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European Assessment Document for

Flexible plug expansion joints
for road bridges with flexible filling
based on a synthetic polymer as
binder



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This European Assessment Document (EAD) has been developed taking into account up-to-date technical and scientific knowledge at the time of issue and is published in accordance with the relevant provisions of Regulation (EU) 305/2011 as a basis for the preparation and issuing of European Technical Assessments (ETA).

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1 SCOPE OF THE EAD

1.1 Description of the construction product

This EAD covers flexible plug expansion joints for road bridges with flexible filling based on synthetic polymer as binder (in the following referred to as FPEJ).

FPEJ are used to ensure the continuity of the running surface as well as its load bearing capacity under the movement of the bridges whatever the nature of the structure constitutive material is.

FPEJ according to this EAD are in-situ constructed expansion joints comprising a flexible polymer material as joint filling mixture, based on synthetic polymer (e.g., 2- or 3-component polyurethane/polyurea mixture, polymethyl methacrylate resin (PMMA)), which is flush with the running surface, supported over the bridge deck gap by the metallic bridging plate and may include other suitable optional components specified below.

The performance of the product assessed according to this EAD applies only for the specific composition of the flexible polymer as tested.

The EAD applies for FPEJ including the optional component movement aid or stabilising element with a minimum thickness of the joint filling mixture D (see Figure 1.1.1) of 60 mm. This limitation does not apply for kits without these components.

The assessment methods according to this EAD are applicable for:

- Continuous and even bridging plate in the area bridging the bridge deck gap g
- Bridging plates of steel grades S235 to S460 according to EN 10025¹ (part 1 to 6) or austenitic and austenitic-ferritic steel according to EN 1993-1-4
- Bridging plate thickness $t = 3$ mm to 15 mm
- Bridging plates execution conforms to EN 1090-2, EXC 3
- Bridge deck gap $g < 300$ mm (length of wheel print, see Figure 2.2.1.1) + 2 x thickness of the joint filling mixture D (see Figure 1.1.1)

This EAD is applicable to FPEJ for road bridges which are consisting of the following mandatory components:

- Joint filling mixture based on synthetic polymer (optionally with additional filling material)
- Bridging plate (optionally equipped with a centring pin)

Optional components to be defined in the ETA, depending on the structure of the FPEJ subject to assessment:

- Surface dressing
- Debonding strip
- Sliding plate/sheet
- Anchorage system for bridging plate
- Anchorage system for L-brackets
- L- brackets
- Movement aid or stabilising element (installed parallel to the main direction of the movement)
- Primer
- Caulking
- Sealant

¹ All undated references to standards in this EAD are to be understood as references to the dated versions listed in chapter 4.

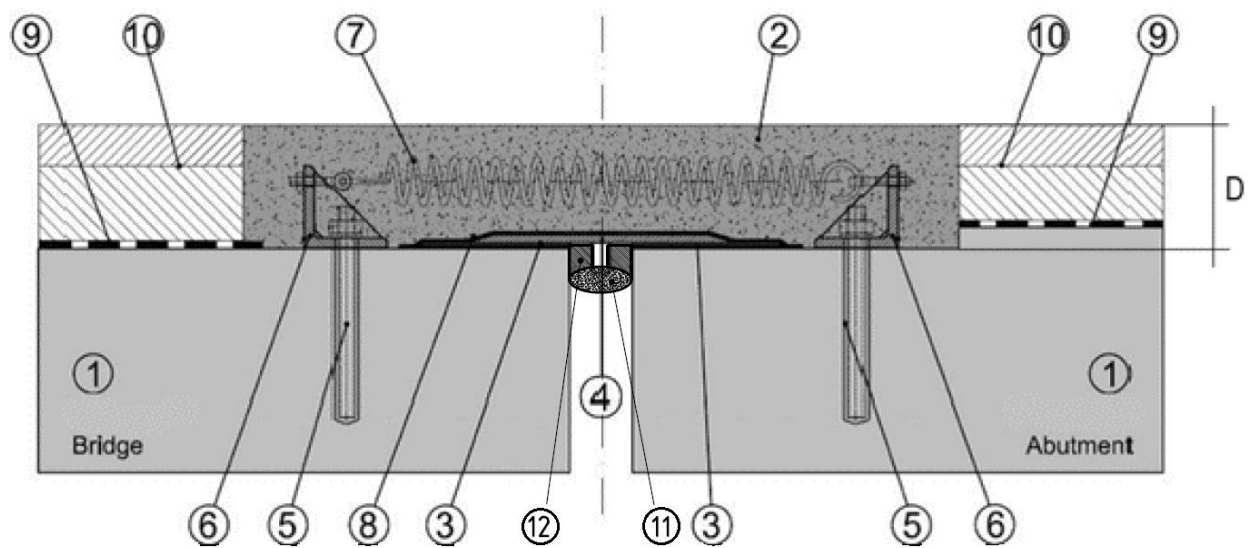


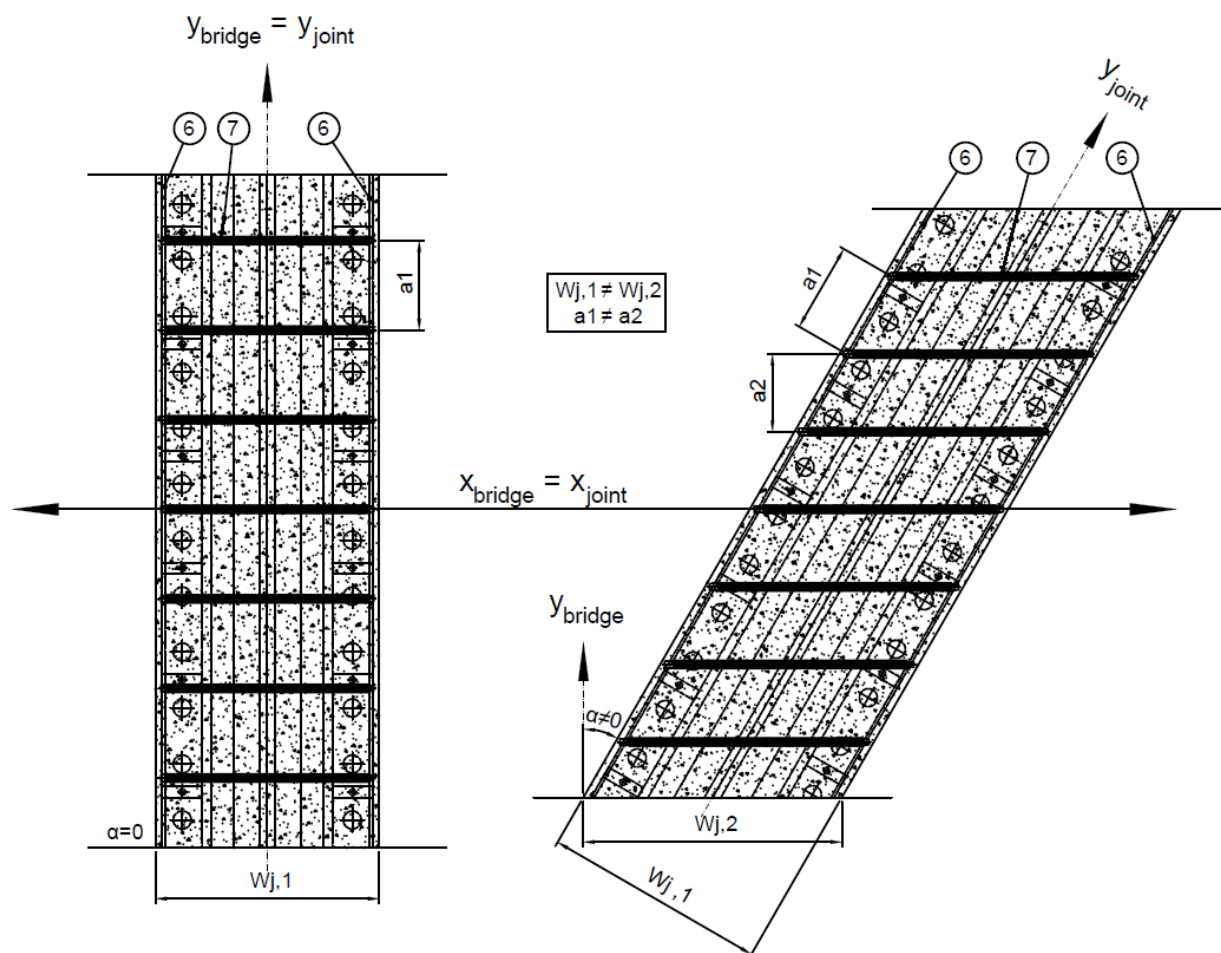
Figure 1.1.1: Example for cross section of the FPEJ according to this EAD

Key for Figure 1.1.1:

- (1) Bridge deck / abutment (not part of the kit)
- (2) Joint filling mixture
- (3) Sliding plate/sheet (optional)
- (4) Bridging plate
- (5) Anchorage system (optional)
- (6) L - Brackets (optional)
- (7) Movement aid/stabilising elements (optional)
- (8) Debonding strip (optional)
- (9) Bridge deck waterproofing (not part of the kit)
- (10) Adjacent pavement (not part of the kit)
- (11) Caulking
- (12) Sealant
- D Thickness of the joint filling mixture

In general, the angle between the main direction of movement of the bridge and the axis of the FPEJ is 90° (skew angle α according to Figure 1.3.15.1 = 0°). For possible change of this angle, the joint width w_j and the geometric conditions of the movement aids/stabilising elements shall be considered (see Figure 1.1.2). The movement aids/stabilising elements are always installed parallel to the main direction of movement of the bridge.

The resulting movement in the main direction of bridge movement (see Figure 1.1.2) of the FPEJ installed at an angle shall not exceed the assessed movement capacity of the product (assessment according to Clause 2.2.3).

Figure 1.1.2: Limitation of the skew angle α due to geometric conditions

Legend to Figure 1.1.2:

- $w_{j,1}$ Width of the FPEJ perpendicular to the longitudinal joint axis y_{joint} [mm]
 $w_{j,2}$ Width of the FPEJ, when installed with a skew angle $\alpha \neq 0$, in direction of main direction of the movement of the bridge x_{bridge} [mm]
 a_i Distance between movement aid/stabilising elements [mm]
 (6)+(7) L - Brackets and movement aid/stabilising elements according to Figure 1.1.1
 α skew angle of the FPEJ [°]

FPEJs for moveable bridges are not covered by this EAD.

For products according to this EAD, there are no components which are replaceable.

FPEJ according to this EAD are related to the atmospheric corrosivity categories C4 or C5 according to EN ISO 9223, whereas durability classes according to EN ISO 12944-1 and EN ISO 14713-1 respectively apply.

This EAD applies for products with the following corrosion protection aspects:

- For structural steel components in contact with the environment (e.g., not completely embedded in the pre-coat layer) full corrosion protection system is applied.
- In case of use of stainless steel for components, the steel type is selected under consideration of the corrosivity categories of the atmosphere using the conditions given in EN 1993-1-4, Annex A, A.2, A.3, A.4 and A.5.
- Aluminium alloys have a corrosion resistance of at least category "B" according to EN 1999-1-1, Table D2, or equivalent. Furthermore, interaction between concrete and the aluminium alloy is prevented.

- Permanent steel bolts are at least electrolytic zinc plated. For coating with Fe/Zn 25 EN ISO 2081 applies, for or hot dip galvanisation EN ISO 10684 applies. In case of stainless steel EN ISO 3506-1 applies, whereas EN 1993-1-4 Annex A, A.2, A.3, A.4 and A.5 needs to be considered.

The product is not fully covered by EAD 120011-00-0107.

Compared to the previous version of the EAD, the following changes are introduced:

- Extension of the operating temperature range (Clause 1.2.1.2) and extension of working life (Clause 1.2.2) and related assessment methods included in Clauses 2.2.2, 2.2.3 and 2.2.12.
- Elements for characterisation included in Clause 2.2 in EAD 120011-00-0107 have been removed and in terms of assessment methods the Annexes A and D are superseding previous references to EOTA Technical Reports 010 and 011.
- Furthermore, the set of components has been extended. This applies to Clause 1.1, and related tables in Chapter 3.
- In addition, editorial and formal rearrangements have been made throughout the document.

Concerning product packaging, transport, storage, maintenance, replacement and repair it is the responsibility of the manufacturer to undertake the appropriate measures and to advise his clients on the transport, storage, maintenance, replacement and repair of the product as he considers necessary.

It is assumed that the product will be installed according to the manufacturer's instructions or (in absence of such instructions) according to the usual practice of the building professionals.

Relevant manufacturer's stipulations, e.g., with regard to the intended end use conditions, having influence on the performance of the product covered by this European Assessment Document shall be considered for the determination of the performance and detailed in the ETA as long as the details of the assessment methods as laid down in this EAD are respected.

1.2 Information on the intended use(s) of the construction product

1.2.1 Intended use(s)

FPEJ are intended to be used to ensure the continuity of the running surface as well as bearing capacity and the movement of the bridges whatever the nature of the structure constitutive material.

The product is intended to be used on roads with a slope in traffic direction to be defined according to the conditions applied in the assessment according to Clause 2.2.2 and Clause 2.2.3.

The maximum slope in traffic direction covered by the assessment shall be stated in the ETA.

1.2.1.1 User categories

The user categories covered by the assessment according to Clause 2.2.11 shall be stated in the ETA:

User categories:

- Vehicles
- Cyclists
- Pedestrians.

1.2.1.2 Operating temperature

The operating temperature is defined as the shade air temperature according to EN 1991-1-5, Clause 3.1.2.

The product according to this EAD is intended to be used under operating temperatures given below:

- Levels of minimum operating temperature T_{min} : -40° C; -20 °C; -10 °C
- Levels of maximum operating temperature T_{max} : + 35 °C; +45 °C; +60 °C

The operating temperature range covered by the assessment according to Clause 2.2.2, Clause 2.2.3 and Clause 2.2.12 shall be stated in the ETA.

1.2.2 Working life/Durability

The assessment methods included or referred to in this EAD have been written based on the manufacturer's request to take into account a working life of the FPEJ for the intended use of 10 years or 15 years, when installed in the works (provided that the FPEJ is subject to appropriate installation (see 1.1)). These provisions are based upon the current state of the art and the available knowledge and experience.

The working life of 10 and 15 years respectively is taken into account in the assessment methods for resistance to fatigue (Clause 2.2.2 and Annex B), movement capacity (Clause 2.2.3 and Annex C) and ageing resulting from UV radiation and weathering (Clause 2.2.14).

When assessing the product, the intended use as foreseen by the manufacturer shall be taken into account. The real working life may be, in normal use conditions, considerably longer without major degradation affecting the basic requirements for works².

The indications given as to the working life of the construction product cannot be interpreted as a guarantee neither given by the product manufacturer or his representative nor by EOTA when drafting this EAD nor by the Technical Assessment Body issuing an ETA based on this EAD, but are regarded only as a means for expressing the expected economically reasonable working life of the product.

It is likely that the working life of the FPEJ is influenced by the following aspects which are not subject of the assessment for these products:

- Adjacent pavement,
- Traffic behaviour (e.g., bumping, including stationary, rolling, queuing traffic),
- Climatic conditions.

The aspects stated above shall be given in the ETA in conjunction with the indication about the working life.

1.3 Specific terms used in this EAD

1.3.1 Joint filling mixture

Mixture based on synthetic polymer (e.g., 2- or 3-component polyurethane/polyurea mixture, polymethyl methacrylate resin (PMMA)), with or without additional filling material, e.g., made of rubber granules or equivalent material (see (2) in Figure 1.1.1).

1.3.2 Sliding plate/sheet

A sheet or plate between bridge deck and bridging plate to reduce friction (see (3) in Figure 1.1.1).

1.3.3 Debonding strip

A sheet between joint filling mixture and bridging plate to allow free movement of the bridging plate (see (8) in Figure 1.1.1).

1.3.4 Caulking

A backing material, which is placed in the bridge deck gap to provide support for sealant in an FPEJ (see (11) in Figure 1.1.1).

² The real working life of a product incorporated in a specific works depends on the environmental conditions to which that works is subject, as well as on the particular conditions of the design, execution, use and maintenance of that works. Therefore, it cannot be excluded that in certain cases the real working life of the product may also be shorter than referred to above.

1.3.5 Anchorage system

A means of connecting metallic components of the FPEJ to the main structure or the abutment (see (5) in Figure 1.1.1).

1.3.6 Movement aids/stabilising elements

Optional components which are incorporated in the FPEJ to ensure appropriate behaviour with respect to the intended use of the FPEJ (see (7) in Figure 1.1.1).

1.3.7 Bridging plate

A metallic plate, which bridges the bridge deck gap and prevents ingress of the joint filling mixture into the bridge deck gap (see (4) in Figure 1.1.1).

1.3.8 Primer

A liquid used to pre-treat a surface with the purpose of improving adhesion.

1.3.9 Sealant

A flexible material poured into a bridge deck gap with the purpose of sealing the bridge deck gap (see (12) in Figure 1.1.1).

1.3.10 Surface dressing

Application of small sized aggregates to provide texture and skid resistance to the surface of a FPEJ.

1.3.11 Joint recess

A regular opening, cut or formed in the road surface over the bridge deck gap g to contain the FPEJ system.

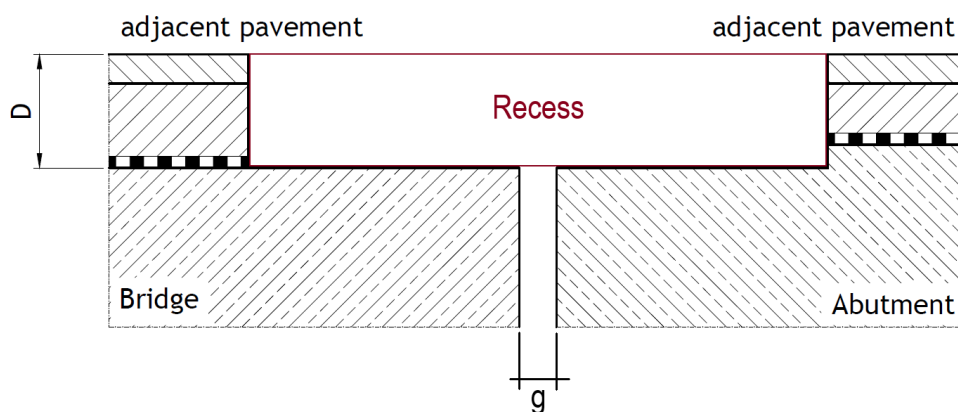


Figure 1.3.11.1: Joint recess

1.3.12 Pre-coat layer

A layer applied to the internal surfaces of the joint recess for the purpose of improving adhesion between the filling mixture and sealing the internal faces of the joint recess.

1.3.13 Bridge deck gap (structure gap) g [mm]

Opening between two adjacent parts of the main structure, which is bridged by the FPEJ (distance between two structural elements).

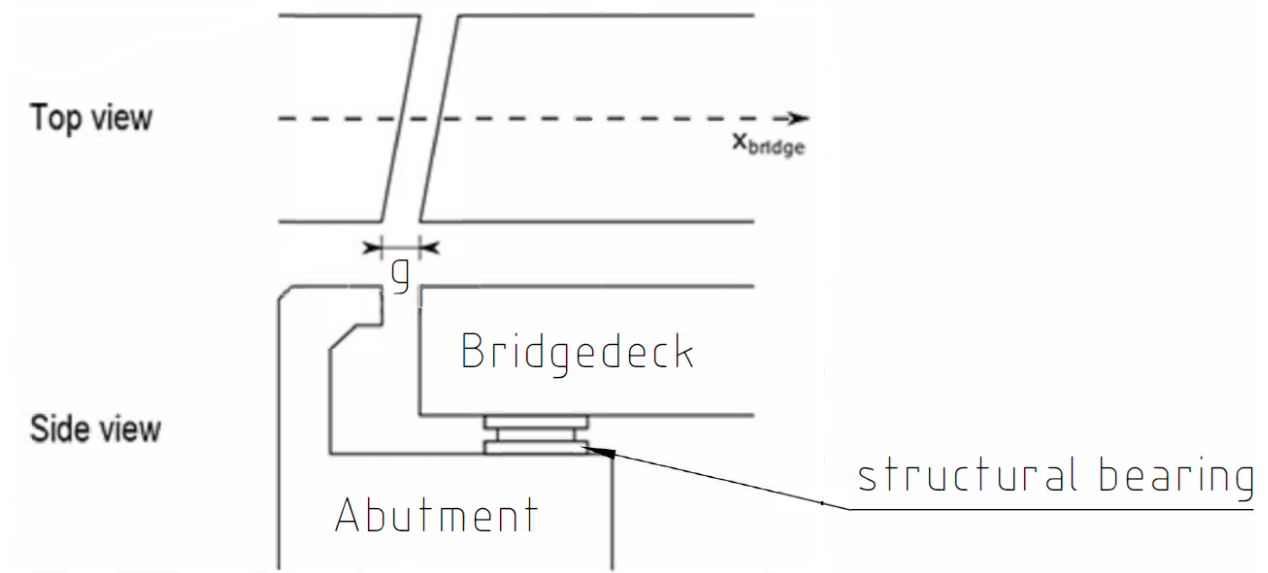


Figure 1.3.13.1: Bridge deck gap

Legend:

x_{bridge} main direction of the movement of the bridge
 g bridge deck gap [mm]

1.3.14 Movement capacity M [mm]

The range of the relative displacement between the extreme positions. The movement capacity M is the sum of maximum extension e_{max} and maximum compression c_{max} measured in the slow movement capacity test according to Annex C, C.5, method a.

1.3.15 Skew angle of the FPEJ α [°]

The skew angle α is the angle between the axis perpendicular to the main direction of the movement of the bridge (y_{bridge}) and the longitudinal axis of the FPEJ (y_{joint}). The movement capacity of the FPEJ is described in relation to the skew angle α .

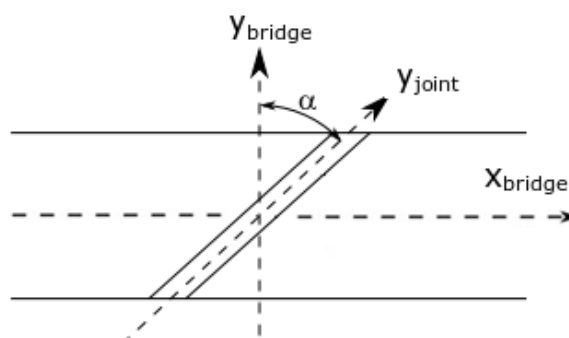


Figure 1.3.15.1: Definition of skew angle α

Legend:

x_{bridge}	main direction of the movement of the bridge
y_{bridge}	axis perpendicular to the main direction of the movement of the bridge (x_{bridge})
y_{joint}	longitudinal FPEJ axis
α	skew angle of the FPEJ

1.3.16 Wear

Damages resulting from repeated movements either within the FPEJ or between a part of the FPEJ and the structure.

1.3.17 Joint width $w_{j,i}$ [mm]

The joint width $w_{j,1}$ perpendicular to the longitudinal FPEJ axis y_{joint} shall remain unchanged for all skew angles α . The joint width $w_{j,2}$, measured in direction x_{bridge} , is variable and depends on the skew angle α . See Figure 1.1.2.

1.3.18 MPII

Manufacturer's Product Installation Instructions.

