Next Generation Flexible Expansion Joint

POLYFLEX®Advanced PU

from certification to installation

Australia, November 2017 Pascal Savioz

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Asphaltic plug joints


Mat joints


Aluminium strip seal joint


Bolted finger joints

Pictures we often see on small movement joints after a few years

Expansion joints, whether on big or small bridges, have the reputation of being some of the most problematic parts of the bridges. This is mainly due to the dynamic impact loading, as well as the fact that expansion joints are at the road surface. Any maintenance, refurbishment or replacement work automatically results in lane closures and thus, traffic jams.

Problems that are encountered most often:

- Fatigue damage of non-fatigue proofed materials
- Insufficient anchoring
- Excessive wear and tear (e.g. of rubber and aluminium materials)
- Substantial water ingress, leakage
- Plastic deformation at high temperatures, cracking at low temperatures
- Safety concerns when steel parts protrude through the damaged joints into the carriageway
- High noise generation and low driving comfort

Even small movement expansion joints need highest attention during selection, design, fabrication, installation and maintenance

POLYFLEX® Advanced PU flexible plug joint system
Introduction

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Challenge to develop a new expansion joint system that reduces all of the mentioned problems, for:

- Long maintenance-free working life
- No spontaneous / catastrophic failure mechanism
- Maintaining full water-tightness
- Favorable behavior at very low and very high temperatures
- Relatively versatile movement range (e.g. up to 135 mm)
- Maximized driving comfort and low noise generation
- Minimized installation effort, time and errors

POLYFLEX® Advanced PU flexible plug joint system
Description of system

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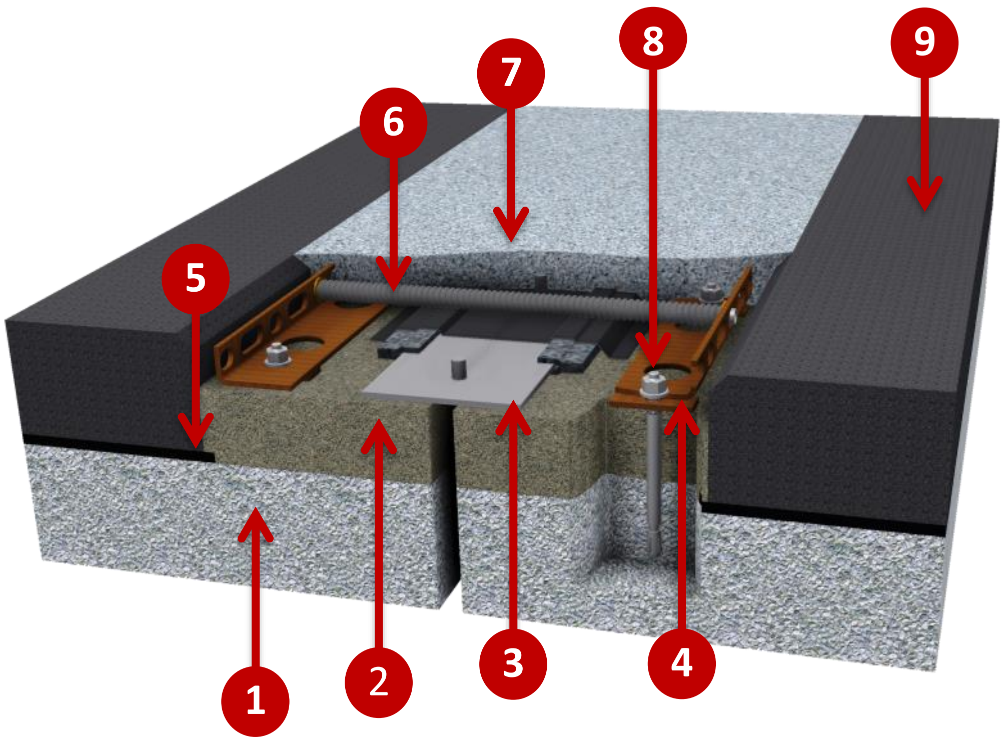

1) Structure (abutment/bridge)
2) Substructure in polymeric concrete
3) Cover plate
4) Steel angle
5) Bridge water proofing
6) Stabilizing element (only > PA50)
7) **POLYFLEX® material with high performance PU**
8) Anchorage (only secondary to keep angle in place)
9) Surfacing - Asphalt or concrete

Overview of the various components of the polyurethane based system

POLYFLEX® Advanced PU flexible plug joint system
A new polyurethane based plug joint

