansion joints
  - Latest developments in noise reduced expansion joints
  - Evaluating the effectiveness of noise reducing measures
  - Evaluation of enclosing the space beneath an expansion joint
  - Case Study – Queensferry Crossing
- 3. Flexible plug low-noise expansion joints**
4. Conclusion

## TENSA POLYFLEX® Advanced PU - flexible plug expansion joint



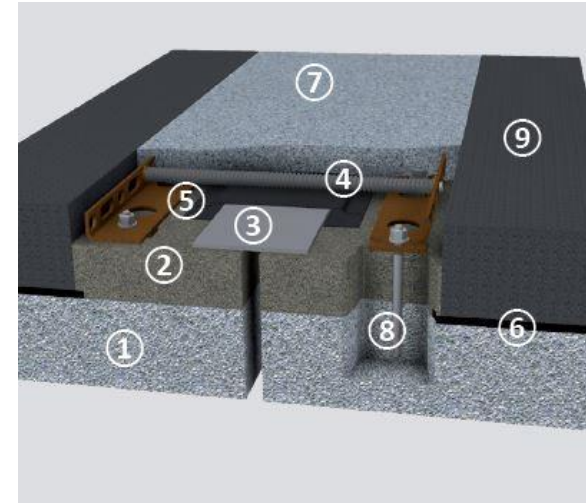
**Continuous road surface – durable, low-noise solution**



## TENSA POLYFLEX® Advanced PU – technical design

### technical design and amendments:

- 14 types
- movement capacity of 15 to 135 mm
- joint thickness 60 und 70 mm
- cover plate embedded in PU (due to noise emission)
- EPDM foil
- pin + gap limitation for bottom cover plate
- rubber granulate in PU compound – better skid resistance

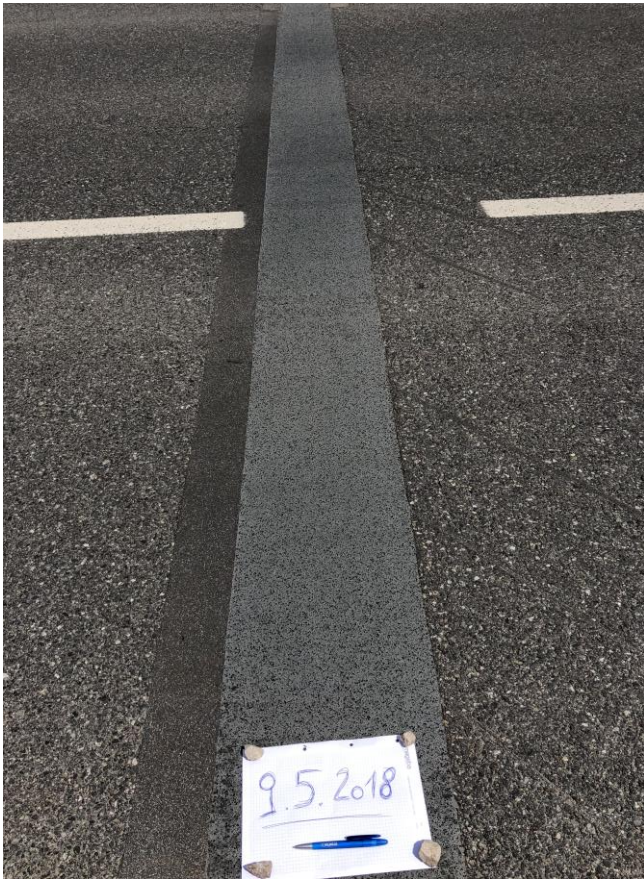


- 1 Abutment
- 2 Polymer concrete bedding/substructure
- 3 Cover plate
- 4 Perforated steel angle
- 5 EPDM sliding sheet
- 6 Bridge sealing
- 7 POLYFLEX® ADVANCED PU-flexible material
- 8 Anchoring
- 9 Surfacing made of asphalt or concrete

# TENSA POLYFLEX® Advanced PU – performance in service



Austria – main road Obj. B25.06, PA 30,  
installation 2010

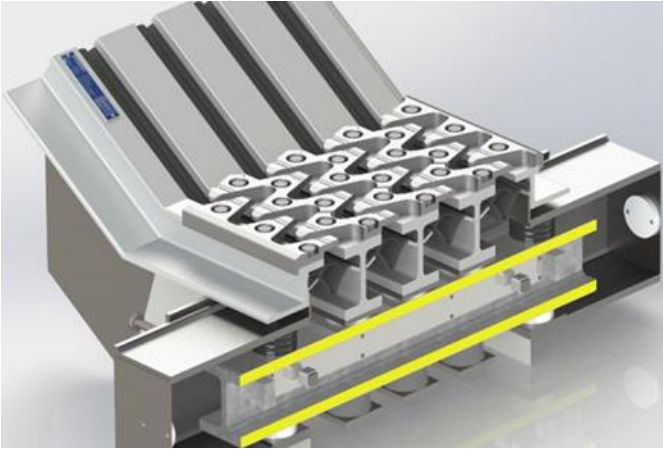


Austria – main road Bridge 25, PA 40,  
installation 2012

## Overview

1. Introduction
2. Mechanical noise reduced expansion joints
  - Latest developments in noise reduced expansion joints
  - Evaluating the effectiveness of noise reducing measures
  - Evaluation of enclosing the space beneath an expansion joint
  - Case Study – Queensferry Crossing
3. Flexible plug low-noise expansion joints
4. **Conclusion**

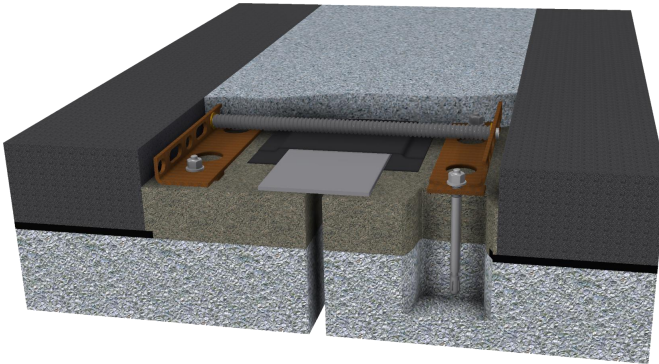
## Conclusion - Mechanical noise reduced expansion joints



- Strip seal joints and modular joints can especially **benefit** from additional noise reducing measures
- Noise reducing sinus plates as well as noise barriers are **well proven**.
- Sinus plate solution carries National Highways approval.
- ETA and EAD establish the **latest and highest levels of noise evaluations**
- Effectiveness of noise reduction mats depend much on the **specific structure** and its conditions.



## Conclusion - Flexible plug low-noise expansion joints



- Continuous surface joints offer the lowest noise solutions, but durability is key.
- POLYFLEX® developed as a higher quality, modern alternative to single seal, asphaltic plug and mat joints.
- Flexible PU material exhibits elastic deformation behaviour.
- 15 years Design Life according to ETA approval.





**mageba**  
engineering connections®

**Thank you for your attention!**