1.3.19 Symbols

Symbol	Description	Unit
a_i	Distance between movement aid/stabilising elements	[mm]
c_{max}	Maximum compression applied in the slow movement capacity test	[mm]
$d(y)$	Deformation at point y along the transversal measurement profile MPi	[mm]
$d(y)_{max}$	Maximum deformation at point y along a transversal measurement profile MPi	[mm]
$d(y)_{min}$	Minimum deformation at point y along a transversal measurement profile MPi	[mm]
e_0	Extension before starting the test = 0	[mm]
e_{max}	Maximum extension applied in the slow movement capacity test	[mm]
f_y	Yield strength according to EN 1993-1-1, Table 5.1	[N/mm ²]
g	Bridge deck gap	[mm]
g_{max}	Bridge deck gap at maximum extension e_{max}	[mm]
g_{min}	Bridge deck gap at maximum compression c_{max}	[mm]
g_{ref}	Reference bridge deck gap before testing of the specimen	[mm]
h	Waterlevel in the watertightness test	[mm]
$k_{F,1}(T_{max}, c_{max})$	Temperature dependant constant for reaction forces F at T_{max} and c_{max} of the 1 st assessment method	[-]
$k_{F,1}(T_{min}, e_{max})$	Temperature dependant constant for reaction forces F at T_{min} and e_{max} of the 1 st assessment method	[-]
$k_{F,2}$	System constant for reaction forces of the 2 nd assessment method	[kN/mm]
$k_{F,2}(T_{max}, c_{max})$	System constant for reaction forces at T_{max} and c_{max} of the 2 nd assessment method	[kN/mm]

$k_{F,2}(T_{min}, e_{max})$	System constant for reaction forces at T_{min} and e_{max} of the 2 nd assessment method	[kN/mm]
$k_{\epsilon,1}(T_{max}, c_{max})$	Temperature dependant constant for deformations ϵ at T_{max} and c_{max} of the 1 st assessment method	[-]
$k_{\epsilon,1}(T_{min}, e_{max})$	Temperature dependant constant for deformations ϵ at T_{min} and e_{max} of the 1 st assessment method	[-]
$k_{\epsilon,2}$	System constant for deformations of the 2 nd assessment method	[-]
$k_{\epsilon,2}(T_{max}, c_{max})$	System constant for deformations at T_{max} and c_{max} of the 2 nd assessment method	[-]
$k_{\epsilon,2}(T_{min}, e_{max})$	System constant for deformations at T_{min} and e_{max} of the 2 nd assessment method	[-]
l_s	Specimen length in x direction	[mm]
n_b	Number of individual test result for the bond strength to support	[-]
n_m	Number of measurement points along a transversal measurement profile MPi in y direction within the half width of wheel print	[-]
n_{fast}	Number of cycles in the fast movement capacity test	[-]
n_{rut}	Number of passes in the over-rolling test	[-]
t	Bridging plate thickness	[mm]
$w_{1k,el}$	Elastic deflection of the bridging plate	[mm]
$w_{fast,max}$	Maximum displacement applied during testing the movement capacity under fast occurring movements	[mm]
$w_{fast,min}$	Starting position for the displacement to be applied during testing the movement capacity under fast occurring movements	[mm]
w_j	Width of the FPEJ	[mm]
$w_{j,1}$	Width of the FPEJ perpendicular to the longitudinal joint axis y_{joint}	[mm]
$w_{j,2}$	Width of the FPEJ, when installed with a skew angle $\alpha \neq 0$, in direction of main direction of the movement of the bridge x_{bridge}	[mm]
$w_{j,max}$	Width of the FPEJ at maximum extension e_{max}	[mm]
$w_{j,min}$	Width of the FPEJ at maximum compression c_{max}	[mm]
$w_{j,ref}$	Reference width of the FPEJ before testing	[mm]
$w_{j,ref,i}$	Reference width of the FPEJ specimen i	[mm]
wp_L	Length of wheel print (in traffic direction, x_{joint})	[mm]
wp_w	Width of wheel print	[mm]
w_s	Specimen width	[mm]
x_{bridge}	Main direction of the movement of the bridge	[-]
x_{joint}	Axis of the FPEJ in direction of the main direction of the movement of the bridge (x_{bridge})	[-]
y_{bridge}	Axis perpendicular to the main direction of the movement of the bridge	[-]
y_{joint}	Longitudinal joint axis	[-]
$z_o(y)$	Vertical distance at point y along the transversal measurement profile before testing	[mm]

$z_T(y)$	Vertical distance at point y along the transversal measurement profile after testing	[mm]
BH	Final bulge height	[mm]
BH_i	Bulge height of an individual transvers measurement profile MPi	[mm]
$BH_{L,i}$	Left maximum bulge height	[mm]
$BH_{R,i}$	Right maximum bulge height	[mm]
D	Thickness of the joint filling mixture	[mm]
D_i	Thickness of the joint filling mixture of specimen i	[mm]
E	Modulus of elasticity according to EN 1993-1-1, Clause 5.2.5	[N/mm ²]
$EC20$	Effective Concentrations causing a 20% effect	[mg/l]
$F_i(T_{exp}, c_{max})$	Maximum reaction force of the variant specimen i at $T_{i,exp}$ at maximum compression c_{max}	[kN]
$F_i(T_{exp}, e_{max})$	Maximum reaction force of the variant specimen i at $T_{i,exp}$ at maximum extension e_{max}	[kN]
$F_i(T_{max}, c_{max})$	Effective reaction force of the variant specimen i at T_{max} at maximum compression c_{max}	[kN]
$F_i(T_{min}, e_{max})$	Effective reaction force of the variant specimen i at T_{min} at maximum extension e_{max}	[kN]
$F(T_0, e_0)$	Reaction force before testing at T_0 and before applying movements (e_0) = 0	[kN]
$F(T_{max}, e_0)$	Force caused by the heating of the FPEJ from T_0 to T_{max}	[kN]
$F(T_{max}, c_{max})$	Reaction force at T_{max} at maximum compression c_{max}	[kN]
$F(T_{min}, e_0)$	Force caused by the cooling of the FPEJ from T_0 to T_{min}	[kN]
$F(T_{min}, e_{max})$	Reaction force at T_{min} at maximum extension e_{max}	[kN]
$F(T_{ref}, c_{max})$	Maximum reaction force of the reference specimen at T_{ref} at maximum compression c_{max}	[kN]
$F(T_{ref}, e_{max})$	Maximum reaction force of the reference specimen at T_{ref} at maximum extension e_{max}	[kN]
$F_{fast,max}$	Maximum reaction force measured during testing the movement capacity under fast occurring movements	[kN]
$F_{fast,min}$	Minimum reaction force measured during testing the movement capacity under fast occurring movements	[kN]
G'	Storage modulus	[Pa]
G''	Loss modulus	[Pa]
G^*	Complex modulus	[Pa]
M	Movement capacity	[mm]
M_i	Movement capacity of specimen i	[mm]
MP_i	Transversal measurement profile	[-]
PRD_{AIR}	Proportional rut depth	[%]
PTV_{v+c}	Pendulum test value for user categories vehicles and cyclists	[-]
PTV_p	Pendulum test value for user category pedestrians	[-]
$Q_{1k,el}$	Characteristic elastic resistance of the bridging plate	[kN]
$Q_{1k,pl}$	Characteristic plastic resistance of the bridging plate	[kN]

$Q_{1k,fat}$	Characteristic fatigue resistance of the bridging plate	[kN]
RD_i	Rut depth of transversal measurement profile MPi	[mm]
RD	Final rut depth	[mm]
T_0	Temperature during construction of the FPEJ as defined in the MPII	[°C]
$T_{0,shear}$	Shear-force amplitude	[Pa]
$T_{i,exp}$	Mean temperature at testing of other specimen i for testing at temperature between +5°C and +30°C	[°C]
T_{max}	Levels of maximum operating temperature	[°C]
T_{min}	Levels of minimum operating temperature	[°C]
T_{ref}	Mean temperature at testing of reference specimen (equal to specimen tested at minimum and maximum service temperature) for testing at temperature between +5°C and +30°C	[°C]
T_{test}	Test temperature for testing the movement capacity under fast occurring movements	[°C]
$TS1$	Axle of heavy vehicle on lane 1	[-]
$TS2$	Axle of heavy vehicle on lane 2	[-]
α	Skew angle of the FPEJ	[°]
γ_0	Deformation amplitude	[-]
ΔF	Difference between maximum and minimum reaction force measured during testing the movement capacity under fast occurring movements	[kN]
$\Delta H_{A,diesel}$	Relative change of shore hardness A after exposure to diesel	[%]
$\Delta H_{A,heat}$	Relative change of shore hardness A after accelerated ageing by heat	[%]
$\Delta H_{A,ice}$	Relative change of shore hardness A after ageing resulting from freeze/thaw with de-icing salts	[%]
$\Delta H_{A,petrol}$	Relative change of shore hardness A after exposure to diesel	[%]
$\Delta H_{A,UV}$	Relative change of shore hardness A after exposure to UV radiation and weathering	[%]
Δw	Dynamic amplitude during testing the movement capacity under fast occurring movements	[mm]
$\Delta \epsilon_{b,diesel}$	Relative change of the elongation at break after exposure to diesel	[%]
$\Delta \epsilon_{b,heat}$	Relative change of elongation at break after accelerated ageing by heat	[%]
$\Delta \epsilon_{b,ice}$	Relative change of the elongation at break after ageing resulting from freeze/thaw with de-icing salts	[%]
$\Delta \epsilon_{b,petrol}$	Relative change of the elongation at break after exposure to petrol	[%]
$\Delta \epsilon_{b,UV}$	Relative change of the elongation at break after exposure to UV radiation and weathering	[%]
$\Delta \sigma_{b,diesel}$	Relative change of the tensile strength after exposure to diesel	[%]

$\Delta\sigma_{b,heat}$	Relative change of tensile strength after accelerated ageing by heat	[%]
$\Delta\sigma_{b,ice}$	Relative change of tensile strength after ageing resulting from freeze/thaw with de-icing salts	[%]
$\Delta\sigma_{b,petrol}$	Relative change of the tensile strength after exposure to petrol	[%]
$\Delta\sigma_{b,UV}$	Relative change of the tensile strength after exposure to UV radiation and weathering	[%]
$\Delta\sigma_{max,heat}$	Relative change of the bond strength to support after accelerated ageing by heat	[%]
$\Delta\sigma_{max,ice}$	Relative change of the bond strength to support after ageing resulting from freeze/thaw with de-icing salts	[%]
$\Delta\sigma_{max,UV}$	Relative change of the bond strength to support after exposure to UV radiation and weathering	[%]
$\Delta\sigma_D$	Characteristic constant amplitude fatigue limit at N_D stress cycles (according to EN1993-1-9, Clause 3.2.3) according to Table 8.1 relating to the applicable detail category according to EN 1993-1-9, Table 10.1 to Table 10.5	[N/mm ²]
$\varepsilon(T_{ref}, c_{max})$	Maximum deformation of the reference specimen at T_{ref} at maximum compression c_{max}	[mm]
$\varepsilon(T_{ref}, e_{max})$	Maximum deformation of the reference specimen at T_{ref} at maximum extension e_{max}	[mm]
$\varepsilon_i(T_{exp}, c_{max})$	Maximum deformation of the variant specimen i at $T_{i,exp}$ at maximum compression c_{max}	[mm]
$\varepsilon_i(T_{exp}, e_{max})$	Maximum deformation of the variant specimen i at $T_{i,exp}$ at maximum extension e_{max}	[mm]
$\varepsilon_{i,max}$	Effective maximum deformation of the variant specimen i at T_{max} at maximum compression c_{max}	[mm]
$\varepsilon_{i,min}$	Effective minimum deformation of the variant specimen i at T_{min} at maximum extension e_{max}	[mm]
ε_{max}	Maximum (positive) vertical deformation at maximum compression c_{max}	[mm]
ε_{min}	Minimum (negative) vertical deformation at maximum extension e_{max}	[mm]
θ	Angle of load distribution in the joint filling mixture and adjacent pavement	[°]
δ	Loss angle	[°]
σ_{max}	Bond strength to support	[N/mm ²]
$\sigma_{max,i}$	Individual test result for the bond strength to support	[N/mm ²]

2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

2.1 Essential characteristics of the product

Table 2.1.1 shows how the performance of the FPEJ is assessed in relation to the essential characteristics.

Table 2.1.1 Essential characteristics of the product and methods and criteria for assessing the performance of the product in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 1: Mechanical resistance and stability			
1	Mechanical resistance	2.2.1	Level $Q_{1k,pl}$ [kN] $Q_{1k,el}$ [kN] $w_{1k,el}$ [mm]
2	Resistance to fatigue	2.2.2	Description Level $Q_{1k,fat}$ [kN] RD [mm] $d(y)_{max}$ [mm] $d(y)_{min}$ [mm] BH [mm] n_{rut} [-]
3	Movement capacity	2.2.3	Description Level M [mm] e_{max} [mm] c_{max} [mm] ε_{min} [mm] ε_{max} [mm] $\varepsilon_{i,min}$ [mm] $\varepsilon_{i,max}$ [mm] $F(T_{min}, e_{max})$ [kN] $F(T_{max}, c_{max})$ [kN] $F_i(T_{min}, e_{max})$ [kN] $F_i(T_{max}, c_{max})$ [kN] Δw [mm] Frequency [Hz] n_{fast} [-] T_{test} [°C] $F_{fast,max}$ [kN] $F_{fast,min}$ [kN]
4	Resistance to wear	2.2.4	Description
5	Water tightness	2.2.5	Description
6	Bond strength to support	2.2.6	Description Level σ_{max} [N/mm ²]

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 2: Safety in case of fire			
7	Reaction to fire	2.2.7	Class
Basic Works Requirement 3: Hygiene, health and the environment			
8	Content, emission and/or release of dangerous substances	2.2.8	Description Level EC_{20} [mg/l]
Basic Works Requirement 4: Safety and accessibility in use			
9	Level differences in the running surface	2.2.9	Level Maximum level differences [mm] and steps [mm] in unloaded conditions Maximum level differences after loading [mm]
10	Skid resistance	2.2.10	Level PTV_{v+c} [-] PTV_p [-]
11	Wheel tracking (only for maximum operating temperature $T_{max} = +60$ °C according to Clause 1.2.1.2)	2.2.11	Level PRD_{AIR} [%] Thickness of the specimens [mm]
Aspects of durability			
12	Resistance against chemicals (petrol, diesel)	2.2.12	Level $\Delta\sigma_{b,petrol}$ [%] $\Delta\sigma_{b,diesel}$ [%] $\Delta\epsilon_{b,petrol}$ [%] $\Delta\epsilon_{b,diesel}$ [%] $\Delta H_{A,petrol}$ [%] $\Delta H_{A,diesel}$ [%]
13	Accelerated ageing by heat	2.2.13	Level $\Delta\sigma_{b,heat}$ [%] $\Delta\epsilon_{b,heat}$ [%] $\Delta H_{A,heat}$ [%] $\Delta\sigma_{max,heat}$ [%]
14	Ageing resulting from UV radiation and weathering	2.2.14	Description Level $\Delta\sigma_{b,UV}$ [%] $\Delta\epsilon_{b,UV}$ [%] $\Delta H_{A,UV}$ [%] $\Delta\sigma_{max,UV}$ [%]
15	Ageing resulting from ozone	2.2.15	Description
16	Ageing resulting from freeze/thaw with de-icing salts	2.2.16	Level $\Delta\sigma_{b,ice}$ [%] $\Delta\epsilon_{b,ice}$ [%] $\Delta H_{A,ice}$ [%] $\Delta\sigma_{max,ice}$ [%]

2.2 Methods and criteria for assessing the performance of the product in relation to essential characteristics of the product

This chapter is intended to provide instructions for TABs. Therefore, the use of wordings such as “shall be stated in the ETA” or “it has to be given in the ETA” shall be understood only as such instructions for TABs on how results of assessments shall be presented in the ETA. Such wordings do not impose any obligations for the manufacturer and the TAB shall not carry out the assessment of the performance in relation to a given essential characteristic when the manufacturer does not wish to declare this performance in the Declaration of Performance.

If for any components covered by harmonised standards or European Technical Assessments the manufacturer of the component has included the performance regarding the relevant essential characteristic in the Declaration of Performance, retesting of that component for issuing the ETA under the current EAD is not required.

2.2.1 Mechanical resistance

Purpose of the assessment

Purpose of the assessment is to assess the capability of the product to resist static loading conditions for axle load configurations (reference: EN 1991-2, Clause 6.3.2) depicted in Figure 2.2.1.1.

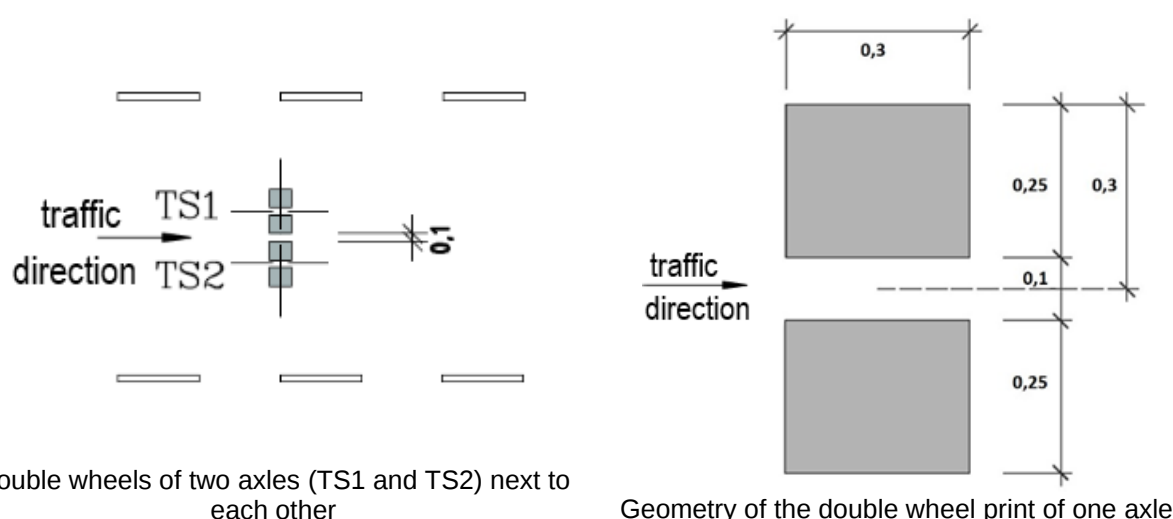


Figure 2.2.1.1: Axle load configuration – top view (dimensions are in [m])
the traffic direction is considered equal to the direction of x_{bridge} and x_{joint}

Different to EN 1991-2, Clause 6.3.2, wheel prints consider a length in driving direction of 0,3 m and a width of 0,25 m. The assessment considers the load distribution in the joint filling mixture and adjacent pavement with $\theta = 45^\circ$ (see Figure 2.2.1.2). This effect shall be considered in both directions x_{joint} and y_{joint} and is taken into account in equation (2.2.1.1).

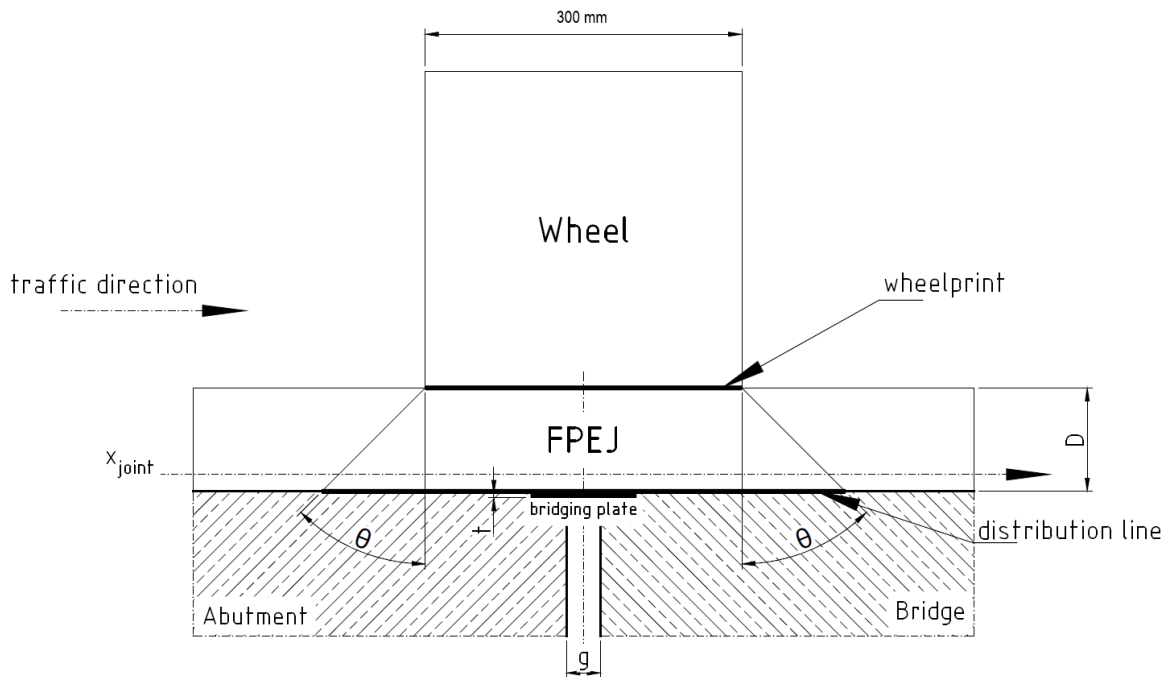


Figure 2.2.1.2: Load distribution from the loaded surface of the joint filling mixture to the bridging plate – cross section

Assessment method

Characteristic axle load resistance shall be assessed for plastic $Q_{1k,pl}$ and elastic $Q_{1k,el}$ resistance of the bridging plate for each configuration of nominal thickness t and nominal material yield strength f_y of the bridging plate in relation to applicable minimum thickness of the joint filling mixture D and maximum bridge deck gap g (see Figure 1.3.13.1). Background for the calculations below is given in Annex F.

$$Q_{1k,pl} = \frac{4 \cdot (650 + D) \cdot (300 + 2 \cdot D) \cdot t^2 \cdot f_y}{g^2} \quad (2.2.1.1)$$

$$Q_{1k,el} = \frac{2 \cdot Q_{1k,pl}}{3} \quad (2.2.1.2)$$

Where:

$Q_{1k,pl}$ [kN] = Characteristic axle load plastic resistance of the bridging plate³

$Q_{1k,el}$ [kN] = Characteristic axle load elastic resistance of the bridging plate⁴

D [mm] = minimum thickness of the joint filling mixture

t [mm] = nominal thickness of the bridging plate

f_y [N/mm²] = nominal yield strength according to EN 1993-1-1⁵, Table 5.1

g [mm] = bridge deck gap (see Figure 1.3.13.1)

Assessed characteristic elastic axle load resistance shall be applied for the assessment regarding elastic deflection of the bridging plate $w_{1k,el}$ to be considered for the assessment according to 2.2.10.

$$w_{1k,el} = \frac{Q_{1k,el} \cdot g^4 \cdot 12 \cdot 5}{2 \cdot (650 + D) \cdot (300 + 2 \cdot D) \cdot 384 \cdot E \cdot t^3} \quad (2.2.1.3)$$

Where:

$w_{1k,el}$ [mm] = Elastic deflection of the bridging plate

E [N/mm²] = modulus of elasticity according to EN 1993-1-1, Clause 5.2.5

³ „ $Q_{1k,pl}$ [kN]” is the force in which permanent (plastic) deformation of the bridging plate introduced by axle load is starting.

⁴ „ $Q_{1k,el}$ [kN]” is the force until which only reversible (elastic) deformation of the bridging plate is occurring.