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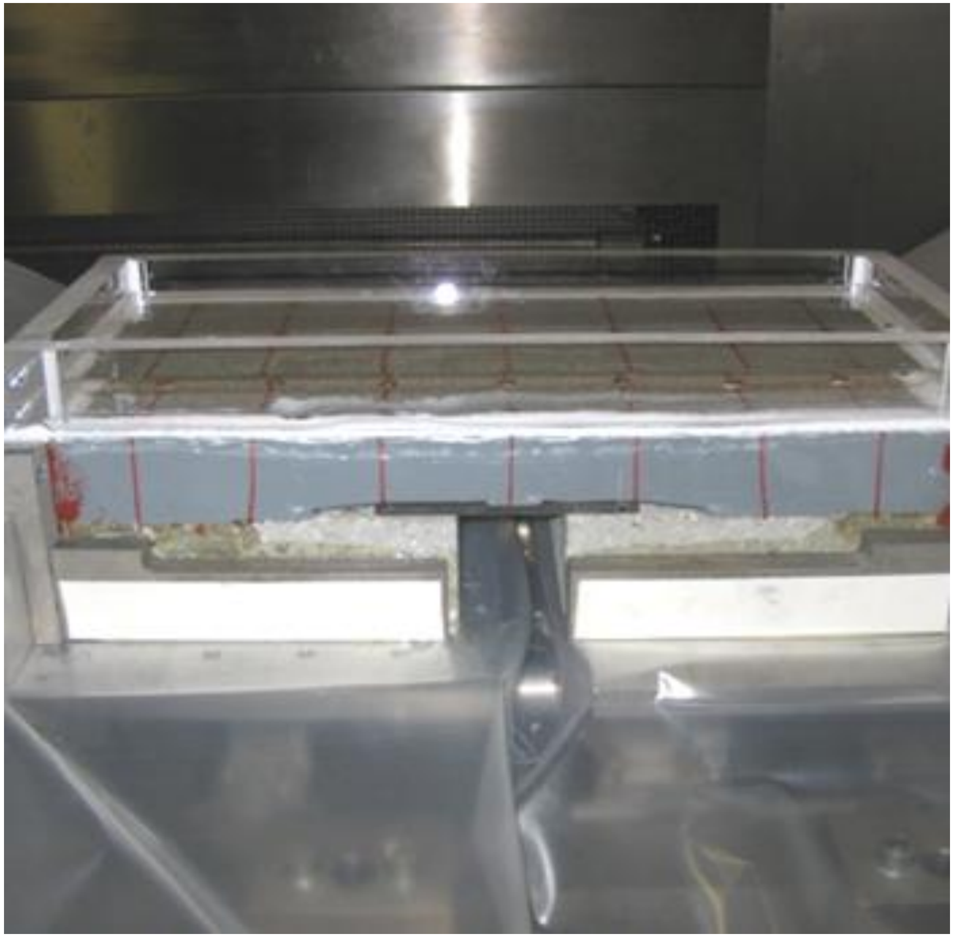

How can we overcome the problems of a classical bituminous plug joint such as:

1. **Lack of water tigthness**
2. Low durability (often << 10 years!)
3. Bump in summer, slack in winter
4. Plastic deformation at high temperatures and at locations of higher horizontal loads (braking and acceleration forces)
5. Rutting effects

-> 100% water tightness proven by Water tightness test at BAM Berlin

Not only the PU material needs to be watertight, but the <u>whole system</u>

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A new polyurethane based plug joint