⁵ EN 1993-1-1:2022, Edition 3 shall be used as the Table 5.1 has different content in editions 2 and 1 which are all still valid.

Expression of results

The results of the assessment shall be stated in the ETA by means of the following:

- Characteristic axle load resistance for plastic $Q_{1k,pl}$ and elastic $Q_{1k,el}$ resistance of the bridging plate, both in [kN] and elastic deflection of the bridging plate $w_{1k,el}$ in [mm] for each configuration of nominal thickness t and nominal material yield strength f_y of the bridging plates in relation to applicable minimum thickness of the joint filling mixture D and maximum bridge deck gap g .

2.2.2 Resistance to fatigue

Purpose of the assessment

Purpose of the assessment is to assess the capability of the product to resist dynamic loading conditions for axle load configurations based on EN 1991-2, Clause 6.3.2 depicted in Figure 2.2.1.1.

Different to EN 1991-2, Clause 6.3.2, wheel prints consider a length in driving direction of 0,3 m and width of 0,25 m. The assessment considers the load distribution in the joint filling mixture and adjacent pavement with $\theta = 45^\circ$ (see Figure 2.2.1.2). This effect shall be considered in both directions x_{joint} and y_{joint} and is taken into account in equation (2.2.2.1).

Assessment method

Assessment shall be done by means of calculation of the bridging plate and by means of testing of the assembled kit as stated below.

Assessment by means of calculation of the bridging plate:

Characteristic fatigue axle load resistance $Q_{1k,fat}$ shall be assessed for fatigue resistance of the bridging plate for each configuration of nominal thickness t and reference value of the fatigue strength $\Delta\sigma_D$ of the bridging plate at $N_c = 2$ million cycles in relation to applicable minimum thickness of the joint filling mixture D and maximum bridge deck gap g . Background for the calculations below is given in Annex G.

$$Q_{1k,fat} = \frac{8 \cdot (600 + 2 \cdot D) \cdot (300 + 2 \cdot D) \cdot t^2 \cdot \Delta\sigma_D}{3 \cdot g^2} \quad (2.2.2.1)$$

Where:

$Q_{1k,fat}$ [kN] = Characteristic axle load fatigue resistance of the bridging plate

D [mm] = minimum thickness of the joint filling mixture

t [mm] = nominal thickness of the bridging plate

$\Delta\sigma_D$ [N/mm²] = characteristic constant amplitude fatigue limit at N_D stress cycles (according to EN1993-1-9, Clause 3.2.3) according to Table 8.1 relating to the applicable detail category according to EN 1993-1-9, Table 10.1 to Table 10.5⁶

g [mm] = bridge deck gap (see Figure 1.3.13.1)

Example for the determination of $\Delta\sigma_D$ for a bridging plate consisting of a plane steel plate without any welding details (thermally cut material subject to normal stress with subsequent grinding):

Detail category 160 according to EN1993-1-9, Table 10.1, construction detail 4 is applicable for this type of bridging plate.

In the next step, the bridging plate type shall be assigned to the relevant figure in clause 8.1 of EN 1993-1-9. For the plane steel plate without any welding details EN 1993-1-9, Figure 8.1 “Characteristic fatigue resistance curves of non-welded constructional details subject to nominal normal stress ranges” (a) “light notch effects” applies. “Light notch effects” is relevant in that case because the detail category 160 is covered by this curve.

Next, EN 1993-1-9, Table 8.1 shall be used to obtain the relevant value for $\Delta\sigma_D$, which is 160 N/mm² for this example.

⁶ Bending stress leads to tensile and compression stress in the structural member on its upper respectively lower side. For calculation of fatigue resistance only those stresses are of relevance.

Assessment by means of testing of the kit:

Resistance to fatigue of FPEJ shall be assessed by testing for repeated loading, by vehicle wheels which typically lead to deformation or wheel rutting of the FPEJ, resulting from dynamic loading by traffic (according to Annex B)

The requirements in Table 2.2.2.1 shall be fulfilled.

Table 2.2.2.1: Requirements and assessment criteria

Requirements
After testing according to Annex B there shall be no cracking or de-bonding of the joint filling mixture exceeding 1 mm width and 5 mm depth and the resulting deformations RD and BH assessed according to Annex B shall be less than 10 mm.

In the assessments according to Annex B the maximum slope in traffic direction and the working life shall be taken into account accordingly. Details are given in Annexe B.

Expression of results

The following results of the assessment shall be given in the ETA:

Calculations:

- Characteristic fatigue axle load resistance by means of fatigue resistance of the bridging plate ($Q_{1k, fat}$) in [kN] for each configuration of nominal thickness t [mm] and reference value of the fatigue strength $\Delta\sigma_D$ [N/mm²] of the bridging plate in relation to applicable minimum thickness of the joint filling mixture D [mm] and maximum bridge deck gap g [mm]

Testing:

- Fulfilment of the requirements given in Table 2.2.2.1: fulfilled / not fulfilled
- Final rut depth RD , maximum deformation $d(y)_{max}$ [mm], minimum deformation $d(y)_{min}$ [mm] and final bulge height BH , both in [mm]
- Related number of passes n_{rut} [-] as applied in test according to Annex B

2.2.3 Movement capacity

Purpose of the assessment

The movement capacity of a FPEJ is the capability to allow the displacement of the parts of the main structure (bridge deck and abutment according to Figure 1.1.1) in direction x_{bridge} resulting from temperature variation (leading to large but slowly occurring movements) and traffic action (leading to small but fast occurring movements). It shall be assessed how the FPEJ is affected by these effects. The FPEJ shall be able to sustain these movements without restricting its function as well as not causing detrimental effects on the structure and surrounding surfacing material.

As a consequence of the temperature variation, the maximum compression c_{max} of the FPEJ is occurring at T_{max} and the maximum extension e_{max} at T_{min} . The movement capacity M is defined as the sum of e_{max} and c_{max} .

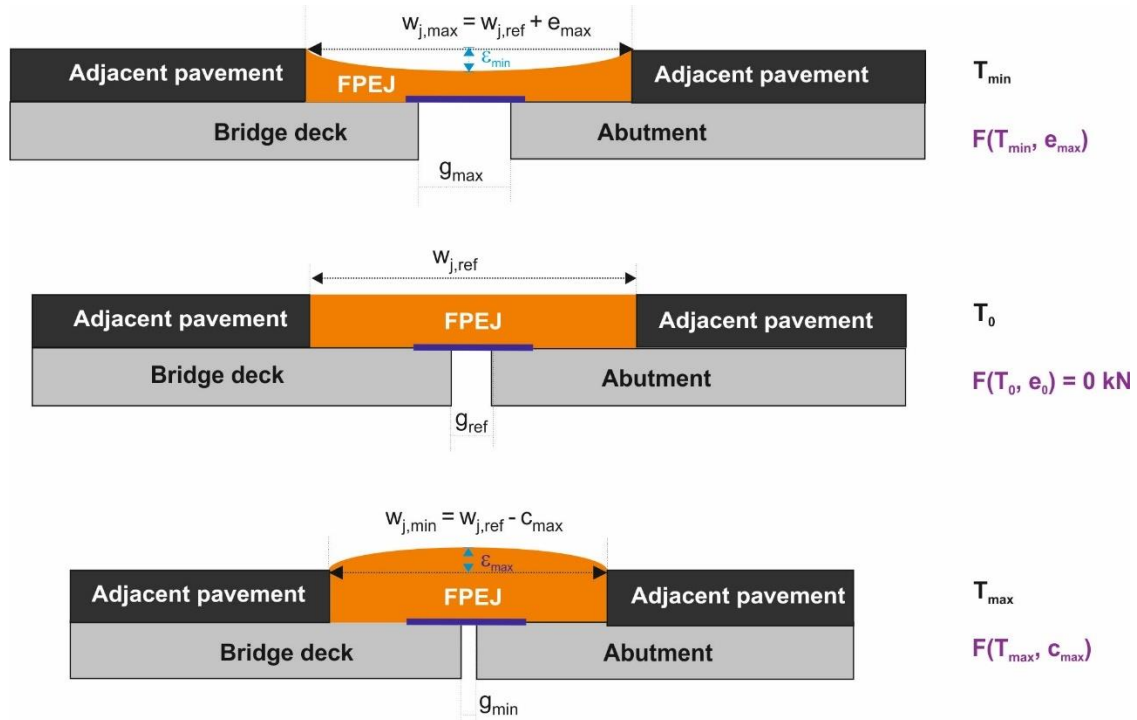


Figure 2.2.3.1: Extension and compression of the FPEJ and resulting vertical deformations ϵ_{min} and ϵ_{max} (exaggerated) and reaction forces $F(T_{min}, e_{max})$ and $F(T_{max}, c_{max})$

Legend to Figure 2.2.3.1:

$w_{j,max}$	Width of the FPEJ at maximum extension e_{max} [mm]
$w_{j,min}$	Width of the FPEJ at maximum compression c_{max} [mm]
$w_{j,ref}$	Reference width of the FPEJ before testing [mm]
g_{max}	Bridge deck gap at maximum extension e_{max} [mm]
g_{ref}	Reference bridge deck gap before testing of the specimen [mm]
g_{min}	Bridge deck gap at maximum compression c_{max} [mm]
ϵ_{min}	Minimum (negative) vertical deformation at maximum extension e_{max} [mm]
ϵ_{max}	Maximum (positive) vertical deformation at maximum compression c_{max} [mm]
$F(T_{min}, e_{max})$	Reaction force at T_{min} at maximum extension e_{max} [kN]
$F(T_0, e_0)$	Reaction force before testing at T_0 and before applying movements (e_0) = 0 [kN]
$F(T_{max}, c_{max})$	Reaction force at T_{max} at maximum compression c_{max} [kN]
T_0	Temperature during construction of the FPEJ as defined in the MPII [°C]
e_0	Extension before starting the test = 0 [mm]
e_{max}	Maximum extension applied in the slow movement capacity test [mm]
c_{max}	Maximum compression applied in the slow movement capacity test [mm]

Assessment method

It is a characteristic of FPEJ that, as the structure expands and contracts, it generates tension or compression in the joint filling mixture. This is resulting from large but slowly occurring movements depending on seasonal temperature changes and from relatively small but often repeated movements induced by the traffic.

For both tests according to Annex C, Clause C.5, method a and method b a separate test specimen shall be used.

Assessment of large but slowly occurring movements

Movements related to seasonal temperature changes result in a combination of extension and compression of the FPEJ. The movement capacity M is the sum of maximum extension e_{max} and maximum compression c_{max} of the FPEJ, defined according to equation (2.2.3.1), and shall be taken from the MPII.

$$M = e_{max} + c_{max} \quad (2.2.3.1)$$

With:

M	Movement capacity [mm]
e_{max}	Maximum extension applied in the slow movement capacity test [mm]
c_{max}	Maximum compression applied in the slow movement capacity test [mm]

The movement capacity with respect to large but slowly occurring movements shall be assessed by testing according to Annex C, Clause C.5, method a. In the assessments according to Annex C, the maximum slope in traffic direction shall be taken into account according to Annex C, Clause C.4.

After testing there shall be no cracking or de-bonding of the joint filling mixture exceeding the values given in Table 2.2.3.1.

The test can be conducted according to 1st or 2nd assessment method stated below, whereas both methods are equivalent.

1st Assessment method

The FPEJ shall be tested according to Annex C, Clause C.5, method a (slow occurring movements), whereas for selection of the test specimen the provisions in Annex C, Clause C.2 shall be considered. The reaction forces $F(T_{min}, e_{max})$ and $F(T_{max}, c_{max})$ and deformations ϵ_{min} and ϵ_{max} shall be measured.

The assessment of the movement capacity M for the envisaged range of products to be covered by the ETA for all variants (including the one tested at operating temperature T_{max} and T_{min} as described above, but using a new identical specimen = reference specimen), including all components (e.g., movement aids, stabilising elements), as far as relevant, shall be done according to Annex C; Clause C.5, method a (slow occurring movements) with the following deviations:

Instead of testing under consideration of T_{max} and T_{min} , the test shall be performed at a defined intermediate temperature T_{ref} and $T_{i,exp}$ (between +5 °C and +30 °C), with the condition that all other testing conditions shall remain unchanged (i.e., slope in traffic direction and displacement ratio e_{max}/c_{max}).

T_{ref} [°C] Mean temperature at testing of reference specimen (equal to specimen tested at minimum and maximum service temperature) for testing at temperature between +5°C and +30°C
Defined as: (maximum temperature at testing + minimum temperature at testing) / 2

$T_{i,exp}$ [°C] Mean temperature at testing of other specimen i for testing at temperature between +5°C and +30°C
Defined as: (maximum temperature at testing + minimum temperature at testing) / 2

The reaction forces and deformations defined below shall be measured as described Annex C, Clause C.5, method a.

For products of the same type, a linear correlation is assumed between the change in temperature, the change in reaction forces and change in deformation: From the reaction forces $F(T_{min}, e_{max})$, $F(T_{max}, c_{max})$, $F(T_{ref}, e_{max})$ and $F(T_{ref}, c_{max})$ and deformations ϵ_{min} , ϵ_{max} , $\epsilon(T_{ref}, e_{max})$ and $\epsilon(T_{ref}, c_{max})$ the constants k_F and k_ϵ shall be calculated according to the equations (2.2.3.2) to (2.2.3.5).

$$k_{F,1}(T_{min}, e_{max}) = \frac{F(T_{min}, e_{max})}{F(T_{ref}, e_{max})} \quad (2.2.3.2)$$

$$k_{F,1}(T_{max}, c_{max}) = \frac{F(T_{max}, c_{max})}{F(T_{ref}, c_{max})} \quad (2.2.3.3)$$

$$k_{\epsilon,1}(T_{min}, e_{max}) = \frac{\epsilon_{min}}{\epsilon(T_{ref}, e_{max})} \quad (2.2.3.4)$$

$$k_{\epsilon,1}(T_{max}, c_{max}) = \frac{\epsilon_{max}}{\epsilon(T_{ref}, c_{max})} \quad (2.2.3.5)$$

Where:

$k_{F,1}(T_{min}, e_{max})$ [-] Temperature dependant constant for reaction forces F at T_{min} and e_{max} of the 1st assessment method
 $k_{F,1}(T_{max}, c_{max})$ [-] Temperature dependant constant for reaction forces F at T_{max} and c_{max} of the 1st assessment method

$k_{\varepsilon,1}(T_{min}, e_{max})$ [-] Temperature dependant constant for deformations ε at T_{min} and e_{max} of the 1st assessment method

$k_{\varepsilon,1}(T_{max}, c_{max})$ [-] Temperature dependant constant for deformations ε at T_{max} and c_{max} of the 1st assessment method

$F(T_{ref}, e_{max})$ [kN] Maximum reaction force of the reference specimen at T_{ref} at maximum extension e_{max}

$F(T_{ref}, c_{max})$ [kN] Maximum reaction force of the reference specimen at T_{ref} at maximum compression c_{max}

$\varepsilon(T_{ref}, e_{max})$ [mm] Maximum deformation of the reference specimen at T_{ref} at maximum extension e_{max}

$\varepsilon(T_{ref}, c_{max})$ [mm] Maximum deformation of the reference specimen at T_{ref} at maximum compression c_{max}

The determined constants (according to the equations (2.2.3.2) to (2.2.3.5)) for the reference test is applied to the measurement results for reaction forces and deformations obtained at intermediate temperature T_{ref} and $T_{i,exp}$ for each type of the FPEJ to calculate the expected reaction forces and deformations at the extreme temperatures T_{max} and T_{min} for the envisaged range of products to be covered by the ETA.

The reaction forces and deformations at T_{min} and T_{max} for each variant i shall be calculated according to the equations (2.2.3.6) to (2.2.3.9).

$$F_i(T_{min}, e_{max}) = F_i(T_{exp}, e_{max}) \cdot k_{F,1}(T_{min}, e_{max}) \cdot \frac{T_{i,exp} - T_{min}}{T_{ref} - T_{min}} \quad (2.2.3.6)$$

$$F_i(T_{max}, c_{max}) = F_i(T_{exp}, c_{max}) \cdot k_{F,1}(T_{max}, c_{max}) \cdot \frac{T_{max} - T_{i,exp}}{T_{max} - T_{ref}} \quad (2.2.3.7)$$

$$\varepsilon_{i,min} = \varepsilon_i(T_{exp}, e_{max}) \cdot k_{\varepsilon,1}(T_{min}, e_{max}) \cdot \frac{T_{i,exp} - T_{min}}{T_{ref} - T_{min}} \quad (2.2.3.8)$$

$$\varepsilon_{i,max} = \varepsilon_i(T_{exp}, c_{max}) \cdot k_{\varepsilon,1}(T_{max}, c_{max}) \cdot \frac{T_{max} - T_{i,exp}}{T_{max} - T_{ref}} \quad (2.2.3.9)$$

With:

$F_i(T_{min}, e_{max})$ [kN]	Effective reaction force of the variant specimen i at T_{min} at maximum extension e_{max}
$F_i(T_{max}, c_{max})$ [kN]	Effective reaction force of the variant specimen i at T_{max} at maximum compression c_{max}
$F_i(T_{exp}, e_{max})$ [kN]	Maximum reaction force of the variant specimen i at $T_{i,exp}$ at maximum extension e_{max}
$F_i(T_{exp}, c_{max})$ [kN]	Maximum reaction force of the variant specimen i at $T_{i,exp}$ at maximum compression c_{max}
$\varepsilon_i(T_{exp}, e_{max})$ [mm]	Maximum deformation of the variant specimen i at $T_{i,exp}$ at maximum extension e_{max}
$\varepsilon_i(T_{exp}, c_{max})$ [mm]	Maximum deformation of the variant specimen i at $T_{i,exp}$ at maximum compression c_{max}
$\varepsilon_{i,min}$ [mm]	Effective minimum deformation of the variant specimen i at T_{min} at maximum extension e_{max}
$\varepsilon_{i,max}$ [mm]	Effective maximum deformation of the variant specimen i at T_{max} at maximum compression c_{max}

Example for the assessment of effective reaction force of a variant i with 20 mm movement capacity M at $T_{min} = -40$ °C at maximum extension $e_{max} = 13$ mm considering the results for the reference specimen with 50 mm movement capacity M :

The movement capacity test on a specimen with 50 mm movement capacity is assessed with a reaction force $F(T_{min}, e_{max}) = 53,6$ kN at $T_{min} = -40$ °C at maximum extension $e_{max} = 33$ mm.

The same variant (reference specimen) is assessed with $F(T_{ref}, e_{max}) = 16,3$ kN at $T_{ref} = +18$ °C at maximum extension $e_{max} = 33$ mm.

Temperature dependant constant for reaction forces for T_{min} and e_{max} results to:

$$k_{F,1}(T_{min}, e_{max}) = \frac{F(T_{min}, e_{max})}{F(T_{ref}, e_{max})} = \frac{53,6}{16,3} = 3,3 \text{ [-]}.$$

A variant i with 20 mm movement capacity M is assessed with $F_i(T_{i,exp}, e_{max}) = 25,3$ kN at $T_{i,exp} = +20$ °C at maximum extension $e_{max} = 13$ mm.

The effective reaction force of that variant i at $T_{min} = -40$ °C at maximum extension $e_{max} = 13$ mm results to:

$$F_i(T_{min}, e_{max}) = F_i(T_{exp}, e_{max}) \cdot k_{F,1}(T_{min}, e_{max}) \cdot \frac{T_{i,exp} - T_{min}}{T_{ref} - T_{min}} = 25,3 \cdot 3,3 \cdot \frac{20 - (-40)}{18 - (-40)} = 86,3 \text{ [kN]}$$

The other effective reaction forces and effective deformations according to equations (2.2.3.7) to (2.2.3.9) shall be assessed for all variants i accordingly.

For all tests as described above the requirements given in Table 2.2.3.1 shall be fulfilled.

Table 2.2.3.1: Requirements and assessment criteria

Requirements
After testing according to Annex C, method a and method b there shall be no cracking or de-bonding of the joint filling mixture exceeding 1 mm width and 5 mm depth.

2nd Assessment method

The assessment of the movement capacity for the envisaged range of products to be covered by the ETA, including all components (e.g., movement aids, stabilising elements), as far as relevant, shall be done according to Annex C, Clause C.5, method a (slow occurring movements) at the minimum operating temperature T_{min} and maximum operating temperature T_{max} to be covered by the ETA. For selection of the test specimen the provisions in Annex C, Clause C.2 shall be considered. The reaction forces $F(T_{min}, e_{max})$ and $F(T_{max}, c_{max})$ and deformations ε_{min} and ε_{max} shall be measured.

For the test described above, the requirements given in Table 2.2.3.1 shall be fulfilled.

As an approximation, for a range of the FPEJ with the same construction details, the same components and the same functional principle, the maximum reaction force and the maximum vertical deformation are assumed to be linearly dependent on the thickness of the joint filling mixture D [mm], movement capacity M [mm] and the inverse of the joint width $w_{j,ref}$ [mm], as defined in equations (2.2.3.10) and (2.2.3.11).

$$F(T, x) = k_{F,2}(T, x) \frac{D \cdot M}{w_{j,ref}} \quad (2.2.3.10)$$

$$\varepsilon(T, x) = k_{\varepsilon,2}(T, x) \frac{D \cdot M}{w_{j,ref}} \quad (2.2.3.11)$$

With:

$k_{F,2}$ [kN/mm]	System constant for reaction forces of the 2 nd assessment method
$k_{\varepsilon,2}$ [-]	System constant for deformations of the 2 nd assessment method
T [°C]	T_{min} , or T_{max}
x [mm]	e_{max} or c_{max}

Hence, for similar types under identical testing conditions (temperature, slope in traffic directions, displacement ratio e_{max}/c_{max}) maximum force and maximum deformation shall be extrapolated from the test results of one type.

From the specimen tested the reaction forces $F(T_{min}, e_{max})$ and $F(T_{max}, c_{max})$ and deformations ε_{min} and ε_{max} are determined, which allows to calculate the system constants for reaction forces and deformation according to the equations (2.2.3.12) to (2.2.3.15):

$$k_{F,2}(T_{max}, c_{max}) = F(T_{max}, c_{max}) \frac{w_{j,ref}}{D \cdot M} \quad (2.2.3.12)$$

$$k_{F,2}(T_{min}, e_{max}) = F(T_{min}, e_{max}) \frac{w_{j,ref}}{D \cdot M} \quad (2.2.3.13)$$

$$k_{\varepsilon,2}(T_{max}, c_{max}) = \varepsilon_{max} \frac{w_{j,ref}}{D \cdot M} \quad (2.2.3.14)$$

$$k_{\varepsilon,2}(T_{min}, e_{max}) = \varepsilon_{min} \frac{w_{j,ref}}{D \cdot M} \quad (2.2.3.15)$$

With:

$k_{F,2}(T_{max}, c_{max})$ [kN/mm]	System constant for reaction forces at T_{max} and c_{max} of the 2 nd assessment method
$k_{F,2}(T_{min}, e_{max})$ [kN/mm]	System constant for reaction forces at T_{min} and e_{max} of the 2 nd assessment method
$k_{\varepsilon,2}(T_{max}, c_{max})$ [-]	System constant for deformations at T_{max} and c_{max} of the 2 nd assessment method
$k_{\varepsilon,2}(T_{min}, e_{max})$ [-]	System constant for deformations at T_{min} and e_{max} of the 2 nd assessment method

With the system constants the effective reaction force and effective deformation of each FPEJ specimen i within the range shall be calculated according to equations (2.2.3.16) to (2.2.3.19):

$$F_i(T_{max}, c_{max}) = k_{F,2}(T_{max}, c_{max}) \frac{D_i \cdot M_i}{w_{j,ref,i}} \quad (2.2.3.16)$$

$$F_i(T_{min}, e_{max}) = k_{F,2}(T_{min}, e_{max}) \cdot \frac{D_i \cdot M_i}{w_{j,ref,i}} \quad (2.2.3.17)$$

$$\varepsilon_{i,max} = k_{\varepsilon,2}(T_{max}, c_{max}) \frac{D_i \cdot M_i}{w_{j,ref,i}} \quad (2.2.3.18)$$

$$\varepsilon_{i,min} = k_{\varepsilon,2}(T_{min}, e_{max}) \cdot \frac{D_i \cdot M_i}{w_{j,ref,i}} \quad (2.2.3.19)$$

With:

D_i [mm]	Thickness of the joint filling mixture of specimen i
M_i [mm]	Movement capacity of specimen i
$w_{j,ref,i}$ [mm]	Reference width of the FPEJ specimen i

Assessment of relatively small but often repeated movements

The movement capacity with respect to fast (traffic induced) expansion and contraction shall be assessed by testing according to Annex C, Clause C.5, method b. In the assessments according to Annex C, the maximum slope in traffic direction shall be taken into account according to Annex C, Clause C.4.

For selection of the test specimen the provisions in Annex C, Clause C.2 shall be considered.

Note: It is assumed that the FPEJ has the same behaviour to traffic action on three axes. Therefore, it is only necessary to test the transversal horizontal displacement in direction of x_{joint} and x_{bridge} (means in the main direction of movement of the bridge). For the test described above, the requirements given in Table 2.2.3.1 shall be fulfilled.

Expression of results

The results of the assessment of the movement capacity shall be stated in the ETA by means of the following:

Testing according to Annex C, Clause C.5, method a and related calculations as stated above

- Movement capacity M in [mm] and related maximum extension e_{max} and maximum compression c_{max} for the whole range of products,
- The related maximum vertical deformations ε_{min} and ε_{max} and $\varepsilon_{i,min}$ and $\varepsilon_{i,max}$ in [mm] for the whole range of products,
- The maximum reaction forces $F(T_{min}, e_{max})$ and $F(T_{max}, c_{max})$ and $F_i(T_{min}, e_{max})$ and $F_i(T_{max}, c_{max})$ in [kN] for the whole range of products,
- Description of observed damages with reference to Table 2.2.3.1.

Testing according to Annex C, Clause C.5, method b

- The dynamic amplitude Δw in [mm] and the frequency in [Hz] used for the test,
- The number of cycles n_{fast} [-] applied in the test and test temperature T_{test} in [°C],
- The maximum reaction forces $F_{fast,max}$ and $F_{fast,min}$ in [kN] (force in direction of the joint axis x_{joint}),
- Description of observed damages with reference to Table 2.2.3.1.

2.2.4 Resistance to wear

Purpose of the assessment

Wear for FPEJ is related to movements either between two parts of the FPEJ or between parts of the FPEJ and the main structure. It shall be assessed how the FPEJ is affected by repeated movement in this respect.

Assessment method

Assessment shall be carried out after the assessment of movement capacity for fast occurring movements (according to Annex C, Clause C.5, method b). The test specimen shall be investigated for signs of wear at the end of the test.

Expression of results

In the ETA observations regarding wear at moving parts shall be described by means of observed damages.

2.2.5 Watertightness

Purpose of the assessment

It shall be assessed whether the main structure and the sub-components of the FPEJ under the running surface are protected from water and its chemical contents.

Assessment method

Opening of the test specimen to maximum extension e_{max} shall be carried out at a specimen temperature between +20 °C and +45 °C with a speed not exceeding 6 mm per hour. The extended specimen shall be fixed after the maximum extension e_{max} is reached and the specimen shall then be cooled down to a temperature of +25±5 °C. The water basin shall be attached above the surface of the specimen and sealed with a removable material (see Figure 2.2.5.1), whereas the water basin shall extend over the connection area of the joint filling mixture and the adjacent pavement by 50±10 mm.

Preparation of the test specimen

The test is executed after testing of the movement capacity according to Clause 2.2.3 (both tests, fast and slow occurring movements according to Annex C, Clause C.5, methods a and b) at the same test specimens used for the assessment of movement capacity and at the maximum extension e_{max} (as applied during testing according to Annex C, Clause C.5, method a) at a temperature of +25±5 °C.

The preparation of the test specimen is under the responsibility of the manufacturer. Check of appropriate documentation of the specimen preparation to be provided by the manufacturer is task of the testing body.

Execution of the test

Tap water with a temperature of +25±5 °C shall be added up to a level h between 30 mm and 60 mm and the watertightness of the specimens shall be checked for 360 min.

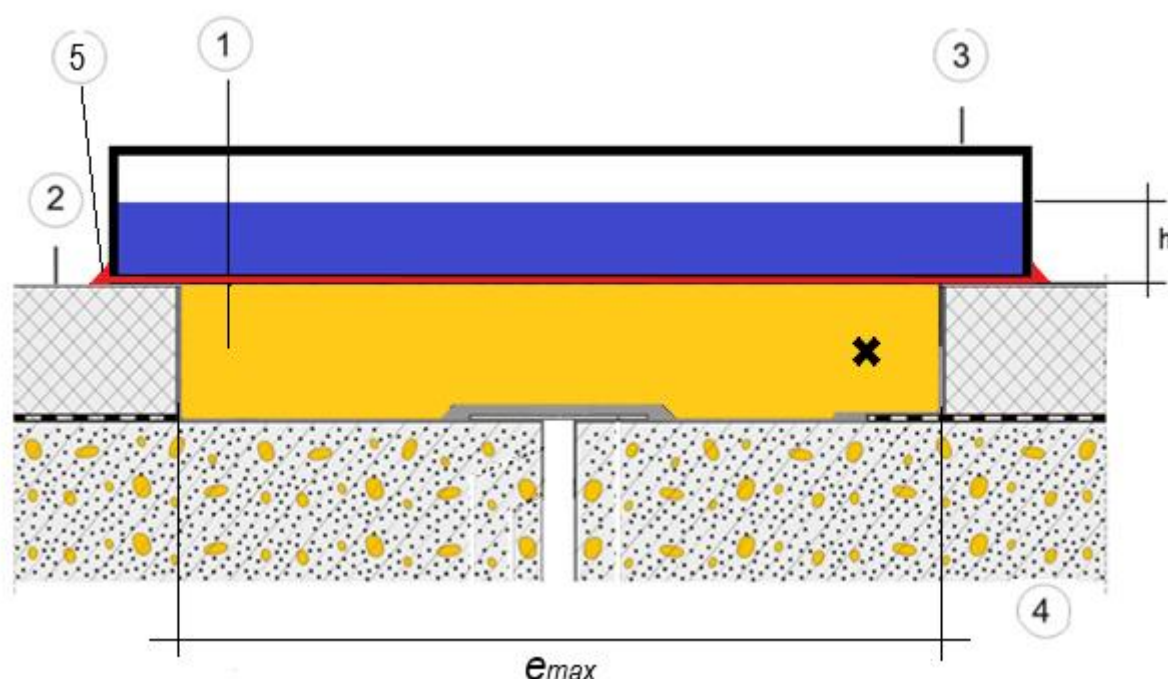


Figure 2.2.5.1: Attachment of the water basin to the test specimen – cross section

Legend to Figure 2.2.5.1:

- 1 - FPEJ specimen
- 2 - Adjacent pavement
- 3 - Water basin
- 4 - Substructure
- 5 - Sealing material
- x - Temperature cell (embedded anywhere in the joint filling mixture, approximately 20 mm deep)
- e_{max} : maximum extension as applied in the movement capacity test according to Clause C.5, method a

After the test visual inspection shall be carried out to detect leakage. Locations where leakage is observed shall be reported. The extension shall be measured with a tolerance of ± 1 mm and reported. The ambient temperature, the water level h and duration of the test shall be measured and reported.

Expression of results

The result of the assessment of the watertightness (whether there is any moisture beneath the FPEJ specimen or not) shall be stated in the ETA, whereas the following results of assessment apply: Watertight; Not watertight.

2.2.6 Bond strength to support

Purpose of the assessment

The bond strength between the joint filling mixture and the support shall be assessed to observe adhesion/cohesion failure between these materials.

Assessment method

Assessment shall be carried out according to EN 13596. The test shall be performed on Type 1 specimens according to Figure 1 a) in Clause 4 of EN 13375, whereas instead of the waterproofing sheet the joint filling mixture shall be applied, whereas the thickness of the layer of the joint filling mixture shall be the thickness of the joint filling mixture $D \pm 10$ mm of the FPEJ. Instead of the concrete support defined in EN 13375, Clause 5.2, epoxy-concrete may be used for the support of the joint filling mixture. The test shall be carried out on at least 3 specimens consisting of the joint filling mixture of the FJEP kit including primer and

other pre-treatment procedures (e.g., sand blasting or heat activation of the adjacent parts), but without any other components described in Clause 1.1. The preparation of the test specimen is under the responsibility of the manufacturer. Check of appropriate documentation of the specimen preparation to be provided by the manufacturer is task of the testing body.

The bond strength to support σ_{max} [N/mm²] shall be calculated as the mean value of the individual test results $\sigma_{max,i}$ according to equation (2.2.6.1).

$$\sigma_{max} = \frac{\sum_{i=1}^n \sigma_{max,i}}{n} \quad (2.2.6.1)$$

With:

σ_{max} Bond strength to support [N/mm²]
 $\sigma_{max,i}$ Individual test result for the bond strength to support [N/mm²]
 n_b Number of individual test result for the bond strength to support [-]

The mode of failure shall be described as follows:

- Cohesive failure of support
- Adhesive failure between support and primer (in case a primer is part of the kit)
- Adhesive failure between primer and joint filling mixture (in case a primer is part of the kit)
- Adhesive failure between support and joint filling mixture
- Cohesive failure in joint filling mixture
- Combination of above-mentioned failure modes

The mode of failure is expressed as the percentage area and site of fracture in the system under test, in terms of adhesive, cohesive or adhesive/cohesive failure.

Expression of results

The bond strength to support σ_{max} in [N/mm²] and for each tested specimen the mode of failure including the percentage area and location of fracture, referring to the possible different failure modes as stated above, shall be stated in the ETA.

2.2.7 Reaction to fire

Purpose of the assessment

Reaction to fire shall be assessed for the joint filling mixture of the FPEJ as this is the part of the FPEJ that is subject to exposure to fire.

Assessment method

The joint filling mixture according to Clause 1.3.1 (with or without surface dressing) shall be tested, using the method(s) relevant for the corresponding reaction to fire class according to EN 13501-1. The joint filling mixture shall be classified according to the Commission Delegated Regulation (EU) No 2016/364 in connection with EN 13501-1. The provisions given in Annex E shall be considered for mounting and fixing of the specimens for testing.

Expression of results

The reaction to fire class of the joint filling mixture and the conditions, for which the classification is valid, shall be stated in the ETA.

2.2.8 Content, emission and/or release of dangerous substances

Purpose of the assessment

The performance of the product regarding the emissions and/or release and, where appropriate, the content of dangerous substances will be assessed on the basis of the information provided by the manufacturer⁷ after identifying the release scenarios taking into account the intended use(s) of the product and the Member States where the manufacturer intends his product to be made available on the market.

Assessment method

The identified intended release scenario for this product and intended use with respect to dangerous substances is:

S/W2: Product with indirect contact to soil, ground- and surface water

As far as relevant for the intended use covered by the release scenario S/W2 the performance of the joint filling mixture concerning leachable substances has to be assessed. A leaching test with subsequent eluate analysis must take place, each in duplicate.

Leachable substances

Leaching tests are conducted according to EN 16637-2. The leachant shall be pH-neutral demineralised water and the ratio of liquid volume to surface area shall be selected according to EN 16637-2, Clause 9.2.

Test specimens: EN 16673-2, Clause 8 shall be considered, whereas the specimens shall be cubes of the joint filling mixture with dimensions of 100 mm x 100 mm x 100 mm.

In eluates of "6 hours" and "64 days", the following biological tests shall be conducted:

- Acute toxicity test with *Daphnia magna* Straus according to EN ISO 6341
- Toxicity test with algae according to EN ISO 8692
- Luminescent bacteria test according to EN ISO 11348-1, EN ISO 11348-2 or EN ISO 11348-3

For each biological test, *EC*₂₀-values [mg/l] shall be determined from dilution ratios 1:2, 1:4, 1:6, 1:8 and 1:16.

If the parameter TOC is higher than 10 [mg/l], the following biological tests shall be conducted with the eluates of "6 hours" and "64 days" eluates:

- Biological degradation according to OECD Test Guideline 301 part A, B, E or F.

Expression of results

Determined toxicity in biological tests must be expressed as *EC*₂₀-values in [mg/l]. Maximum determined biological degradability must be expressed as "...% within ...hours/days". The respective test methods for analysis must be specified.

⁷ The manufacturer may be asked to provide to the TAB the REACH related information which shall accompany the DoP (cf. Article 6(5) of Regulation (EU) No 305/2011).

The manufacturer is **not** obliged to:

- provide the chemical constitution and composition of the product (or of constituents of the product) to the TAB, or
- provide a written declaration to the TAB stating whether the product (or constituents of the product) contain(s) substances which are classified as dangerous according to Directive 67/548/EEC and Regulation (EC) No 1272/2008 and listed in the "Indicative list on dangerous substances" of the SGDS, taking into account the installation conditions of the construction product and the release scenarios resulting from there.

Any information provided by the manufacturer regarding the chemical composition of the products is not to be distributed to EOTA to other TABs or beyond.

2.2.9 Level differences in the running surface

Purpose of the assessment

The level differences in the running surface shall be assessed for the FPEJ without any imposed horizontal deformations and in unloaded condition as well as after loading.

Assessment method

Level differences in the running surface

Without any imposed horizontal deformations and in unloaded condition the level differences in the running surface of the FPEJ from the ideal connection line between the two adjacent pavements in the traffic direction (equals x_{joint}) shall not be greater than 5 mm. Steps shall not be greater than 3 mm (without considering surface texture). See Figure 2.2.9.1 for the definition of level differences and steps. This rule shall be applied in a horizontal position. As this is of relevance for the product before/without loading, the assessment shall be done by analysis of the MPII and technical drawings of the FPEJ.



- ① Ideal connection line
- ② Running surface of the FPEJ
- ③ FPEJ

The level differences could be in the opposite direction.

Figure 2.2.9.1: Definition of level differences and steps in the running surface for unloaded condition

After loading, the sum of level differences assessed for mechanical resistance according to Clause 2.2.1 (elastic deflection of the bridging plate $w_{1k,el}$ according to equation (2.2.1.3)) and the deformation RD resulting from the assessment of the assembled kit according to Annex B, Clause B.5.1 shall not be more than ± 12 mm.

Expression of results

The maximum level differences and steps in [mm] for unloaded condition and maximum level differences after loading in [mm] as stated above shall be stated in the ETA.

2.2.10 Skid resistance

Purpose of the assessment

The grip of the trafficked surface of the FPEJ shall be assessed.

Assessment method

The skid resistance of the FPEJ shall be assessed without surface dressing by using the portable skid resistance pendulum tester as described in EN 13036-4, Clause 9.2, using the 57 rubber slider for carriageways (user categories vehicles and cyclists according to Clause 1.2.1.1) and the 96 rubber slider

for footpaths (user category pedestrians according to Clause 1.2.1.1). For both, the normal slider width of 76,2 mm shall be used.

At least one laboratory specimen shall be prepared under the responsibility of the manufacturer and following the MPII in order to obtain a representative surface texture. Check of appropriate documentation of the specimen preparation to be provided by the manufacturer is task of the testing body. The dimensions of the specimen shall comply with EN 13036-4, Clause 9.2.1, the thickness of the specimen shall be the thickness of the joint filling mixture $D \pm 10 \%$ (if there is a range of possible thicknesses D , the thickness of the specimen shall be within this range).

The test shall be performed according to EN 13036-4, Clause 11, taking into account the relevant conditions for measurements in the laboratory (EN 13036-4, Clause 9.2) (e.g., Clause 11.14 of EN 13036-4 is not relevant as referred Clause 10.3 is only relevant for field sampling).

The Pendulum Test Value (PTV) for the user category assessed shall be calculated according to EN 13036-4, Clause 12.

Expression of results

The following results shall be stated in the ETA:

PTV_{V+C} [-] for user category vehicles and cyclists

PTV_p [-] for user category pedestrians

2.2.11 Wheel tracking (only for maximum operating temperature $T_{max} = +60$ °C according to Clause 1.2.1.2)

Purpose of the assessment

The rutting behaviour of the joint filling mixture under high operating temperature ($T_{max} = +60$ °C according to Clause 1.2.1.2) shall be assessed, if the FPEJ is intended to be used at this operating temperature.

Assessment method

Assessment shall be done according to EN 12697-22. Whereas the test shall be conducted with the “small size device for use with rectangular plates” according to EN 12697-22, Clause 6.3. The test shall be carried out according to EN 12697-22, Clause 8.3 and evaluated by “Procedure B” in air according to EN 12697-22, Clause 8.3.5. The assessment shall be carried out on test specimens according to EN 12697-22, Clause 7. Different to EN 12697-22, Clause 7.2.1.1 the test specimen shall be manufactured from the joint filling mixture without surface dressing and without any other component of the FPEJ. At least two specimens (according to EN 12697-22, Table 2) shall be prepared, taking into account the MPII, under the responsibility of the manufacturer. Check of appropriate documentation of the specimen preparation to be provided by the manufacturer is task of the testing body. The test shall be performed at constant temperature $+60$ °C (tolerance ± 2 °C), in order to cope with the level of the highest maximum operating temperature according to Clause 1.2.1.2. By means of this, surface areas, directly exposed to the sun, and to be assessed for the maximum operating temperature increased by 15 K is covered.

The proportional rut depth PRD_{AIR} [%] shall be calculated for each test specimen according to EN 12697-22, Clause 9.3.2.3.

Expression of results

The mean proportional rut depth PRD_{AIR} [%] according to EN 12697-22, Clause 9.3.2.4 and the thickness of the specimens according to EN 12697-22, Clause 7.3.2 shall be stated in the ETA.

2.2.12 Resistance against chemicals (petrol, diesel)

Purpose of the assessment

The influence of exposure to chemicals on the joint filling mixture shall be assessed.

Assessment method

Assessment shall be done on specimens produced from the joint filling mixture according to Clause 1.3.1 without surface dressing. Assessment of resistance of the joint filling mixture against petrol and diesel shall be done according to EN 13529, Clause 6.2 without pressure, whereas the duration of exposure is defined with 3 days in order to cover ordinary and extraordinary situations. Deviating from EN 13529, instead of the evaluation according to EN 13529, Clause 6.4, the relative change of tensile strength and elongation at break according to EN ISO 527-2 and the relative change of Shore hardness A according to ISO 48-4 shall be assessed. Deviating from EN 13529, Clause 6.1 the test specimens for the assessment of the relative change of material characteristics shall be:

- Change of tensile strength $\Delta\sigma_{b,petrol}$ and $\Delta\sigma_{b,diesel}$ and elongation at break $\Delta\varepsilon_{b,petrol}$ and $\Delta\varepsilon_{b,diesel}$: free films of the joint filling mixture with sufficient size to produce the required amount of test specimen (at least 5 for each chemical) Type A2 according to EN ISO 527-2, Figure 1 and Table 1. Deviating from these conditions, the thickness of the specimens for joint filling mixture including filling material shall be equal to the maximum grain size of the filling material or according to EN ISO 527-2, Table 1, whichever is the greater. Test speed of 50 mm/min shall be used. The free films shall be produced, taking into account the provisions for mixing and curing of the joint filling mixture as prescribed in the MPII in the following way:
 - A rigid support (e.g. of plywood, glass, plastic coated chipboard or MDF) of sufficient size to provide an even and stable support on which to prepare the free films shall be placed on a firm support ensuring that it is horizontal.
 - A release agent, to avoid adhesion to the support and to allow subsequent removal of the free films, shall be applied to the support and, where necessary, allowed to dry. Examples of release agents known to work are siliconised paper, spray furniture polish, spray silicone release agent and microcrystalline paraffin wax.
 - The joint filling mixture shall be applied by spreading to the prepared support.
 - After curing the sample shall be removed, without straining, from the support. Any area of free film falling outside the specified specimen thickness shall be rejected.

The test specimen shall be prepared according to EN ISO 527-3, Clause 6.2.

- Change of Shore hardness A $\Delta H_{A,petrol}$ and $\Delta H_{A,diesel}$: one free film of the joint filling mixture with sufficient size to take at least 5 measurements according to ISO 48-4, Clause 9.3 and with thickness between 6 mm and thickness of the joint filling mixture D shall be produced for exposure to each chemical. For testing of a joint filling mixture including filling material, the minimum thickness shall be 6 mm or equal to the maximum grain size of the filling material, whichever is the greater. The free films shall be produced as described above, taking into account the provisions for mixing and curing of the joint filling mixture as prescribed in the MPII (deviation to ISO 48-4, Clause 8 regarding the provisions related to the minimum time between vulcanisation and testing).

The preparation of the test specimen is under the responsibility of the manufacturer. Check of appropriate documentation of the specimen preparation to be provided by the manufacturer is task of the testing body.

Solutions as defined in EN 13529, Annex A, Table A.1, row 1 and row 3 shall be used.

Deviation to EN 13529, Clause 6.4: After the exposure to petrol and diesel the specimens shall be dried till mass constancy before testing.

Tensile strength shall be determined according to EN ISO 527-1, Clause 10.1 and elongation at break shall be determined according to EN ISO 527-1, Clause 10.2.

The relative change of the tensile strength $\Delta\sigma_{b,petrol}$ and $\Delta\sigma_{b,diesel}$, elongation at break $\Delta\varepsilon_{b,petrol}$ and $\Delta\varepsilon_{b,diesel}$ and Shore hardness A $\Delta H_{A,petrol}$ and $\Delta H_{A,diesel}$ shall be calculated by dividing the arithmetic average of the individual test results after exposure by the arithmetic average of the individual test results of the unconditioned material.

Expression of results

The relative change of tensile strength $\Delta\sigma_{b,petrol}$ and $\Delta\sigma_{b,diesel}$, elongation at break $\Delta\varepsilon_{b,petrol}$ and $\Delta\varepsilon_{b,diesel}$ and Shore hardness A $\Delta H_{A,petrol}$ and $\Delta H_{A,diesel}$ in [%] compared to the values of the material characteristics in the initial state shall be stated in the ETA.

2.2.13 Accelerated ageing by heat

Purpose of the assessment

The influence of exposure to heat on the joint filling mixture shall be assessed.

Assessment method

Assessment shall be done on specimens produced from the joint filling mixture according to Clause 1.3.1 without surface dressing.

Conditioning for the assessment of accelerated ageing by heat shall be done by exposure of the test specimens to an increased temperature (70 °C/28 d; see Clause D.2 in Annex D) in accordance with Annex D.