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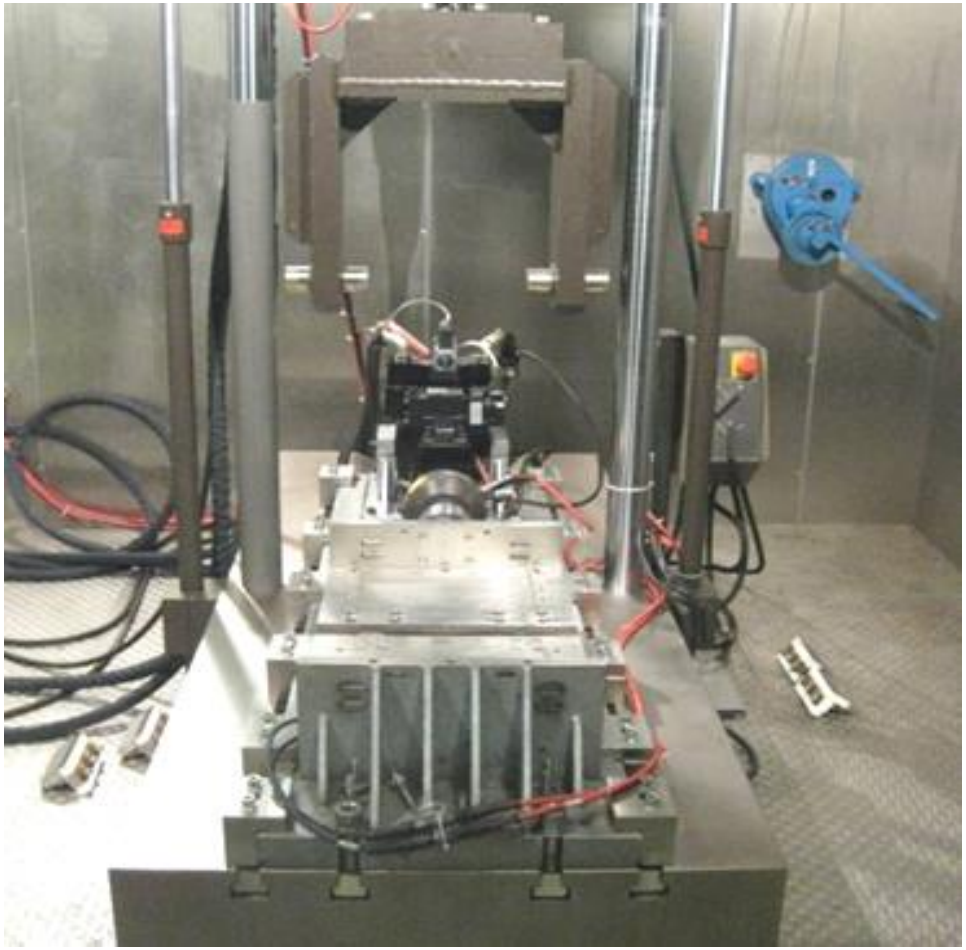

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- **Full size 1:1 testing** for movements at temperature ranges from **-40°C to +60°C**
- **> 7.500.000 cycles** with 1 mm amplitude at 5Hz

Fatigue testing at BAM Berlin confimed extended service life

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A new polyurethane based plug joint

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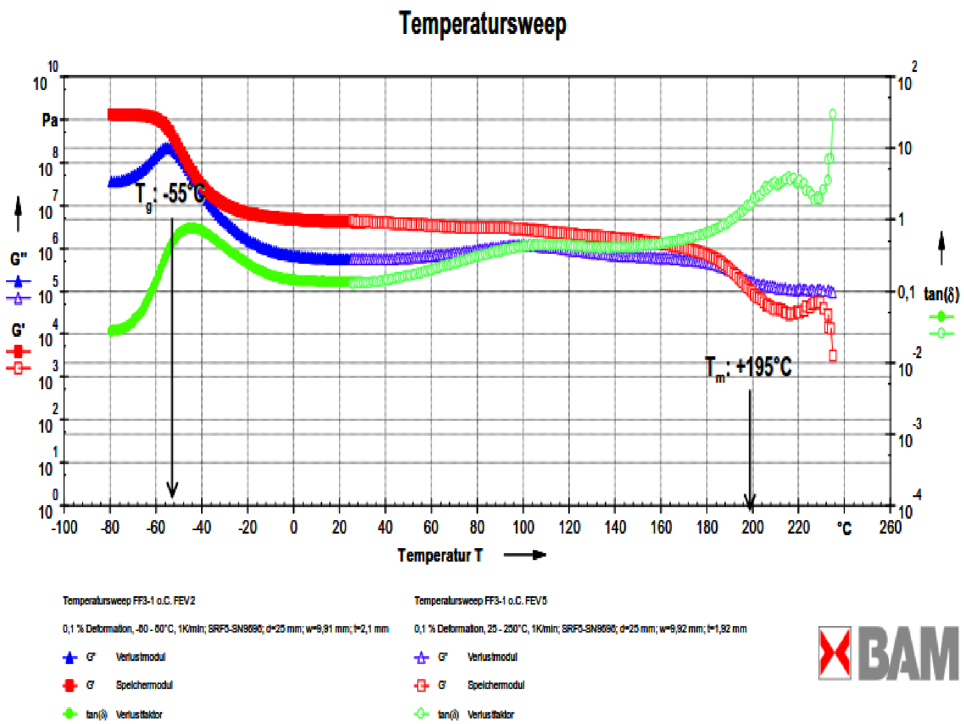