The test specimens for the assessment of the relative change of material characteristics shall be:

- Tensile strength $\Delta\sigma_{b,heat}$ and elongation at break $\Delta\varepsilon_{b,heat}$: free films of the joint filling mixture with sufficient size to produce the required amount of test specimen (at least 5) Type A2 according to EN ISO 527-2, Figure 1 and Table 1. Deviating from these conditions, the thickness of the specimens for joint filling mixture including filling material shall be equal to the maximum grain size of the filling material or according to EN ISO 527-2, Table 1, whichever is the greater. Test speed of 50±5 mm/min shall be used. The free films shall be produced as defined in Clause 2.2.12, taking into account the provisions for mixing and curing of the joint filling mixture as prescribed in the MPII. The test specimen shall be prepared as described in Clause 2.2.12.
- Shore hardness A $\Delta H_{A,heat}$: one free film of the joint filling mixture with sufficient size to take at least 5 measurements according to ISO 48-4, Clause 9.3 and with thickness between 6 mm and thickness of the joint filling mixture D shall be produced. For testing of a joint filling mixture including filling material, the minimum thickness shall be 6 mm or equal to the maximum grain size of the filling material, whichever is the greater. The free film shall be produced as defined in Clause 2.2.12, taking into account the provisions for mixing and curing of the joint filling mixture as prescribed in the MPII (deviation to ISO 48-4, Clause 8 regarding the provisions related to the minimum time between vulcanisation and testing).
- Bond strength to support $\Delta\sigma_{max,heat}$: at least 3 specimens consisting of the joint filling mixture including primer and other pre-treatment procedures (e.g., sand blasting or heat activation of the adjacent parts), but without any other components described in Clause 1.1, produced according to the provisions in Clause 2.2.6 shall be tested according to Clause 2.2.6 after exposure.

The preparation of the test specimen is under the responsibility of the manufacturer. Check of appropriate documentation of the specimen preparation to be provided by the manufacturer is task of the testing body.

Tensile strength shall be determined according to EN ISO 527-1, Clause 10.1 and elongation at break shall be determined according to EN ISO 527-1, Clause 10.2.

The relative change of the tensile strength $\Delta\sigma_{b,heat}$, elongation at break $\Delta\varepsilon_{b,heat}$, Shore hardness A $\Delta H_{A,heat}$ and bond strength to support $\Delta\sigma_{max,heat}$ shall be calculated by dividing the arithmetic average of the individual test results after exposure by the arithmetic average of the individual test results of the unconditioned material.

Expression of results

For both assessment methods the relative change in % compared to the values of the material in the initial state shall be stated in the ETA together with the respective assessment method used. In addition, the changing in appearance shall be stated in the ETA in case of 2nd assessment method.

The relative change of tensile strength $\Delta\sigma_{b,heat}$, elongation at break $\Delta\varepsilon_{b,heat}$, shore hardness A $\Delta H_{A,heat}$ and bond strength to support $\Delta\sigma_{max,heat}$ in [%] compared to the values of the material characteristics in the initial state shall be stated in the ETA.

2.2.14 Ageing resulting from UV radiation and weathering

Purpose of the assessment

The influence of exposure to UV radiation and weathering on the joint filling mixture shall be assessed.

Assessment method

Assessment shall be done on joint filling mixture according to Clause 1.3.1 without surface dressing.

Conditioning for the assessment of ageing resulting from UV radiation and weathering shall be done by exposure of the test specimens in accordance with Annex A.

Specimens shall be exposed for a total of 2020 hours for a working life of 10 years and 3030 hours for a working life of 15 years.

Details on exposure conditions are defined in Annex A, Clause A.5, by categorisation to climatic zones:

- condition “S” (severe condition) and
- condition “M” (moderate condition).

The climatic conditions “M” or “S” and the exposure procedure shall follow Annex A.

The test specimens for the assessment of the relative change of material characteristics shall be:

- Tensile strength $\Delta\sigma_{b,UV}$ and elongation at break $\Delta\varepsilon_{b,UV}$: free films of the joint filling mixture with sufficient size to produce the required amount of test specimen (at least 5) Type A2 according to EN ISO 527-2, Figure 1 and Table 1. Deviating from these conditions, the thickness of the specimens for joint filling mixture including filling material shall be equal to the maximum grain size of the filling material or according to EN ISO 527-2, Table 1, whichever is the greater. Test speed of 50 ± 5 mm/min shall be used. The free films shall be produced as defined in Clause 2.2.12, taking into account the provisions for mixing and curing of the joint filling mixture as prescribed in the MPII. The test specimen shall be prepared as described in Clause 2.2.12.
- Shore hardness A $\Delta H_{A,UV}$: one free film of the joint filling mixture with sufficient size to take at least 5 measurements according to ISO 48-4, Clause 9.3 and with thickness between 6 mm and thickness of the joint filling mixture D shall be produced. For testing of a joint filling mixture including filling material, the minimum thickness shall be 6 mm or equal to the maximum grain size of the filling material, whichever is the greater. The free film shall be produced as defined in Clause 2.2.12, taking into account the provisions for mixing and curing of the joint filling mixture as prescribed in the MPII (deviation to ISO 48-4, Clause 8 regarding the provisions related to the minimum time between vulcanisation and testing).
- Bond strength to support $\Delta\sigma_{max,UV}$: at least 3 specimens consisting of the joint filling mixture including primer and other pre-treatment procedures (e.g., sand blasting or heat activation of the adjacent parts), but without any other components described in Clause 1.1, produced according to the provisions in Clause 2.2.6 shall be tested according to Clause 2.2.6 after exposure.

The preparation of the test specimen is under the responsibility of the manufacturer. Check of appropriate documentation of the specimen preparation to be provided by the manufacturer is task of the testing body.

Tensile strength shall be determined according to EN ISO 527-1, Clause 10.1 and elongation at break shall be determined according to EN ISO 527-1, Clause 10.2.

The relative change of the tensile strength $\Delta\sigma_{b,UV}$, elongation at break $\Delta\varepsilon_{b,UV}$, Shore hardness A $\Delta H_{A,UV}$ and bond strength to support $\Delta\sigma_{max,UV}$ shall be calculated by dividing the arithmetic average of the individual test results after exposure by the arithmetic average of the individual test results of the unconditioned material.

Expression of results

As the climatic condition “S” (severe condition) covers the climatic condition “M” (moderate condition), only in case when the assessment procedure for climatic condition “M” is used, this shall be stated in ETA.

The relative change of tensile strength $\Delta\sigma_{b,UV}$, elongation at break $\Delta\varepsilon_{b,UV}$, shore hardness A $\Delta H_{A,UV}$ and bond strength to support $\Delta\sigma_{max,UV}$ in [%] compared to the values of the material characteristics in the initial state shall be stated in the ETA.

2.2.15 Ageing resulting from ozone

Purpose of the assessment

The influence of exposure to ozone on the joint filling mixture shall be assessed.

Assessment method

Assessment shall be done on joint filling mixture according to Clause 1.3.1 without surface dressing.

To assess the sensitivity of the joint filling mixture to ozone, the joint filling mixture shall be tested. The test specimen shall be assessed according to test method ISO 1431-1 (Test procedure A: static condition).

The test conditions are the following: 72 hours of exposure at the temperature of 40 °C, with an ozone concentration of 50 pphm. The test specimen is submitted to 20 % of elongation.

In deviation to ISO 1431-1, Clause 7.2 the test specimen shall be prepared from a free film as defined in Clause 2.2.12, the thickness of the specimens for joint filling mixture including filling material shall be equal to the maximum grain size of the filling material or according to ISO 1431-1, Clause 7.2, whichever is the greater.

For the evaluation of size of defects is performed visually, in case of visible cracks the size shall be measured by a calliper gauge.

Expression of results

Cracks shall be described in the ETA by means of:

- No visible cracks
- visible cracks

2.2.16 Ageing resulting from freeze/thaw with de-icing salts

Purpose of the assessment

The influence of exposure to de-icing salts on the joint filling mixture shall be assessed.

Assessment method

The specimens, shall be subjected to 50 cycles in accordance with EN 13687-1, whereas the resistance to alkali is covered in general by using a 1% NaOH solution or NaCl solution as defined in EN 13687-1. The duration of exposure is defined with 3 days in order to cover ordinary and extraordinary situations. In case of surface dressing made of mineral material, assessment shall be done on joint filling mixture including surface dressing.

The test specimens for the assessment of the relative change of material characteristics shall be:

- Tensile strength $\Delta\sigma_{b,ice}$ and elongation at break $\Delta\varepsilon_{b,ice}$: free films of the joint filling mixture with sufficient size to produce the required amount of test specimen (at least 5) Type A2 according to EN ISO 527-2, Figure 1 and Table 1. Deviating from these conditions, the thickness of the specimens for joint filling mixture including filling material shall be equal to the maximum grain size of the filling material or according to EN ISO 527-2, Table 1, whichever is the greater. Test speed of 50±5 mm/min shall be used. The free films shall be produced as defined in Clause 2.2.12, taking into account the provisions for mixing and curing of the joint filling mixture as prescribed in the MPII. The test specimen shall be prepared as described in Clause 2.2.12.
- Shore hardness A $\Delta H_{A,ice}$: one free film of the joint filling mixture with sufficient size to take at least 5 measurements according to ISO 48-4, Clause 9.3 and with thickness between 6 mm and thickness of

the joint filling mixture D shall be produced. For testing of a joint filling mixture including filling material, the minimum thickness shall be 6 mm or equal to the maximum grain size of the filling material, whichever is the greater. The free film shall be produced as defined in Clause 2.2.12, taking into account the provisions for mixing and curing of the joint filling mixture as prescribed in the MPII (deviation to ISO 48-4, Clause 8 regarding the provisions related to the minimum time between vulcanisation and testing).

- Bond strength to support $\Delta\sigma_{max,ice}$: at least 3 specimens consisting of the joint filling mixture including primer and other pre-treatment procedures (e.g., sand blasting or heat activation of the adjacent parts), but without any other components described in Clause 1.1, produced according to the provisions in Clause 2.2.6 shall be tested according to Clause 2.2.6 after exposure.

The preparation of the test specimen is under the responsibility of the manufacturer. Check of appropriate documentation of the specimen preparation to be provided by the manufacturer is task of the testing body.

Tensile strength shall be determined according to EN ISO 527-1, Clause 10.1 and elongation at break shall be determined according to EN ISO 527-1, Clause 10.2.

The relative change of the tensile strength $\Delta\sigma_{b,ice}$, elongation at break $\Delta\epsilon_{b,ice}$, Shore hardness A $\Delta H_{A,ice}$ and bond strength to support $\Delta\sigma_{max,ice}$ shall be calculated by dividing the arithmetic average of the individual test results after exposure by the arithmetic average of the individual test results of the unconditioned material.

Expression of results

The relative change of tensile strength $\Delta\sigma_{b,ice}$, elongation at break $\Delta\epsilon_{b,ice}$, shore hardness A $\Delta H_{A,ice}$ and bond strength to support $\Delta\sigma_{max,ice}$ in [%] compared to the values of the material characteristics in the initial state shall be stated in the ETA.

3 ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE

3.1 System(s) of assessment and verification of constancy of performance to be applied

For the products covered by this EAD the applicable European legal act is Commission Decision 2001/19/EC.

The system is 1.

3.2 Tasks of the manufacturer

The cornerstones of the actions to be undertaken by the manufacturer of the product in the procedure of assessment and verification of constancy of performance are laid down in Table 3.2.1.

The manufacturer (regarding the components he buys from the market with DoP) shall take into account the Declaration of Performance issued by the manufacturer of that component. No retesting is necessary.

Table 3.2.1 Control plan for the manufacturer; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC) [including testing of samples taken at the factory in accordance with a prescribed test plan]					
1	Incoming material	Documentation of incoming materials For individual components Rows 4 to 36 of this Table apply	For individual components Rows 4 to 36 of this Table apply	According to control plan	Each Delivery
2	Production	Description of production	According to control plan	According to control plan	Continuously
3	Documentation of FPC	Documentation (description, working/testing instructions) Calibration of measurement means	Documentation According to of fulfilment of Rows 4 to 36 of this Table apply	According to control plan	Continuously
Joint filling mixture based on synthetic polymer (without additional filling material)					
4	Viscosity	EN ISO 3219-2	MDV*) Tolerances laid down in control plan	According to control plan	Each batch (batch means production unit)
5	Density	EN ISO 2811-1	MDV*) Tolerances laid down in control plan	According to control plan	Each batch
6	Functional group content Isocyanate content (as far as relevant) Amine functions (as far as relevant)	EN 1242 EN 1877-2	MDV*) Tolerances laid down in control plan	According to control plan	Each batch
7	IR- spectroscopy components and hardened joint filling mixture (as far as relevant)	EN 1767, Procedure 7.1	MDV*) The position and the relative intensity of the peaks shall be in accordance with the reference spectrum.	According to control plan	Each batch
8	TGA of hardened joint filling mixture	Clause 3.4.1	According to control plan	According to control plan	Once a year
9	DMA	Clause 3.4.2	According to control plan	According to control plan	Once a year
Parameters 4 - 9 are related to the essential characteristics 3,5,6,7,8 in Table 2.1.1 for the FPEJ					

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Joint filling mixture based on synthetic polymer (with additional filling material, where relevant)					
10	Hardness Shore A of hardened mixture	ISO 48-8	MDV*) Tolerances laid down in control plan	According to control plan	Each batch (batch means production unit)
11	Tensile strength of hardened mixture	Clause 3.4.3	MDV*) Tolerances laid down in control plan	According to control plan	Each batch
12	Elongation at break of hardened mixture	Clause 3.4.3	MDV*) Tolerances laid down in control plan	According to control plan	Each batch
13	Amount of additional filling material made of e.g., rubber granules (according to Table 2c)	According to control plan	According to control plan	According to control plan	According to control plan
	Parameters 10 - 13 are related to the essential characteristics 3,5,6,7,8 in Table 2.1.1 for the FPEJ				
Additional filling material					
14	Grain size	According to control plan	MDV *) Tolerances laid down in control plan	According to control plan	Each batch
15	Moisture content (where relevant)			According to control plan	Each batch
16	Type and related material parameters	According to control plan	Confirmation with technical data sheet	According to control plan	Each delivery
	Parameters 14 - 16 are related to essential characteristics 3,7,8 in Table 2.1.1 for the FPEJ				
Surface dressing					
17	Type and grain size	Clause 3.4.4	MDV*) Tolerances laid down in control plan	1	Each delivery
18	Chemical composition (where relevant, depending on the type of material)	According to control plan	Confirmation with technical data sheet	According to control plan	Each delivery
	Parameters 17 - 18 are related to essential characteristics 5,7 in Table 2.1.1 for the FPEJ				

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Movement aid/stabilising element					
19	Material quality	According to control plan	According to control plan; Confirmation with technical data sheet or inspection document according to EN 10204	According to control plan	Each delivery
20	Dimensions	According to control plan	Confirmation with technical data sheet	According to control plan	Each delivery
	Parameters 19 - 20 are related to essential characteristics 3,4,7 in Table 2.1.1 for the FPEJ				
Sliding plate/sheet					
21	Relevant material parameters	According to control plan	According to control plan; Confirmation with technical data sheet	According to control plan	Each delivery
22	Dimensions (Sliding plate)	According to control plan	Confirmation with technical data sheet	According to control plan	Each delivery
	Parameters 21 - 22 are related to essential characteristics 3,4,7 in Table 2.1.1 for the FPEJ				
Anchorage system of the bridging plate and the L-Brackets					
23	Relevant parameters	According to the relevant technical specification (e.g., EAD 330232-01-0601)	According to control plan; Confirmation with DoP and technical data sheet	According to control plan	Each delivery
24	Dimensions	According to control plan	Confirmation with technical data sheet	According to control plan	Each delivery
	Parameters 23 - 24 are related to essential characteristics 1,2,4,6,7 in Table 2.1.1 for the FPEJ				

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Bridging plate and L-Brackets					
25	Yield point	According to control plan	According to control plan; Inspection document Type 3.1 according to EN 10204	According to control plan	Each delivery
26	Tensile strength	According to control plan	According to control plan; Inspection document Type 3.1 according to EN 10204	According to control plan	Each delivery
27	Elongation at rupture	According to control plan	According to control plan; Inspection document Type 3.1 according to EN 10204	According to control plan	Each delivery
28	Chemical composition	According to control plan	According to control plan; Inspection document Type 3.1 according to EN 10204	According to control plan	Each delivery
29	Dimensions (thickness, width)	Measurement by gauge	According to control plan; Inspection document Type 3.1 according to EN 10204	1	Each delivery
30	Corrosion protection (where relevant)	According to control plan	According to control plan; Inspection document Type 3.1 according to EN 10204	According to control plan	Each delivery
31	Centring pin	According to control plan	According to control plan; Confirmation with technical data sheet	According to control plan	Each delivery

	Parameters 25 - 31 are related to essential characteristics 1,2,4,6,7 in Table 2.1.1 for the FPEJ				
No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Debonding strip					
32	Dimensions	ISO 2286-3	MDV*) Tolerances laid down in control plan; Confirmation with technical data sheet	According to control plan	Each delivery
33	Tensile strength	ISO 37	MDV*) Tolerances laid down in control plan; Confirmation with technical data sheet	According to control plan	Each delivery
34	Elongation at break	ISO 37	MDV*) Tolerances laid down in control plan; Confirmation with technical data sheet	According to control plan	Each delivery
	Parameters 32 - 34 are related to essential characteristics 3,4,7 in Table 2.1.1 for the FPEJ				
Primer					
35	Density	According to control plan	MDV*) Tolerances laid down in control plan	According to control plan	Each delivery
36	Dynamic viscosity	EN ISO 3219-2	MDV*) Tolerances laid down in control plan	According to control plan	Each delivery
	Parameters 35 - 36 are related to essential characteristics 5,7 in Table 2.1.1 for the FPEJ				

*) MDV Manufacturer declared value established by the manufacturer of the kit in relation to the performances of the kit

3.3 Tasks of the notified body

The cornerstones of the actions to be undertaken by the notified body in the procedure of assessment and verification of constancy of performance for the FPEJ are laid down in Table 3.3.1.

Table 3.3.1 Control plan for the notified body; cornerstones

No	Subject/type of control (product, raw/constituent material, component - indicating characteristic concerned)	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Initial inspection of the manufacturing plant and of factory production control					
1	Notified Body will ascertain that the factory production control with the staff and equipment are suitable to ensure a continuous and orderly manufacturing of the FPEJ.	Verification of the complete FPC as described in the control plan agreed between the TAB and the manufacturer	According to Control plan	According to Control plan	When starting the production or a new line
Continuous surveillance, assessment and evaluation of factory production control					
2	The Notified Body will ascertain that the system of factory production control and the specified manufacturing process are maintained taking account of the control plan.	Verification of the controls carried out by the manufacturer as described in the control plan agreed between the TAB and the manufacturer with reference to the raw materials, to the process and to the product as indicated in Table 3.2.1	According to Control plan	According to Control plan	At least once a year

3.4 Special methods of control and testing used for the verification of constancy of performance

Technical data sheets for the various components, including information of chemical composition (where relevant), form part of the manufacturer's technical documentation, deposited with the Technical Assessment Body.

3.4.1 TGA Analysis of hardened joint filling mixture

TGA-Analysis of the hardened joint filling mixture shall be assessed in accordance with EN ISO 11358-1. Both methods given in Clause 8 apply, depending on the type of joint filling mixture.

Whereas, confirmation by comparison of the initial test and position and maximum relative deviation in mass at temperature defined, depending on the material (e.g., 125 °C, 550 °C and 900 °C) shall be given.

3.4.2 DMA Temp.-sweep

Assessment of dynamic-mechanical characteristics versus temperature:

Basis of the investigation are the rules of ISO 4664-1 and ISO 4664-2. A test method according to EN ISO 6721 Part 1-3 (solid specimen) or according to EN 14770 (cured specimen) shall be used with the following specifications.

The dynamic-mechanical behaviour shall be assessed over a temperature range from -60 °C up to +250 °C (temperature sweep) if possible. The interpretation of the results is according to EN ISO 6721. Temperature sweeps at constant frequency and constant deformation amplitude or constant shear force inside linear-viscoelastic range shall be used for the measurement of the dynamic-mechanical behaviour of the binder mass. During the measurement all parameters (controlled parameters, measured parameters) shall be documented. Depending on the binder material (for instance the dimension of the filling materials) and the test equipment a plate-plate measuring device (e.g., diameter of 12,5 mm, 25 mm or 50 mm) or solid rectangular fixture device shall be used as the measuring geometry. The gap between the plates to fill in the test material shall have a minimum distance of 2 – 3 times the dimension of the filler materials. By using a plate-plate test geometry the specimen has to be cured inside the test geometry before testing. By use of SRF test geometry specimen can be prepared from pre-prepared sheets. Free length of SRF specimen shall be 25 mm. The measurement frequency shall be 1 Hz. The tests shall be performed with falling temperature under normal force control.

First, in a preliminary test, the deformation range resp. the shear load range in which the structure of the investigated binder material remains unmodified (reversible loading = linear viscoelastic range), shall be assessed by a so-called "amplitude sweep" for the limits of the temperature range. Resulting from this test, the loading conditions ensuring linear-viscoelasticity range are assessed. (A deformation amplitude between 0,0001 – 0,001 has been shown to be expedient in most cases.) During "amplitude sweep" pre-testing as well as during "temperature sweep" test modus the complex modulus, storage modulus, loss modulus and loss angle shall be assessed over the band of deformation/shear load resp. band of temperature.

The dynamic elastic characteristic values shall be calculated from the following equations:

$G' = [T_{0, \text{shear}} / \gamma_0] \times \cos \delta$	storage modulus G'
$G'' = [T_{0, \text{shear}} / \gamma_0] \times \sin \delta$	loss modulus G''
$G^* = [(G')^2 + (G'')^2]^{1/2}$	complex modulus G^*
$\tan \delta = G'' / G'$	loss factor
$T_{0, \text{shear}}$ = shear-force amplitude in Pa	
γ_0 = deformation amplitude	
$ G^* $ = complex modulus in Pa	
G' = storage modulus in Pa	

G'' = loss modulus in Pa

δ = loss angle

and monitored over the relevant temperature range of -60 °C to 250 °C and serve as a rheological fingerprint for the relevant binder material.

From the course of the G'' the glass transition temperature is assessed at $G''_{\max}$.

Expression of results for G' ; G'' similar course over temperature (no significant changes) ($T_g \pm 5^\circ\text{C}$, but $T_g < -50^\circ\text{C}$).

3.4.3 Tensile strength and elongation at break of the hardened joint filling mixture

The tensile strength and elongation at break of the joint filling mixture (with additional filling material, where relevant) shall be assessed in accordance with EN ISO 527-2, test specimen: Type A2 according to EN ISO 527-2, Figure 1 and Table 1, with defined thickness, aligned with the maximum grain size of the filling material or according to EN ISO 527-2, Table 1 whichever is the greater, whereas a test speed of 50 ± 5 mm/min shall be used.

3.4.4 Type and grain size of the surface dressing

The type and grain size shall be stated on basis of the assessment method given in EN 932-3 (simplified petrographic description) or EN 933-1 (particle size distribution), depending on the type of surface dressing.

4 REFERENCE DOCUMENTS

EAD 120011-00-0107	"Flexible plug expansion joints for road bridges with flexible filling based on a synthetic polymer as binder"
EAD 330232-01-0601	"Mechanical fasteners for use in concrete"
EN 513:2018	"Plastics - Poly(vinyl chloride) (PVC) based profiles - Determination of the resistance to artificial weathering"
EN 932-3:-2022	"Tests for general properties of aggregates - Part 3: Procedure and terminology for simplified petrographic description"
EN 933-1:2012	"Tests for geometrical properties of aggregates — Part 1: Determination of particle size distribution — Sieving method"
EN 1090-2:2018+A1:2024	"Execution of steel structures and aluminium structures - Part 2: Technical requirements for steel structures"
EN 1242:2013	"Adhesives - Determination of isocyanate content"
EN 1297:2004	"Flexible sheets for waterproofing - Bitumen, plastic and rubber sheets for roof waterproofing - Method of artificial ageing by long term exposure to the combination of UV radiation, elevated temperature and water"
EN 1767:1999	"Products and systems for the protection and repair of concrete structures - Test methods - Infrared analysis"
EN 1877-2:2000	"Products and systems for the protection and repair of concrete structures - Test methods; Reactive functions related to epoxy resins - Part 2: Determination of amine functions using the total basicity number"
EN 1991-1-5:2025	"Eurocode 1: Actions on structures - Part 1-5: General actions - Thermal actions"
EN 1991-2:2023	"Eurocode 1: Actions on structures - Part 2: Traffic loads on bridges and other civil engineering works"
EN 1993-1-1:2022	"Eurocode 3: Design of steel structures - Part 1-1: General rules and rules for buildings"
EN 1993-1-4:2006/A2:2020	"Eurocode 3: Design of steel structures - Part 1-4: General rules - Supplementary rules for stainless steels"
EN 1993-1-9:2005+AC:2009	"Eurocode 3: Design of steel structures - Part 1-9: Fatigue"
EN 1999-1-1: 2023	"Eurocode 9: Design of aluminium structures - Part 1-1: General rules"
EN 10025-1:2004	"Hot rolled products of structural steels - Part 1: General technical delivery conditions"
EN 10025-2:2019	"Hot rolled products of structural steels - Part 2: Technical delivery conditions for non-alloy structural steels"
EN 10025-3:2019	"Hot rolled products of structural steels - Part 3: Technical delivery conditions for normalized/normalized rolled weldable fine grain structural steels"
EN 10025-4:2019+A1:2022	"Hot rolled products of structural steels - Part 4: Technical delivery conditions for thermomechanical rolled weldable fine grain structural steels"
EN 10025-5:2019	"Hot rolled products of structural steels - Part 5: Technical delivery conditions for structural steels with improved atmospheric corrosion resistance"
EN 10025-6:2019+A1:2022	"Hot rolled products of structural steels - Part 6: Technical delivery conditions for flat products of high yield strength structural steels in the quenched and tempered condition"
EN 10204:2004	"Metallic products - Types of inspection documents"
EN 12697-22:2020+A1:2023	"Bituminous mixtures - Test methods - Part 22: Wheel tracking"
EN 13036-4:2011	"Road and airfield surface characteristics - Test methods - Part 4: Method for measurement of slip/skid resistance of a surface: The pendulum test"
EN 13108-6:2016	Bituminous mixtures - Material specifications - Part 6: Mastic Asphalt
EN 13375:2019	"Flexible sheets for waterproofing - Waterproofing of concrete bridge decks and other concrete surfaces trafficable by vehicles - Specimens preparation"
EN 13501-1:2018	"Fire classification of construction products and building elements - Part 1: Classification using data from reaction to fire tests"
EN 13529:2003	"Products and systems for the protection and repair of concrete structures - Test methods - Resistance to severe chemical attack"
EN 13596:2004	"Flexible sheets for waterproofing - Waterproofing of concrete bridge decks and other concrete surfaces trafficable by vehicles - Determination of bond strength"
EN 13687-1:2002	"Products and systems for the protection and repair of concrete structures - Test methods; Determination of thermal compatibility - Part 1: Freeze-thaw cycling with de-icing salt immersion"
EN 14770: 2023	"Bitumen and bituminous binders - Determination of complex shear modulus and phase angle - Dynamic Shear Rheometer (DSR)"

EN 16637-2:2023	"Construction products: Assessment of release of dangerous substances - Part 2: Horizontal dynamic surface leaching test"
EN ISO 527-1:2019	"Plastics - Determination of tensile properties - Part 1: General principles"
EN ISO 527-2:2025	"Plastics - Determination of tensile properties - Part 2: Test conditions for moulding and extrusion plastics"
EN ISO 527-3:2018	"Plastics - Determination of tensile properties - Part 3: Test conditions for films and sheets"
EN ISO 2081:2018	"Metallic and other inorganic coatings - Electroplated coatings of zinc with supplementary treatments on iron or steel"
EN ISO 2811-1: 2023	"Paints and varnishes - Determination of density - Part 1: Pycnometer method"
EN ISO 3219-2:2021	"Rheology - Part 2: General principles of rotational and oscillatory rheometry"
EN ISO 3506-1:2020	"Fasteners - Mechanical properties of corrosion-resistant stainless steel fasteners - Part 1: Bolts, screws and studs with specified grades and property classes"
EN ISO 3696:1995	"Water for analytical laboratory use - Specification and test methods"
EN ISO 4892-1:2024	"Plastics - Methods of exposure to laboratory light sources - Part 1: General guidance"
EN ISO 4892-2:2013 /A1:2021	"Plastics - Methods of exposure to laboratory light sources - Part 2: Xenon-arc lamps"
EN ISO 4892-3:2024	"Plastics - Methods of exposure to laboratory light sources - Part 3: Fluorescent UV lamps"
EN ISO 6341:2012	"Water quality - Determination of the inhibition of the mobility of Daphnia magna Straus (Cladocera, Crustacea) - Acute toxicity test"
EN ISO 6721-1:2019	"Plastics - Determination of dynamic mechanical properties - Part 1: General principles"
EN ISO 6721-2:2019	"Plastics - Determination of dynamic mechanical properties - Part 2: Torsion-pendulum method"
EN ISO 6721-3:2021	"Plastics - Determination of dynamic mechanical properties - Part 3: Flexural vibration - Resonance-curve method"
EN ISO 7500-1:2018	Metallic materials - Calibration and verification of static uniaxial testing machines - Part 1: Tension/compression testing machines - Calibration and verification of the force-measuring system
EN ISO 8692:2012	"Water quality - Fresh water algal growth inhibition test with unicellular green algae"
EN ISO 9223:2012	"Corrosion of metals and alloys - Corrosivity of atmospheres - Classification, determination and estimation"
EN ISO 9239-1:2025	"Reaction to fire tests for floorings - Part 1: Determination of the burning behaviour using a radiant heat source"
EN ISO 9513:2012	Metallic materials - Calibration of extensometer systems used in uniaxial testing
EN ISO 10684:2004/ AC:2009	"Fasteners - Hot dip galvanized coatings"
EN ISO 11348-1:2008 /A1:2018	"Water quality - Determination of the inhibitory effect of water samples on the light emission of Vibrio fischeri (Luminescent bacteria test) - Part 1: Method using freshly prepared bacteria"
EN ISO 11348-2:2008 /A1:2018	"Water quality - Determination of the inhibitory effect of water samples on the light emission of Vibrio fischeri (Luminescent bacteria test) - Part 2: Method using liquid-dried bacteria"
EN ISO 11348-3:2008 /A1:2018	"Water quality - Determination of the inhibitory effect of water samples on the light emission of Vibrio fischeri (Luminescent bacteria test) - Part 3: Method using freeze-dried bacteria"
EN ISO 11358-1:2022	"Plastics - Thermogravimetry (TG) of polymers - General principles"
EN ISO 11925-2:2020	"Reaction to fire tests - Ignitability of products subjected to direct impingement of flame - Part 2: Single-flame source test"
EN ISO 12944-1:2017	"Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 1: General introduction"
EN ISO 14713-1:2017	"Zinc coatings - Guidelines and recommendations for the protection against corrosion of iron and steel in structures - Part 1: General principles of design and corrosion resistance"
ISO 37: 2024	"Rubber, vulcanized or thermoplastic -- Determination of tensile stress-strain properties"
ISO 48-4:2018	"Rubber, vulcanized or thermoplastic - Determination of hardness - Part 4: Indentation hardness by durometer method (Shore hardness)"
ISO 48-8:2018	"Rubber, vulcanized or thermoplastic — Determination of hardness — Part 8: Apparent hardness of rubber-covered rollers by Pusey and Jones method"

ISO 1431-1: 2024	"Rubber, vulcanized or thermoplastic - Resistance to ozone cracking - Part 1: Static and dynamic strain testing"
ISO 2286-3:2016	"Rubber- or plastics-coated fabrics -- Determination of roll characteristics – Part 3: Method for determination of thickness"
ISO 4664-1: 2022	"Rubber, vulcanized or thermoplastic - Determination of dynamic properties - Part 1: General guidance"
ISO 4664-2:2006	"Rubber, vulcanized or thermoplastic - Determination of dynamic properties - Part 2: Torsion pendulum methods at low frequencies"
OECD Test Guideline 301 Part A:1992	"OECD Guideline for testing of chemicals – Ready Biodegradability - Part A - DOC Die-Away"
OECD Test Guideline 301 Part B:1992	"OECD Guideline for testing of chemicals – Ready Biodegradability - Part B - CO2 Evolution (Modified Sturm Test)"
OECD Test Guideline 301 Part E:1992	"OECD Guideline for testing of chemicals – Ready Biodegradability - Part E - Modified OECD Screening"
OECD Test Guideline 301 Part F:1992	"OECD Guideline for testing of chemicals – Ready Biodegradability - Part F – Manometric Respirometry"

ANNEX A – EXPOSURE PROCEDURE FOR ARTIFICIAL WEATHERING⁸

A.1 Scope

This Annex specifies exposure procedures for artificial weathering, for the apparatuses and the conditions for exposing test specimens to laboratory light sources, elevated temperature, humidity and wetting conditions.

Distinction is made of to two different sets of conditions for exposure, defined as “conditions M” and “conditions S”, based on the different climatic zones of use in Europe, for either apparatuses with Xenon arc light source or fluorescent UV light source.

A.2 Principle

Test specimens, being a cured joint filling mixture as defined in Clause 1.3.1 are exposed in a Xenon arc or fluorescent UV artificial weathering apparatus at a specified irradiance, Black and White Standard Temperature, relative humidity and spray cycles.

After defined UV radiant dose the changes in characteristics are determined.

A.3 Apparatus

A.3.1 Artificial weathering apparatus

- with a Xenon arc light source or
- with a fluorescent UV light source.

The apparatus shall comply with EN ISO 4892 – Parts 1, 2 and 3 and with the following specifications:

A.3.1.1 Xenon arc light source

In accordance with method A of EN ISO 4892-2, with a spectral irradiance of (550 ± 55) W/m² in the bandpass of 290 nm to 800 nm and a spectral irradiance of (60 ± 12) W/m² in the bandpass of 290 nm to 400 nm.

A.3.1.2 Fluorescent UV light source

In accordance with EN ISO 4892-3, a laboratory light source type 1 (UV-A 340 nm peak) where radiant emission below 400 nm makes up at least 80% of its total light output and where radiant emission below 300 nm is less than 2% of its total light output, with a spectral irradiance of (45 ± 10) W/m² in the bandpass of 300 nm to 400 nm.

A.3.1.3 Test chamber

Containing a frame to retain the test specimen's holders.

A.3.1.3.1 Specimen holders for Xenon arc light source apparatus

The specimen holders for Xenon arc light source apparatus shall be in accordance with Clause 4.7 of EN ISO 4892-2.

A.3.1.3.2 Specimen arrangement for fluorescent UV light source apparatus (in accordance with EN 1297)

The test specimen racks shall allow the specimens to

- lie flat in the plane $\geq 5^\circ$ above the horizontal;
- be mounted so that the exposed face is in the plane of the uniform irradiance.

The specimens (test specimens see Clause A.4) shall be attached to stainless steel platens of at least the same size as the specimens by appropriate means.

⁸ This Annex partly transposes the provisions of EOTA TR 10

The attachment shall leave an area open to free irradiation in order that subsequent tests can be performed on irradiated parts of the specimen.

For inclinations near to horizontal the specimens may alternatively be placed in stainless steel pans of at least the same size as the specimens.

The specimens shall be weighted in this arrangement by means of a U-shaped stainless frame.

The external dimensions of the frame shall correspond to the specimen size.

The cross section of the steel section shall be $(5 \pm 0,5)$ mm by approximately 10 mm.

The dimension of $(5 \pm 0,5)$ mm stands for the width of the cross section, i.e., the plane that is in contact with the specimen.

If the specimens are placed in pans, the lower end of the pans shall have sufficient slits or holes to avoid any collection of water.

A.3.1.4 Spray nozzles

To provide a uniform and continuous wetting of the exposed test specimens for defined periods of time.

For fluorescent UV light source apparatus, the flow rate through the nozzles shall be (10 ± 3) l/(min.m²) of the exposed surface.

A.3.1.5 Means of providing controlled humidity

At the defined level.

A.3.1.6 Means of controlling air temperature

Within the test chamber.

A.3.1.7 Black Standard thermometer

In accordance with Clause 5.2.2.1 of EN ISO 4892-1, with a response time less than 1 minute and a means of recording maximum temperatures during each cycle.

A.3.1.8 White Standard thermometer

In accordance with Clause 5.2.3 of EN ISO 4892-1, and with means of recording maximum temperatures during each cycle.

A.3.1.9 Device

To determine the UV radiant exposure in the wavelength region 280 nm to 400 nm expressed in joules per square metre (J/m²).

A.3.1.10 Device (solar eye control)

To monitor the level of radiation output of the light source(s).

A.3.2 Demineralised water

Grade 3 according to EN ISO 3696.

NOTE – In general the temperature of the water to be used in the spraying procedure will be (25 ± 5) °C.

A.3.3 Cycle timer

A continuously operating cycle timer shall be provided to program the selected cycle of UV and spraying periods.

Hour meters shall be provided to record total time of operation and total time of UV exposure.

A.4 Test specimen

A.4.1 Dimensions

The test specimens shall be made from the joint filling mixture as defined in Clause 1.3.1.

The preparation of the test specimens is under the responsibility of the manufacturer. Check of appropriate documentation of the specimen preparation to be provided by the manufacturer is task of the testing body.

The dimensions of test specimens shall be determined by the size of the test specimen racks or holder and shall in any way be of sufficient size to provide the test specimens (number and size) needed for the test methods to evaluate any exposure effects on the material characteristics of joint filling mixture as defined in Clause 2.2.14.

NOTE – In general to avoid possible effects, due to exposure to artificial weathering, at the edges of the test specimens meant for evaluation purposes, these test specimens shall be prepared from exposed samples, with greater dimensions.

A.4.2 Number

The number of test specimens equals the number of test specimens needed for those test methods used to evaluate any exposure effects (change of related values) as defined in Clause 2.2.14 plus at least three series of specimens for recommended checks between times.

A.4.3 Preparation

The product shall be applied in such a way, that a free sample is obtained (as defined in Clause 2.2.12).

After curing, the test specimens shall be cut from these free samples with dimensions as defined in Clause 2.2.12.

The test specimens shall be placed loose-laid in the specimen rack or holder.

A.4.4 Curing and conditioning

The free samples shall be cured at a temperature of $(23 \pm 2) ^\circ\text{C}$ and a relative humidity of $(50 \pm 5) \%$ for at least the period as prescribed by the manufacturer.

The test specimens, prepared from the cured free samples, shall be conditioned at a temperature of $(23 \pm 2) ^\circ\text{C}$ and a relative humidity of $(50 \pm 5) \%$ for a period of at least 16 hours and at the most for 168 hours (one week).

A.5 Procedure

A.5.1 General

For the simulation of the different climates in Europe there are different exposure conditions:

- **exposure conditions "M"**: for simulation of moderate climate (**M**)
- **exposure conditions "S"**: for simulation of severe (hot and dry) climate (**S**)

The climatic zones are categorized M (moderate climate) and S (severe climate) as defined in Table A.5.1.1

Table A.5.1.1 – Categorization of climatic zones in Europe

	Moderate climate (M)	Severe climate (S)
Annual radiant exposure on horizontal surface	< 5 GJ/m ²	> 5 GJ/m ²
Average temperature of the warmest month per year	< 22 °C	> 22 °C

If the annual solar radiant exposure on a horizontal surface is equal to or greater than 5 GJ/m² and/or the average temperature of the warmest month of the year is equal to or greater than 22 °C the climate is classified as severe (S).

A.5.2 Exposure conditions "M" for Xenon-arc weathering apparatus

A.5.2.1 The Black Standard Temperature (BST) shall be (60 ± 3) °C.

The air temperature in the test chamber shall be controlled to a constant value such that the BST equals the required value at the end of the dry period.

A.5.2.2 The White Standard Temperature (WST) shall be between 40 °C and 45 °C.

NOTE – The WST is predetermined by the procedure in Clause A.5.2.1. It should lie within the specified range, otherwise the manufacturer of the weathering apparatus should be contacted.

A.5.2.3 The spray cycle used shall be 18/102 (18 minutes spraying / 102 minutes dry period) in accordance with EN ISO 4892-2

NOTE – Sample surfaces shall be continuously sprayed during the spray period, otherwise the manufacturer of the weathering apparatus should be contacted.

A.5.2.4 The relative humidity during the dry period shall be (65 ± 5) %

A.5.3 Exposure conditions "S" for Xenon-arc weathering apparatus

A.5.3.1 The Black Standard Temperature (BST) shall be (70 ± 3) °C.

The air temperature in the test chamber shall be controlled to a constant value such that the BST equals the required value at the end of the dry period.

A.5.3.2 The White Standard Temperature (WST) shall be between 50 °C and 55 °C.

NOTE – The WST is predetermined by the procedure in Clause A.5.3.1. It should lie within the specified range, otherwise the manufacturer of the weathering apparatus should be contacted.

A.5.3.3 The spray cycle used shall be 18/102 (18 minutes spraying / 102 minutes dry period) in accordance with EN ISO 4892-2.

NOTE – Sample surfaces shall be continuously sprayed during the spray period, otherwise the manufacturer of the weathering apparatus should be contacted.

A.5.3.4 The relative humidity during the dry period shall be (65 ± 5) %.

A.5.4 Exposure conditions "M" for fluorescent UV weathering apparatus

A.5.4.1 The Black Standard Temperature (BST) shall be (50 ± 3) °C.

The air temperature in the test chamber shall be controlled to a constant value such that the BST equals the required value at the end of the dry period.

A.5.4.2 The spray cycle used shall be 60 minutes / 300 minutes (1 hour spraying and 5 hours dry period) in accordance with EN ISO 4892-3.

NOTE – Sample surfaces shall be continuously sprayed during the spray period, otherwise the manufacturer of the weathering apparatus should be contacted.

A.5.4.3 The relative humidity during the dry period shall be $(10 \pm 5) \%$.

A.5.5 Exposure conditions "S" for fluorescent UV weathering apparatus

(The exposure conditions "S" for fluorescent UV weathering apparatus is in accordance with the exposure procedure in EN 1297).

A.5.5.1 The Black Standard Temperature (BST) shall be $(60 \pm 3) ^\circ\text{C}$.

The air temperature in the test chamber shall be controlled to a constant value such that the BST equals the required value at the end of the dry period.

A.5.5.2 The spray cycle used shall be 60 minutes / 300 minutes (1 hour spraying and 5 hours dry period) in accordance with EN ISO 4892-3.

NOTE – Sample surfaces shall be continuously sprayed during the spray period, otherwise the manufacturer of the weathering apparatus should be contacted.

A.5.5.3 The relative humidity during the dry period shall be $(10 \pm 5) \%$.

A.5.6 Exposure procedure

A.5.6.1 Expose the test specimens for the weathering tests with the upper surface towards the light source in the artificial weathering apparatus for concerned radiation dose.

The remaining reference test specimens are stored in the dark.

A.5.6.2 The exposure procedure shall be in accordance with EN ISO 4892 and EN 513, respectively with the following modifications.

Before placing the test specimens, prepare the artificial weathering apparatus as follows:

- 1) select the appropriate filter arrangement for Xenon arc light source to achieve the irradiance in accordance with method A of EN ISO 4892-2.
- 2) install the devices for the determination of the radiant exposures defined in A.3.1.9 and A.3.1.10.
- 3) install the Black Standard Thermometer and the White Standard Thermometer in such a position that its temperature measurements will be representative for the test chamber.
- 4) set the test chamber relative humidity to 65% RH for Xenon arc apparatus or 10% RH for fluorescent UV light source apparatus.
- 5) set the spray cycle in accordance with the type of light source.
- 6) set the test chamber air temperature to a constant value to achieve the Black Standard Temperature (BST) in accordance with the relevant exposure conditions ("M" or "S") and the type of light source.
- 7) check the White Standard Temperature (WST) in accordance with the relevant exposure conditions ("M" or "S") and the type of light source.

A.5.6.3 Mount the test specimens in the holders with the upper surface towards the light source.

NOTE 1 – When the test specimens do not completely fill the racks, the empty spaces shall be filled with blank panels to maintain the test conditions within the test chamber.

NOTE 2 – It is recommended NOT to expose specimens of different nature simultaneously in order to avoid interaction of any kind.

A.5.6.4 Start the exposure procedure and control and record:

- the air temperature in the test chamber
- the Black Standard Temperature
- the White Standard Temperature
- the relative humidity.

NOTE – It is difficult to specify minimum recording intervals due to differences in equipment and laboratory procedures. The test laboratory should record at intervals that are appropriate to maintain the test conditions in the particular laboratory on a particular apparatus.

- A.5.6.5 At regular intervals check and record the irradiance in accordance with Clause A.3.1.1 and Clause A.3.1.2.
 - A.5.6.6 The exposure is completed when the specified amount of radiant exposure is reached. The total duration of exposure is defined in Clause 2.2.14.
 - A.5.6.7 Take the test specimens holder from the test chamber and the specimens from the holders and condition them for a period of at least 16 hours at a temperature of $(23 \pm 2) ^\circ\text{C}$ and at a relative humidity of $(50 \pm 5) \%$.
 - A.5.6.8 Examine the test specimens visually and note any visible exposure effects.
 - A.5.6.9 Prepare the test specimens according to the appropriate test method(s) for evaluation of any exposure effects (change of related values) as defined in Clause 2.2.14.
- A.6 Test report

The test report shall give at least the following information:

- a) reference to this Annex of this EAD;
- b) the name of the testing laboratory;
- c) date/period of exposure;
- d) a description of the test specimen, including dimensions, curing and conditioning;
- e) type of artificial weathering apparatus used;
- f) type of light sources and filter system used, if any;
- g) type of temperature measurements and description;
- h) set value of the relative humidity in the test chamber;
- i) spray cycle used;
- j) conditions of test specimen rotation, if any;
- k) UV radiant exposure in MJ/m^2 and, if appropriate, in Xenon-arc apparatus radiant exposure $< 800 \text{ nm}$ in GJ/m^2 ;
- l) exposure time in hours (h);
- m) all visual observations;
- n) results of evaluation of exposure effects.

ANNEX B – RESISTANCE TO FATIGUE – OVER-ROLLING TEST

B.1 – OBJECTIVE

This annex specifies a method to assess by testing the resistance to fatigue of a FPEJ to dynamic vertical loading resulting from the action of over-rolling wheels traversing the FPEJ.

B.2 – PRINCIPLE

The surface of the test specimen shall be subjected to simulated traffic action by the repeated passage of a loaded pneumatic tyre over the test specimen in traffic direction (equals x_{bridge} and x_{joint} , see Figure B.3.1). For a slope in traffic direction up to 4% to be assessed, the test specimen shall be mounted in the test rig horizontally and for a slope in traffic direction > 4% the test specimen shall be mounted with the maximum slope in traffic direction to be assessed. The temperature of the specimen and the vertical load applied by the tyre (in direction of z-axis, see Figure B.3.1) are significant factors for the assessment.

At least one specimen of each type (means same construction details, the same components and the same functional principle) shall be tested.

If the model of the FPEJ is an element of a range with the same construction details, the same components and the same functional principle the specimen shall be chosen in the middle of the range.