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- **Material remains stable** from low up to very high temperatures
- **Stabilizers for larger types** keep the PU at level

Temperature dependent dynamic-mechanical behavior of Polyflex tested at German Federal Institute BAM, Berlin

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A new polyurethane based plug joint

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- **Full size 1:1 testing** with 150 kN load for 3.030 Cycles at 45°C

-> Deformation < 0,5 mm; no damages

-> Complete elastic recovery

Overroll test at Technical University of Munich

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A new polyurethane based plug joint

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5. **Rutting** effects

-> Resistance to rutting is far superior

Further long-term testing to prove durability

POLYFLEX® Advanced PU flexible plug joint system
Rutting test performed at MAPAG Testing Institute, Austria

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- Comparison with traditional asphaltic plug joint
- Testing performed according to EN 12697, Part 22

Asphaltic plug joint after 100 cycles at 60°C (140°F) Extreme rutting, deformations up to 3 cm (1.2'')

New Polyflex® joint after 30,000 cycles at 60°C (140°F). No rutting, no deformation.

Resistance to rutting is far superior over traditional asphaltic plug joints

POLYFLEX® Advanced PU flexible plug joint system
European Technical Approval ETA

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OiB
Member of EOTA

European technical approval **ETA-12/0260**

(English translation, the original version is in German)

Handelsbezeichnung *Trade name*	**POLYFLEX® Advanced PU**
Zulassungsinhaber *Holder of approval*	**Reisner & Wolff Engineering GmbH Terminalstraße 25 4600 Wels Austria**
Zulassungsgegenstand und Verwendungszweck	**Elastische Belagsdehnfuge für einen nominellen Dehnweg von 15 mm – 135 mm**
Generic type and use of construction product	*Flexible plug expansion joint for nominal movement capacity of 15 mm – 135 mm*
Geltungsdauer vom *Validity from* bis zum *to*	**26.07.2012** **25.07.2017**
Herstellwerk *Manufacturing plant*	**Auflistung der Herstellwerke festgelegt in der technischen Dokumentation** *Comprehensive list of manufacturing plants laid down in technical documentation*
Diese Europäische technische Zulassung umfasst	**26 Seiten einschließlich 3 Anhänge**

CUAP process was followed:

Due to the **lack of specific EU regulations**, an **extensive approval process** was required in order to **obtain a European Technical Approval (ETA)** and to permit the application of the CE-label to the product.

This process, called CUAP, was completed in June 2012 – the **first ETA** awarded for an expansion joint.

CUAP = process that assures that all European CEN members approve the technical performance according to specific requirements

Types of Polyflex® joint according to the *European Technical Approval*

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Type	Total Movement mm	Movement Elongation mm	Movement Compression mm	Thickness of PU-layer mm	Width in starting position mm
PA 15	15	10	5	40	280
PA 30	30	20	10	50	350
PA 50	50	33	17	60	459
PA 60	60	40	20	60	500
PA 75	75	50	25	60	600
PA 90	90	60	30	60	750
PA 135	135	90	45	60	1100

- **Table shows examples for general design, width may be interpolated**
- **For individual cases, width and thickness are determined based on required movement**
- **All types are designed for a vertical displacement of ± 10 mm, allowing for bearing replacements**
- **Movements are indicated in SLS, for ULS higher deformations are permitted**

To obtain the Japanese approval testing at the national laboratories NEXCO – Fuji, Japan, had to be done

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A whole series of testing was undergone, especially fast movements due to seismic events were of interest -> all testing successful

Every region has specific requirements, e.g. Nordic countries have issue with spikes used in the winter.
Testing at the state laboratory VTI at Linköping, Sweden in June 2015 was performed to simulate this new requirement: **no abrasion on the joint was found at all** (elastic performance, memory effect)

vti

VTInr:15-067 e rev

SWEDAC ACKREDITERING 1132 ISO/IEC 17025

PROVNINGSRAPPORT
utfärdad av ackrediterat provningslaboratorium
TEST REPORT issued by an Accredited Testing Laboratory

Page 1 (3)

Resistance against spikes and the elastic performance of the material

Compliance with Australian Regulations

Inclusion in Australian bridge code:

Flexible plug joints are now explicitly included in the AS5100.4-2017:

19.2 Joint types

Joints shall be categorized as follows:

(a) Compression seals.

(b) Strip seals.

(c) Saw tooth.

(d) Finger plates.

(e) Flexible plug.

(f) Modular.

(g) Other.

The characteristics and performance history of a particular joint shall be reviewed to determine the suitability of the joint for a specific installation.

Compliance with Australian Regulations

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Temperature:

Verifications for the European Technical Approval for -40°C thru +60°C full compliance is given to AS5100.2-2017, Table 18.2

TABLE 18.2(A)

EXTREMES OF SHADE AIR TEMPERATURES

Location	Height above sea level m	Shade air temperature °C Region I North of 22.5°S Max.	Min.	Region II South of 22.5°S Max.	Min.	Region III Tasmania Max.	Min.
Inland	≤1000	46	0	45	−5	37	−5
	>1000	36	−5	36	−10	32	−10
Coastal	≤1000	44	4	44	−1	35	−1
	>1000	34	−1	34	−6	30	−6

NOTE: Coastal locations are locations that are less than 20 km from the coast.

TABLE 18.2(B)

AVERAGE BRIDGE TEMPERATURES

Shade air temp °C	Average bridge temp °C
Min.	
−8	2
−2	4
4	8
10	12
Max.	
50	54
46	50
42	46
38	43
34	40
30	37

NOTE: Linear interpolation of intermediate values is permitted.

Contact Stress:

Verifications as per above comply fully with AustRoads Guide to Pavement Technology, Part 2 and Main Roads WA Engineering Note 9

Structural Components:

After review for ULS and SLS requirements acc. to AS5100.4 cover plate dimensions and steel grade were adapted to the Australian requirements for full compliance

Installation in an existing structure
Cutting of road surfacing

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Installation
Removal of surfacing

Installation
Cleaning, sandblasting, primer application

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Installation
Casting of substructure

Installation
Installation of angles

Installation
Mixing of material

Installation
Placing of POLYFLEX® Advanced PU mixture

Installation
Perfectly smooth finish prevents vibrations/noise

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Installation
Easily adaptable to suit structure geometry

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Installation
… for vertical and horizontal bends

Reference Projects in Australia
POLYFLEX®Advanced PU

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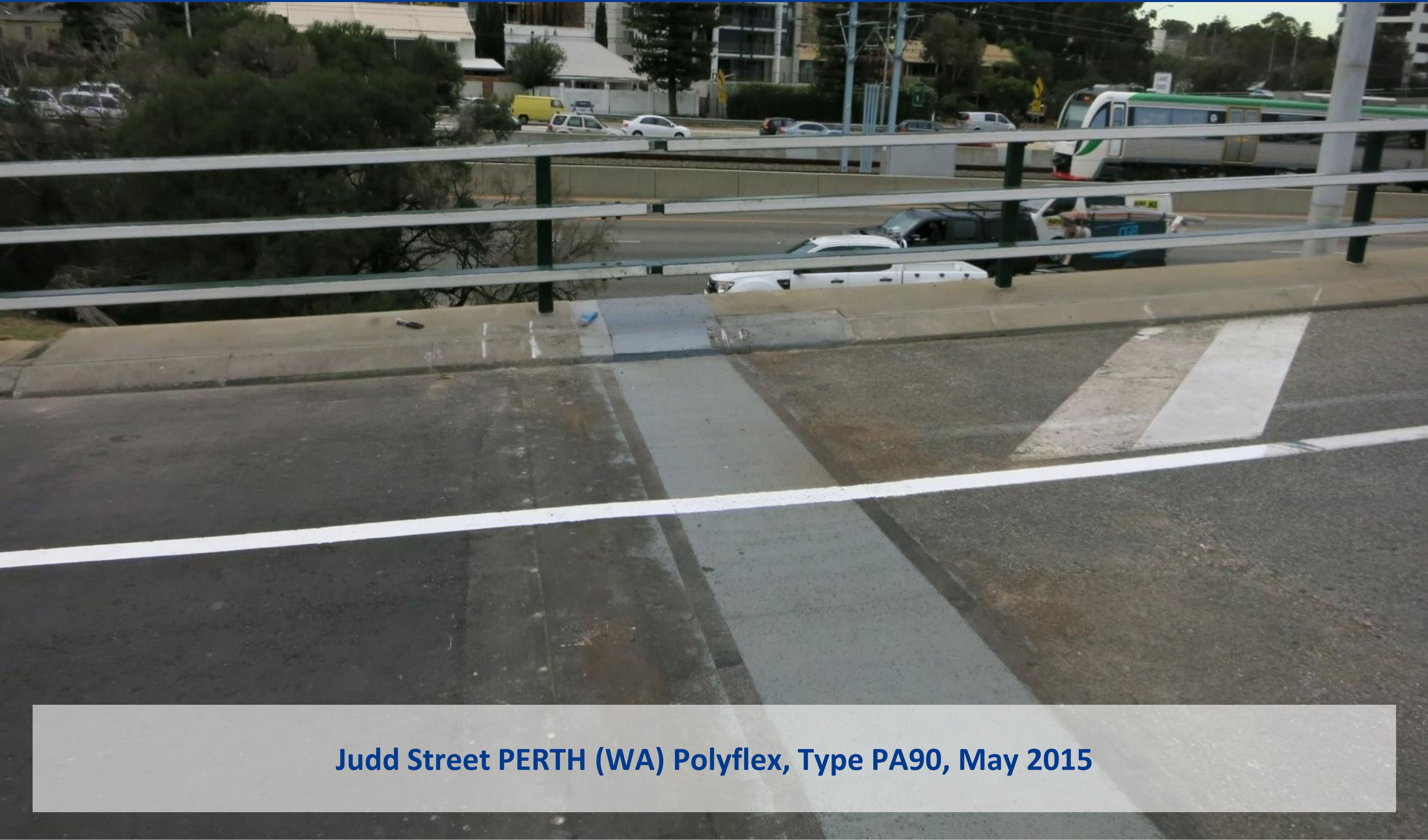