The specimen is assessed by measuring the vertical deformation (in the direction of the z-axis, see Figure B.5.2), the displacement of the joint filling mixture across the flank onto the adjacent pavement, and visual inspection of the FPEJ specimen surface and the bridging plate.

B.3 – EQUIPMENT

The testing rig shall consist of a rigid and resistant to bending frame for mounting the specimen and shall allow the specimen and the mobile load simulator (see Figure B.3.1 and Figure B.3.2) to be positioned at an angle in accordance with the maximum slope in the traffic direction to be assessed. The pneumatic tyre shall be mounted on an axle in such a way as to be able to move over the specimen in direction of x_{joint} (x direction according to Figure B.3.1). The tyre shall be able to pass from the adjacent pavement onto the FPEJ specimen and over to the adjacent surface on the other side. The tyre shall be treaded. The tyre shall be loaded via the axle with a constant pressure in z direction according to Figure B.3.1 by directly loading the axle with suitable weights or by the use of a hydraulic cylinder connected to the axle.

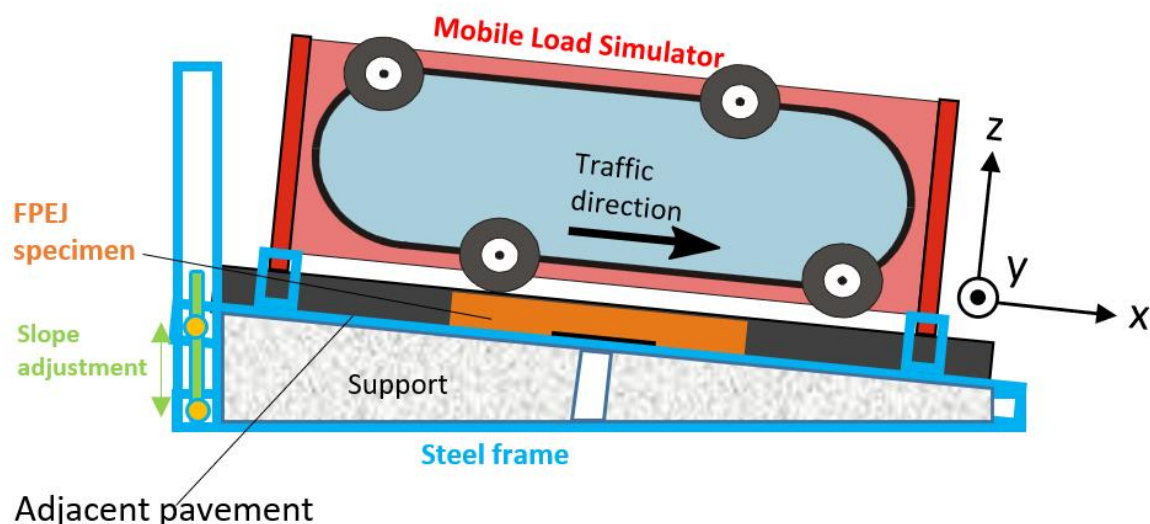


Figure B.3.1 Example of test rig for testing at variable slopes

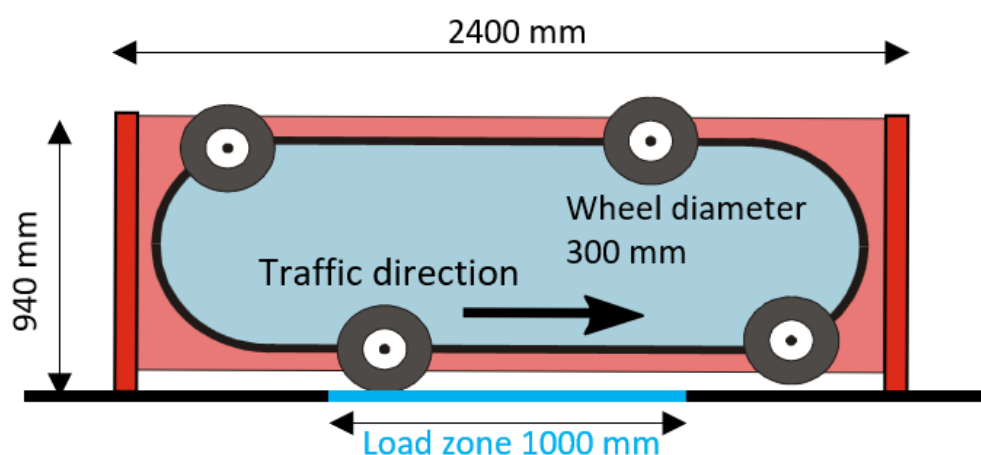


Figure B.3.2: Example of typical dimensions of relevant parts of a mobile load simulator

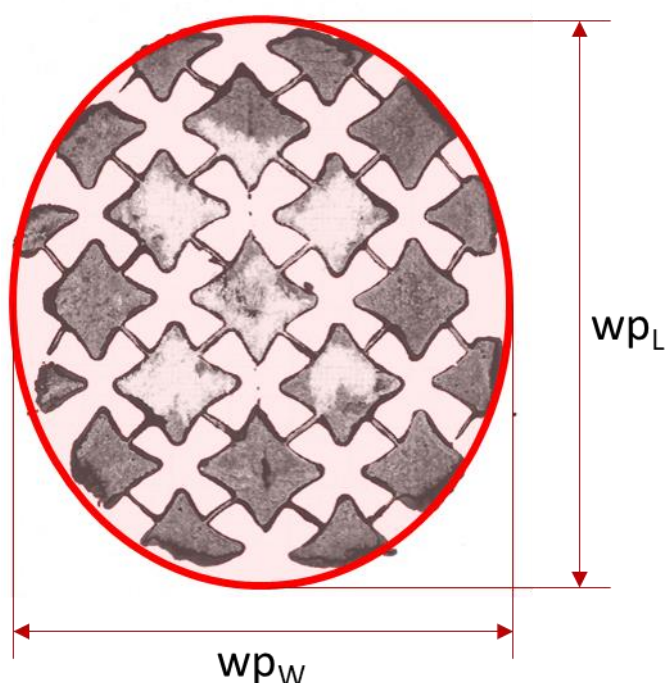


Figure B.3.3: Typical wheel print of a loaded tyre for the over-rolling test

Legend to Figure B.3.3:

wp_w width of wheel print in [mm]

wp_L length of wheel print (in traffic direction, x_{joint}) in [mm]

B.4 – SAMPLES AND PREPARATION OF SPECIMENS

The preparation of the test specimen is under the responsibility of the manufacturer taking into account the envisaged slope in traffic direction to be assessed (means manufacturing of the test specimen at the longitudinal slope to be assessed). Check of appropriate documentation of the specimen preparation to be provided by the manufacturer is task of the testing body. Slopes in traffic direction up to 4 % are represented by a horizontally installed specimen.

The installation of the test specimen in the test frame shall be done by the testing body. Attention shall be paid to proper alignment of the specimen in horizontal, transversal and vertical direction before starting the test in order to prevent initial offsets of the moveable parts of the testing rig influencing the results.

The test specimen shall be constructed in compliance with the actual FPEJ to be assessed and complete with all FPEJ components (bridging plates, movement aids, etc.) and the adjacent pavement. The sides of the joint recess shall be closed using steel side plates during construction of the specimen in order to contain the joint filling mixture (see Figure B.4.1). Before testing, the steel side plates shall be removed. The specimen shall be mounted on a base support with surface preparation as foreseen.



Figure B.4.1: Side view of the test specimen – showing steel side plates used for its construction

Specimen length l_s (in x direction according to Figure B.3.1) is defined as the dimension of the FPEJ specimen in traffic direction (joint width $w_{j,1}$ according to Figure 1.1.2) plus a reproduction of the adjacent pavement to ensure similar bond conditions as in the built in situation (see Figure B.4.2).

The specimen length l_s shall be at least the width of the FPEJ $w_{j,1}$ plus 3 x length of the wheel print wp_L and shall be calculated according to equation (B.4.1).

$$l_s \geq w_{j,1} + 3 \times wp_L \quad (\text{B.4.1})$$

With:

l_s = specimen length in x direction [mm]

$w_{j,1}$ = width of the FPEJ [mm]

wp_L = length of the wheel print [mm]

Specimen width w_s (in y direction according to Figure B.3.1) is defined as the dimension of the specimen perpendicular to the traffic direction (see Figure B.4.2). The minimum specimen width w_s shall be 300 mm or 3 x the width of wheel print wp_W whichever is the greater, see (B.4.2).

$$w_s \geq \text{MAX} \begin{cases} 300 \text{ mm} \\ 3 \times wp_W \end{cases} \quad (\text{B.4.2})$$

With:

w_s = specimen width [mm]

wp_W = width of wheel print [mm]

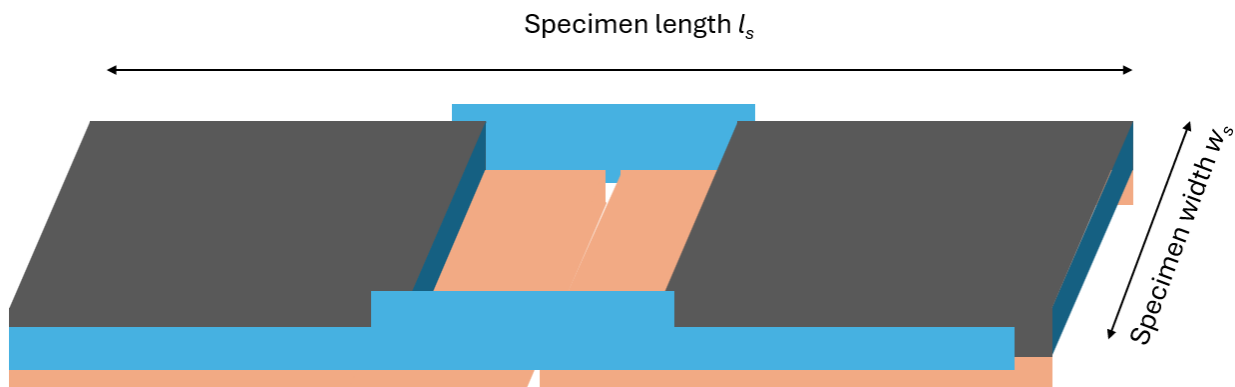


Figure B.4.2: Specimen length l_s and specimen width w_s

B.5 – PROCEDURE

1. No friction is applied on the tyre.
2. The contact pressure shall be $0,5 \pm 0,1 \text{ N/mm}^2$.

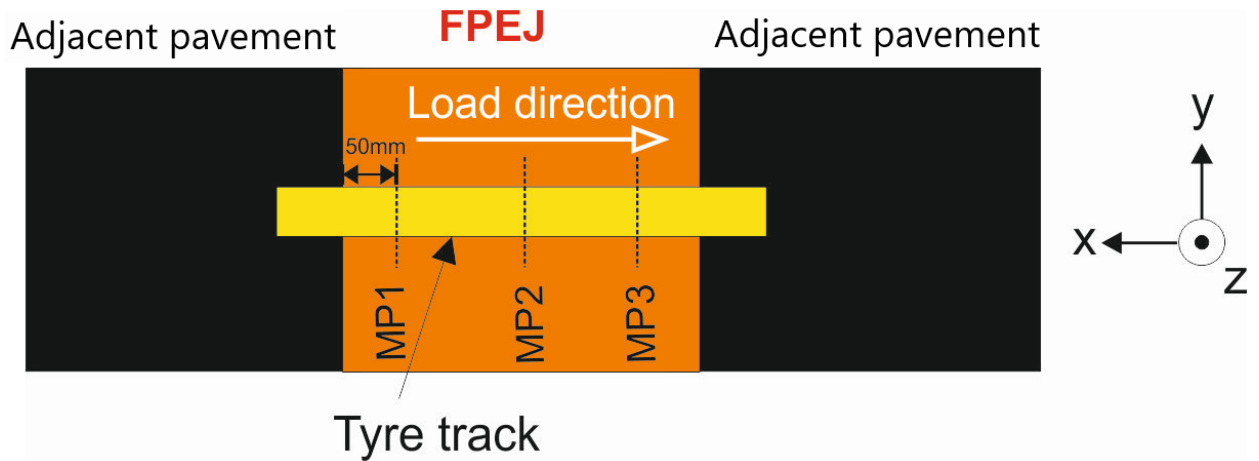
3. The minimum width of the wheel print wp_w on the test specimen shall be 70 mm (see Figure B.3.3). The width of the wheel print wp_w shall be determined by rolling the loaded tyre over a carbon paper or by similar means.
4. Movement direction of loaded tyre: Unidirectional under load (if reciprocating only one way under load). For inclined specimen testing for a slope in traffic direction $>4\%$ the movement direction shall be downwards (= traffic direction according to Figure B.3.1).
5. Movement speed of the tyre shall be constant over the FPEJ specimen surface and between 0,2 m/s and 1,0 m/s.
6. Number of passes n_{rut} shall be (applied continuously):
 - 2000 for a working life of the FPEJ of 10 years
 - 3000 for a working life of the FPEJ of 15 years

Note: In addition to testing according to one of the above two options and after establishing the related test results, the test may be extended on the same test specimen. In that case the results after 2000 passes or 3000 passes respectively, dependent on the working life, and the results after the final number of passes shall be given in the ETA.

7. The test shall be carried out at 60 % of the maximum extension e_{max} (see Figure 2.2.3.1) as defined in the MPII.
8. The temperature of test specimen shall correspond to the maximum operating temperature $T_{max} = +35\text{ °C}$ or $T_{max} = +45\text{ °C}$. If the maximum operating temperature $T_{max} = +60\text{ °C}$, then the test temperature shall be $+45\text{ °C}$. Temperature shall be constant (tolerance $\pm 2\text{ °C}$) and measured $20 \pm 2\text{ mm}$ below the FPEJ specimen's surface in the body of the specimen. The position for the temperature measurement device may be anywhere within the FPEJ specimen, but outside the area of over-rolling.
9. Deformations shall be measured before and $\leq 15\text{ min}$ after testing in order to avoid elastic recovery of the joint filling mixture before measurement, whereas the location of the transversal measurement profiles (MP_i) shall be the same for the measurements before and after testing. The procedure is described below.

Transversal measurement profiles (MP_i) are determined at n (at least at 3) equally distributed positions along the tyre track on the FPEJ (see Figure B.5.1). The distance of the outer transversal measurement profiles (in the example for 3 transversal measurement profiles shown in Figure B.5.1 this applies for MP1 and MP3) from the adjacent pavement shall be $50 \pm 5\text{ mm}$. Measurements at each measurement profile MP_i shall be done over the width of the tyre track and extended $50 \pm 5\text{ mm}$ on both sides (see Figure B.5.1 and Figure B.5.2). Vertical measurements (z direction according to Figure B.5.1 and Figure B.5.2) along the transversal measurement profiles MP_i shall be performed before testing (zero reference) and $\leq 15\text{ min}$ after testing in order to avoid elastic recovery of the joint filling mixture before measurement.

The vertical distance shall be measured with an accuracy of $\pm 0.2\text{ mm}$ at least every 2 mm along each transversal measurement profile relative to a straight metal bar placed above the surface of the specimen or with an automatic profilometer.



MP1 ... MP3 Transversal measurement profiles

Figure B.5.1: Example for vertical deformation measurement with three transversal measurement profiles

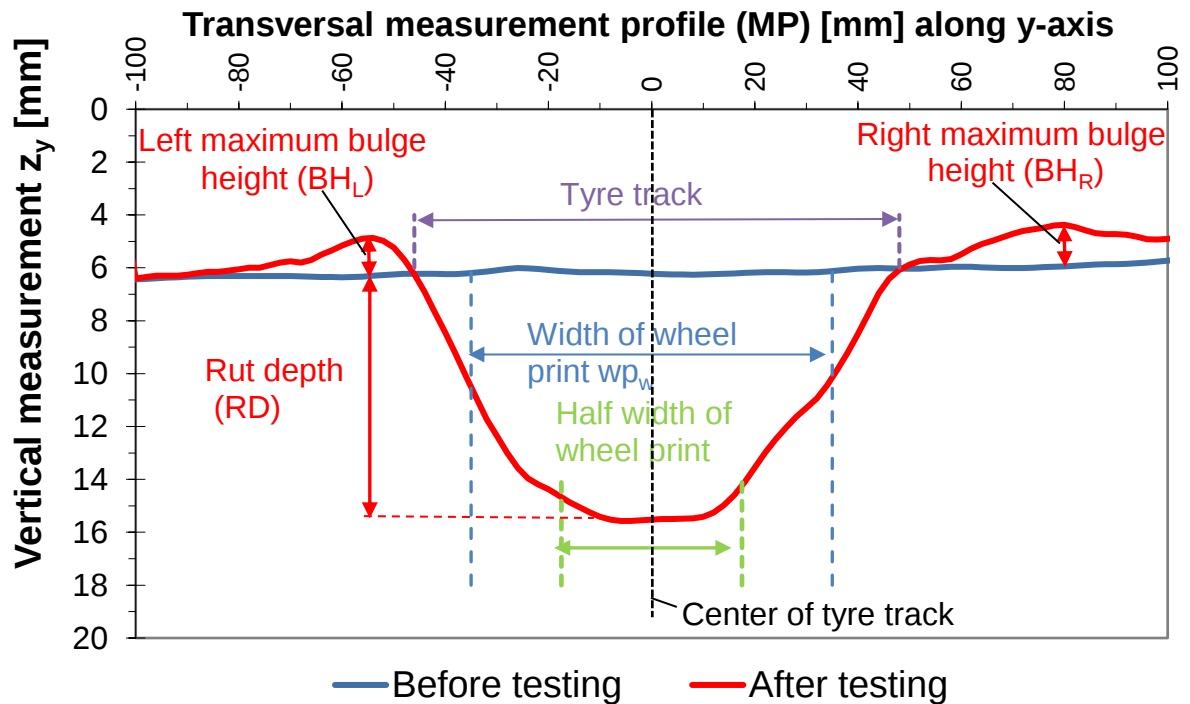


Figure B.5.2: Example of a transversal deformation profile MP_i for determination of rut depth RD_i and bulge height BH_i

B.5.1 – Determination of deformations

Rut depth is defined as negative deformation and bulge height as positive deformation of the surface of the specimen after testing (see Figure B.5.2) in comparison to the surface of the specimen before testing.

1. Rut depth

For the calculation of the vertical deformation $d(y)$ at measurement point y for each transversal measurement profile MP_i the vertical distance measured at point y along the transversal measurement profile after testing $z_T(y)$ is subtracted from the vertical distance at point y along the transversal measurement profile before testing $z_O(y)$ according to equation (B.5.1.1).

$$d(y) = z_O(y) - z_T(y) \quad (\text{B.5.1.1})$$

With:

$d(y)$	deformation at point y along the transversal measurement profile MPi [mm]
$z_o(y)$	vertical distance at point y along the transversal measurement profile before testing [mm]
$z_T(y)$	vertical distance at point y along the transversal measurement profile after testing [mm]

The maximum deformation $d(y)_{max}$ [mm] and minimum deformation $d(y)_{min}$ [mm] of all transversal measurement profiles MPi shall be determined.

The rut depth RD_i of the individual transversal measurement profile MPi in [mm] is defined as the arithmetic average of all $d(y)$ within the centred “half width of the wheel print” (see Figure 5.2) and shall be calculated according to equation (B.5.1.2).

$$RD_i = \frac{\sum_{j=1}^n d(y)}{n} \quad (\text{B.5.1.2})$$

Where:

RD_i	Rut depth of transversal measurement profile MPi [mm]
n_m	number of measurement points along a transversal measurement profile MPi in y direction within the half width of wheel print [-]
$d(y)$	deformation at point y along the transversal measurement profile MPi [mm]

Final rut depth RD in [mm] is the arithmetic average of all individual results of RD_i and shall be calculated according to equation (B.5.1.3).

$$RD = \frac{\sum_{i=1}^n RD_i}{n} \quad (\text{B.5.1.3})$$

With:

RD	Final rut depth [mm]
RD_i	Rut depth of transversal measurement profile MPi [mm]
n	number of individual results of RD_i [-]

2. Bulge height

For each individual transvers measurement profile MPi the left maximum bulge height $BH_{L,i}$ and the right maximum bulge height $BH_{R,i}$ (see Figure B.5.2) shall be calculated by subtracting the vertical distance measured at point y along the transversal measurement profile after testing $z_T(y)$ from the vertical distance at point y along the transversal measurement profile before testing $z_o(y)$ according to equations (B.5.1.4) and (B.5.1.5).

$$BH_{L,i} = \text{MAX} (z_o(y) - z_T(y)) \quad \text{for } y < 0 \text{ mm} \quad (\text{B.5.1.4})$$

$$BH_{R,i} = \text{MAX} (z_o(y) - z_T(y)) \quad \text{for } y > 0 \text{ mm} \quad (\text{B.5.1.5})$$

With:

$BH_{L,i}$	left maximum bulge height [mm]
$BH_{R,i}$	right maximum bulge height [mm]
$z_o(y)$	vertical distance at point y along the transversal measurement profile before testing [mm]
$z_T(y)$	vertical distance at point y along the transversal measurement profile after testing [mm]

The bulge height BH_i of an individual transvers measurement profile MPi is defined as the arithmetic average of the left maximum bulge $BH_{L,i}$ and the right maximum bulge height $BH_{R,i}$ of this individual transvers measurement profile MPi and shall be calculated according to equation (B.5.1.6).

$$BH_i = \frac{BH_{L,i} + BH_{R,i}}{2} \quad (\text{B.5.1.6})$$

With:

BH_i bulge height of an individual transvers measurement profile MPi [mm]
 $BH_{L,i}$ left maximum bulge height [mm]
 $BH_{R,i}$ right maximum bulge height [mm]

Final bulge height BH in [mm] is the arithmetic average of all individual results of BH_i and shall be calculated according to equation (B.5.1.7).

$$BH = \frac{\sum_{i=1}^n BH_i}{n} \quad (\text{B.5.1.7})$$

With:

BH Final bulge height [mm]
 BH_i bulge height of an individual transvers measurement profile MPi [mm]
 n number of individual results of BH_i [-]

B.6 – EXPRESSION OF RESULTS

- Description of damages of specimen surface (cracks and/ or debonding, see Table 2.2.2.1)
- Final rut depth RD [mm] and final bulge height BH [mm] according to Clause B.5.1 and number of passes n_{rut}

B.7 – TEST REPORT

The test report shall refer to this annex and test procedure and include at least:

- The test method and test parameters used to test the product
- Details of the specimen tested: dimensions and description of constituting components (name, producer, material, batch number) including details of specimen preparation
- Test results as required in Clause B.6 above including graphs, photo documentation and description of specimen behaviour during testing and related number of passes n_{rut}
- Deformation profiles transverse to the FPEJ specimen and location of the related transversal measurement profiles MPi
- Temperature of specimen and method of temperature control
- Contact pressure and variation over test period
- Inflation pressure of the tyre
- Tyre condition including width of the wheel print wp_w and length of the wheel print wp_L
- Date of tests
- Date of report
- Identification of the test laboratory

ANNEX C – FPEJ MOVEMENT CAPACITY TEST METHOD

C.1 – OBJECTIVE

This annex specifies methods to assess, by testing, the ability of a FPEJ to accommodate horizontal movements between adjacent bridge deck structures resulting from changes in the relative position of the bridge deck gap g . The test assesses extension and compression performance and related effects (reaction forces and vertical deformations of the upper surface of the test specimen). Differentiation shall be made between the movement capacity under slow occurring and fast occurring movements. Slow occurring movements cover deformations of the bridge deck mainly resulting from seasonal and diurnal temperature changes but also shrinkage and creep. Fast occurring movements cover dynamically repeated deformations of the bridge deck resulting from over-rolling traffic. For each movement rate a special test procedure is described.