Judd Street PERTH (WA) Polyflex, Type PA90, May 2015

Reference Projects in Australia
POLYFLEX®Advanced PU

South Western Highway, PEMBERTON (WA), Type PA 40, November 2015

Reference Projects in Australia
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Harvey Waterpark Bridge, Bunbury (WA), Type PA 40, October 2017

Reference Projects in USA
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Henry Hudson Parkway, New York, Type PA 30, Oct. 2014

Reference Projects in Japan
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Shimomura Bridge near KYOTO, Type PA 50, May 2015

Reference High Speed Railway in Austria
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right: before ballast
below: upstand at cable ducts

ÖBB Kugelsteinbrücke, March 2016

Reference Architectural Application
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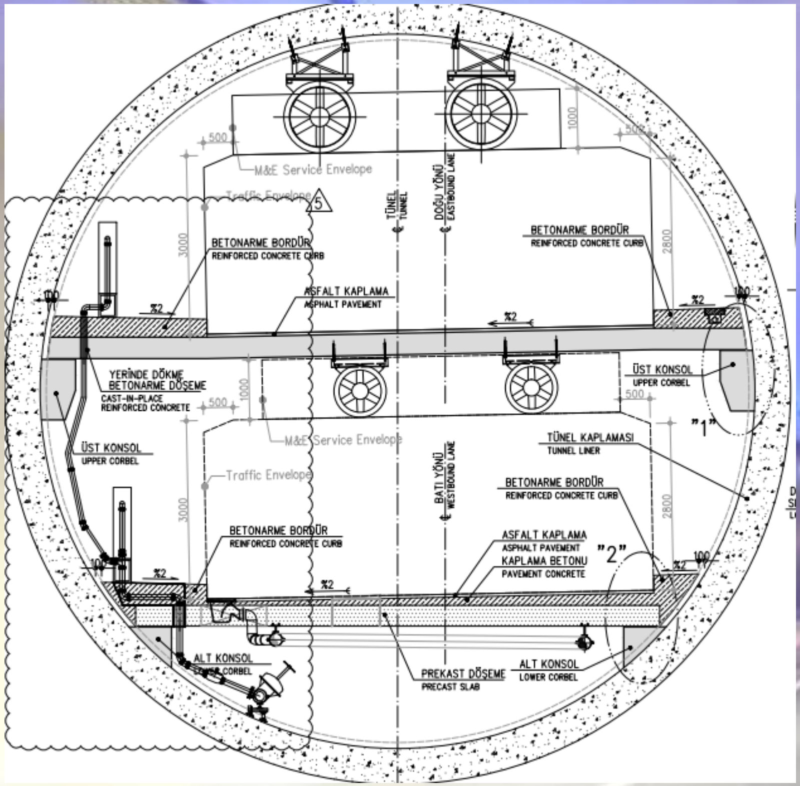
Central Station Zürich, Schweiz, 2015

Reference Tunnel Application
POLYFLEX®Advanced PU



2nd Bosporus Tunnel, Istanbul-Turkey, 2016

Thank you for your attention!