C.2 – PRINCIPLE

A section of the FPEJ assembly (the test specimen) is mounted in the test rig and subjected to simulated bridge movements in the horizontal plane in direction x_{bridge} and x_{joint} by changing the relative position of one side of the FPEJ to the other.

The movements shall be relatively slow to simulate thermal changes in the bridge structure ($\geq 0,2$ mm/h for test method (a)) or relatively fast ($\geq 0,6$ mm/s test method (b)) to simulate changes due to the effect of vehicles passing over the structure. The temperature of the specimen at the time of application of movement is a significant factor determining performance of this type of product. The test apparatus is deformation controlled.

At least one specimen of each type (means same construction details, the same components and the same functional principle) shall be tested.

If the model of expansion joint is an element of a range with the same construction details, the same components and the same functional principle the specimen shall be chosen in the middle of the range.

C.3 – EQUIPMENT

The equipment shall consist of a rigid and resistant to bending frame for mounting the specimen. The frame shall be arranged in two halves such that the two sides of the FPEJ can be moved with minimal friction relative to one another in a horizontal plane in direction x_{bridge} respectively x_{joint} . The equipment shall be housed in a chamber which can be climate controlled. There shall be a facility for control and measurement of specimen temperature, horizontal displacements and loads. Deformation control shall be installed directly at the gap between concrete base plates (representing the bridge deck gap g). The displacements shall be generated step-less and shall be continuously measured. For testing of fast occurring movements according to method b described in Clause C.5, the movements shall follow a pulsating sinusoidal wave form and shall be generated by a controller able to create the sinusoidal load functions and directly control the movement at the specimen's gap. Examples for the test equipment with installed test specimens are shown in Figure C.4.1.1 and Figure C.4.2.1.

C.4 – SAMPLES AND PREPARATION OF SPECIMENS

The preparation of the test specimen is under the responsibility of the manufacturer taking into account the envisaged slope in traffic direction to be assessed (means manufacturing of the test specimen at the longitudinal slope to be assessed). Check of appropriate documentation of the specimen preparation to be provided by the manufacturer is task of the testing body.

The specimen shall be constructed as a 1:1 scale (thickness of the joint filling mixture D and joint width $w_{j,1}$ in traffic direction) of the actual FPEJ including all components (e.g., joint filling mixture, bridging plate, etc.). The specimen shall be constructed on a support that replicates actual bridge deck preparation (see Clause C.4.3). For the test assembly according to Clause C.4.1 a joint recess (see Clause 1.3.11) shall be formed in the surface course to contain the FPEJ specimen. The sides of the joint recess shall be closed using steel side plates during construction of the specimen in order to contain the joint filling mixture (example is given in Annex B, Figure B.4.1). Before testing, the steel side plates shall be removed to permit movement.

The installation of the test specimen in the test frame shall be done by the testing laboratory. Attention shall be paid to proper alignment of the specimen in horizontal, transversal and vertical direction before starting of the test in order to prevent initial offsets of the moveable parts of the testing rig influencing the results.

Specimen length l_s (in x direction according to Figure C.5.1.1) is defined as the dimension of the FPEJ in movement direction (joint width $w_{j,1}$ according to Figure 1.1.2) plus a reproduction of the adjacent pavement, to ensure similar bond conditions as in the built in situation.

Specimen width w_s (in y direction according to Figure C.5.1.1) is defined as the dimension of the specimen perpendicular to the movement direction and shall be at least 0,2 m.

For assessment of slope in traffic direction up to 4 % the specimen support (underlay of FPEJ-specimen) shall be horizontal oriented. Lateral flanks (adjacent pavement or crosshead according to Clause C.4.1 and Clause C.4.2 respectively) shall be vertical oriented.

For assessment of slope in traffic direction >4 % the specimen support (underlay of FPEJ-specimen) shall be sloped according envisaged slope in traffic direction. Lateral flanks (adjacent pavement or crosshead, see Figure C.4.1.1 and Figure C.4.2.1) shall be rectangular oriented to the slope in traffic direction.

C.4.1 Test assembly for testing slow occurring movements according to C.5, method a

The specimen shall be mounted on a solid steel frame, where one side is movable. A hydraulic cylinder equipped with a force and displacement measuring device, shall be used to apply the slow and accurate movement. A schematic representation of the test assembly is shown in Figure C.4.1.1. Details for the test assembly are given in Clause C.4.3.

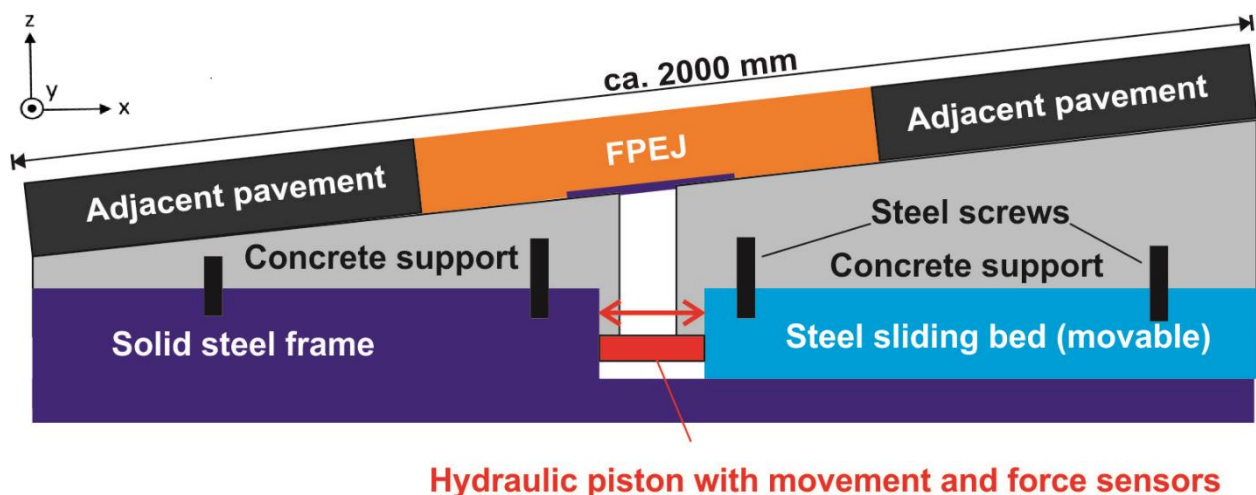


Figure C.4.1.1: Schematic example of the test assembly for slow occurring movements and slopes in traffic direction exceeding 4 % - cross section

For the assessment of slopes in traffic direction up to 4 % the specimen shall be tested with the same device, but with the specimen in horizontal orientation.

C.4.2 Test assembly for testing fast occurring movements according to C.5, method b

The specimen shall be mounted on a solid steel frame, where one side is movable. A schematic representation of the test assembly is shown in Figure C.4.2.1. Details for the test assembly are given in Clause C.4.3.

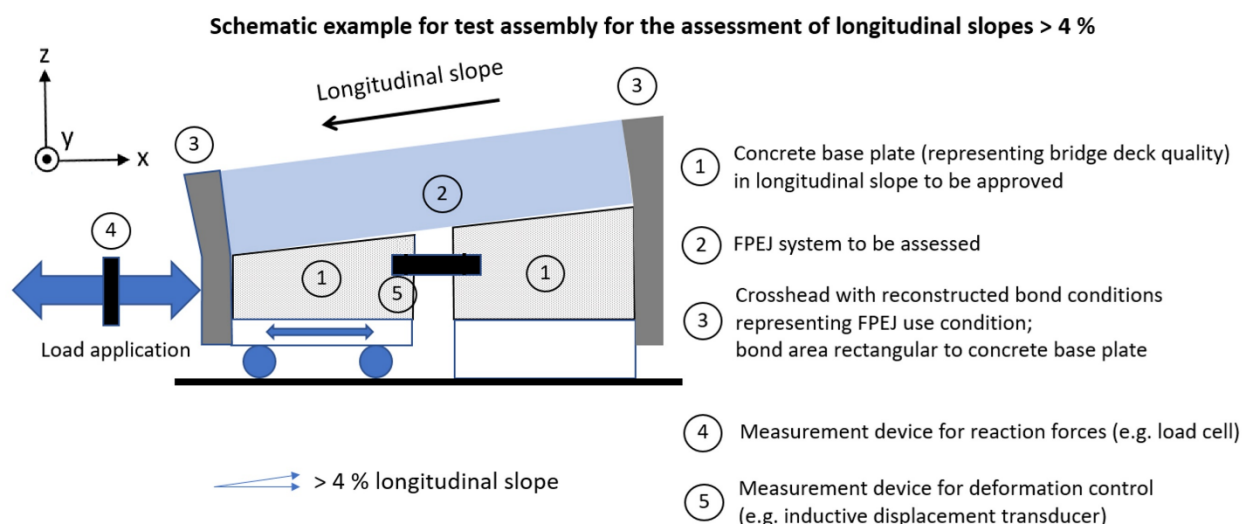


Figure C.4.2.1: Schematic example of the test assembly for fast occurring movements for longitudinal slopes exceeding 4 % - cross section

C.4.3 Details of the test assemblies

For both assemblies given above the concrete base shall represent typical bridge deck quality (e.g., as defined in EN 13375, Clause 5.2).

For the test assembly for testing slow occurring movements according to C.5, method a, the adjacent pavement shall be made of mastic asphalt according EN 13108-6.

For the test assembly for testing fast occurring movements according to Clause C.5, method b, the crossheads shall be made of steel with corrugated surface or any other preparation to simulate bonding conditions of the built in situation of the FPEJ.

For both assemblies given above for the measurement of the reaction forces a load cell with precision according to EN ISO 7500-1, class 1 shall be used.

For both assemblies given above for the measurement of extension and compression (horizontal displacements) as suitable device with precision class 1 according to EN ISO 9513 shall be used. The displacement device of the test assemblies is routed only for horizontal displacements in x direction (according to Figure C.4.1 and C.4.2). Lateral movement tolerance would affect calibration results and are, therefore, excluded by the precision class requested for the test equipment.

For both assemblies given above the temperature shall be measured with at least one temperature cell 20 ± 2 mm below the FPEJ specimen's surface in the body of the FPEJ specimen. The position for the temperature cell may be anywhere within the FPEJ specimen, but outside the area of the bridging plate (see Figure 2.2.5.1 for an example).

C.5 – PROCEDURES

Method a) Movement capacity under slow occurring movements

The specimen shall be subjected to horizontal movement to the maximum extension e_{max} and to the maximum compression c_{max} as specified in the MPII either:

- at a controlled temperature variation which covers the operating temperature range T_{min} in combination with the maximum extension e_{max} and to T_{max} in combination with the maximum compression c_{max} (see Figure C.5.1 for a typical temperature-displacement curve).

or

- at two constant temperatures, which are the minimum operating temperature T_{min} for the maximum extension e_{max} and the maximum operating temperature T_{max} for the maximum compression c_{max} .

The two methods mentioned above are considered equivalent as both are covering the range of operating temperature to be assessed and related performances. The starting temperature for both shall be T_0 as defined in the MPII.

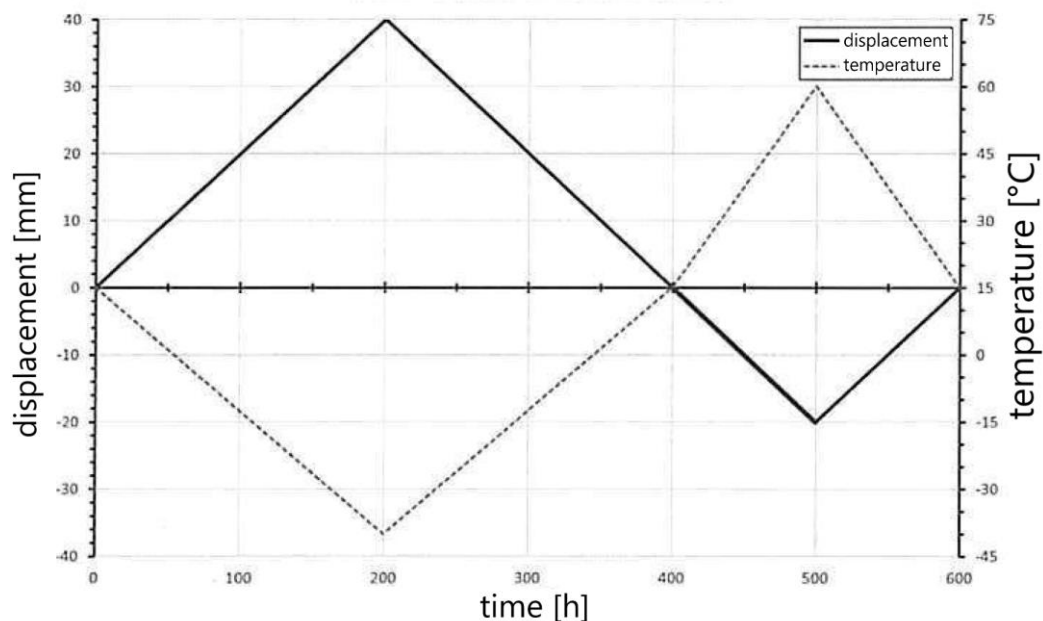


Figure C.5.1: Typical temperature-displacement curve for testing with controlled temperature variation, example for $T_0 = 15\text{ °C}$, $T_{min} = -40\text{ °C}$ in combination with $e_{max} = 20\text{ mm}$ and $T_{max} = 60\text{ °C}$ in combination with $c_{max} = 40\text{ mm}$

For the measurement of vertical deformations resulting from extension and compression of the specimen, at least 5 measurement points shall be marked in the middle of the specimen every 50 mm to 100 mm along the specimen length and one point 50 mm in the adjacent pavement on each side (see Figure C.5.2). Measurement points, made of plastic or metal, glued onto the surface of the FPEJ may help to ensure that the same point is measured before and after testing, especially on rough surfaces. A straight metal bar shall be placed on two metal support, glued on both sides of the FPEJ specimen on the adjacent pavement.

Vertical deformations (in z-direction) shall be measured at the measurement points before the test (starting position e_0 , see Figure 2.2.3.1), at maximum compression c_{max} and at maximum extension e_{max} .

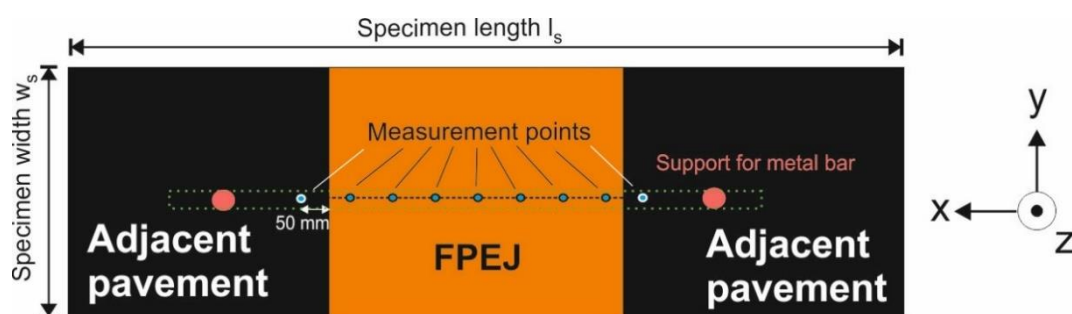


Figure C.5.2: Top view of a test specimen, example with 9 measurement points

Procedure for the assessment of movement capacity under slow occurring movements at two constant temperatures:

- The specimen shall be installed in the testing rig at room temperature without applying any prestress. The force measurement device is now zeroed.
- The specimen shall be first cooled to T_0 . During this process the FPEJ specimen shall stay force free (force controlled movement with $F = 0\text{ N}$).

- After the whole test assembly has reached T_0 , the zero measurement profile according Figure C.5.2 shall be measured in z-direction, e.g. against a horizontal straight steel bar.
- This is now the original start position e_0 and the displacement measurement device is set to zero. The specimen shall now be heated to the first test temperature equal to T_{max} without movement (displacement controlled). The specimen shall be equilibrated until the whole test assembly has reached T_{max} . Due to temperature induced compression of the FPEJ, force is built up.
- Then the specimen shall be deformed at constant test speed to the maximum compression c_{max} , where the vertical deformation at each measurement point along the measurement profile shall be measured, whereas ϵ_{max} is defined as the maximum value of the individual vertical deformations measured against the zero measurement in z-direction at T_0 . In addition, the specimen shall be inspected for adhesion failure, cracks in the FPEJ, deformation of the bridging plate and other possible failures, which shall be photographically documented. The whole procedure shall not take longer than 30 minutes.
- Now the specimen shall be deformed at constant test speed back to the original position e_0 .
- The reaction forces shall be measured continuously during compression of the specimen starting from e_0 to c_{max} and re-extension to e_0 . A load-displacement curve shall be established and $F(T_{max}, c_{max})$ shall be determined as shown in Figure C.5.3.
- At the end of the test at T_{max} , the specimen is inspected again for possible failure as described above.
- In the next step the specimen shall be cooled to the test temperature equal to T_{min} (displacement controlled at e_0) and equilibrated until the whole test assembly has reached T_{min} .
- The specimen shall be deformed at constant test speed to the maximum extension e_{max} . The vertical deformation at each measurement point along the measurement profile shall be measured, whereas ϵ_{min} is defined as the maximum value of the individual vertical deformations measured against the zero measurement in z-direction at T_0 . In addition, the specimen shall be inspected for adhesion failure, cracks in the FPEJ and deformation of the bridging plate and other possible failures, which shall be photographically documented. The whole procedure shall not take longer than 30 minutes.
- Now the specimen shall be deformed at constant test speed back to the original position e_0 .
- The reaction forces shall be measured continuously during extension of the specimen starting from e_0 to e_{max} and re-compression to e_0 . A load-displacement curve shall be established and $F(T_{min}, e_{max})$ shall be determined as shown in Figure C.5.3.
- At the end of the test at T_{min} , the specimen shall be inspected again for possible failure.

The speed range for application of horizontal displacement shall be a minimum of 0,2 mm per hour (any higher rate is considered as more severe and therefore also allowed). Displacement and forces shall be recorded with a sample rate of at least 0,1 Hz.

The specimen shall be loaded one complete cycle (full compression to the maximum compression c_{max} in combination with the highest operating temperature T_{max} and and re-expansion to the original start position e_0 and full extension to the maximum expansion e_{max} in combination with the lowest operating temperature T_{min} , and re-compression to the original start position e_0).

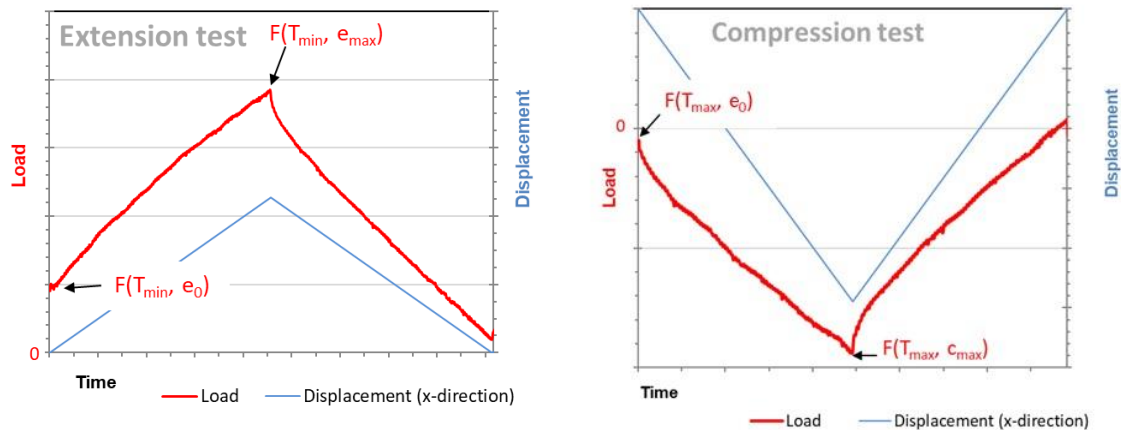


Figure C.5.3: Example of typical load - displacement curves for slow movement capacity tests

- The maximum reaction force $F(T_{min}, e_{max})$ in the extension test is the maximum value of the load curve (Figure C.5.3) including the force $F(T_{min}, e_0)$ caused by the cooling of the FPEJ from T_0 to T_{min} .
- The minimum reaction $F(T_{max}, c_{max})$ force in the compression test is the minimum value of the load curve (Figure C.5.3) including the force $F(T_{max}, e_0)$ caused by the heating of the FPEJ from T_0 to T_{max} .

Procedure for the assessment of movement capacity under slow occurring movements with controlled temperature variation:

- The specimen shall be installed in the testing rig at room temperature without applying any prestress. The force measurement device is now zeroed.
- The specimen shall be first cooled to T_0 . During this process the FPEJ specimen shall stay force free (force-controlled movement with $F = 0$ N).
- After the whole test assembly has reached T_0 , the zero measurement profile according Figure C.5.2 shall be measured in z-direction, e.g. against a horizontal straight steel bar.
- This is now the original start position e_0 and the displacement measurement device is set to zero.
- Then the specimen shall be deformed at constant test speed to the maximum extension e_{max} , and simultaneously cooled to T_{min} (see Figure C.5.1) where the vertical deformation at each measurement point along the measurement profile shall be measured, whereas ϵ_{max} is defined as the maximum value of the individual vertical deformations measured against the zero measurement in z-direction at T_0 . In addition, the specimen shall be inspected for adhesion failure, cracks in the FPEJ, deformation of the bridging plate and other possible failures, which shall be photographically documented. The whole procedure shall not take longer than 30 minutes.
- Now the specimen shall be deformed at constant test speed back to the original position e_0 and simultaneously heated to T_0 (see Figure C.5.1).
- In the next step the specimen shall be heated to the test temperature equal to T_{min} (displacement controlled at e_0) and equilibrated until the whole test assembly has reached T_{min} .
- In the next step, the specimen shall be deformed at constant test speed to the maximum compression c_{max} and simultaneously heated to T_{max} (see Figure C.5.1). The vertical deformation at each measurement point along the measurement profile shall be measured, whereas ϵ_{min} is defined as the maximum value of the individual vertical deformations measured against the zero measurement in z-direction at T_0 . In addition, the specimen shall be inspected for adhesion failure, cracks in the FPEJ and deformation of the bridging plate and other possible failures, which shall be photographically documented. The whole procedure shall not take longer than 30 minutes.

- Now the specimen shall be deformed at constant test speed back to the original position e_0 and simultaneously cooled to T_0 (see Figure C.5.1).
- The reaction forces shall be measured continuously during extension and compression of the specimen. A load-displacement curve shall be established and $F(T_{max}, c_{max})$ and $F(T_{min}, e_{max})$ shall be determined as shown in Figure C.5.4.
- At the end of the test at T_0 , the specimen shall be inspected again for possible failure.

The speed range for application of horizontal displacement shall be a minimum of 0,2 mm per hour (any higher rate is considered as more severe and therefore also allowed). Displacement and forces shall be recorded with a sample rate of at least 0,1 Hz.

The specimen shall be loaded one complete cycle (full compression to the maximum compression c_{max} in combination with the highest operating temperature T_{max} and and re-expansion to the original start position e_0 and full extension to the maximum expansion e_{max} in combination with the lowest operating temperature T_{min} , and re-compression to the original start position e_0).

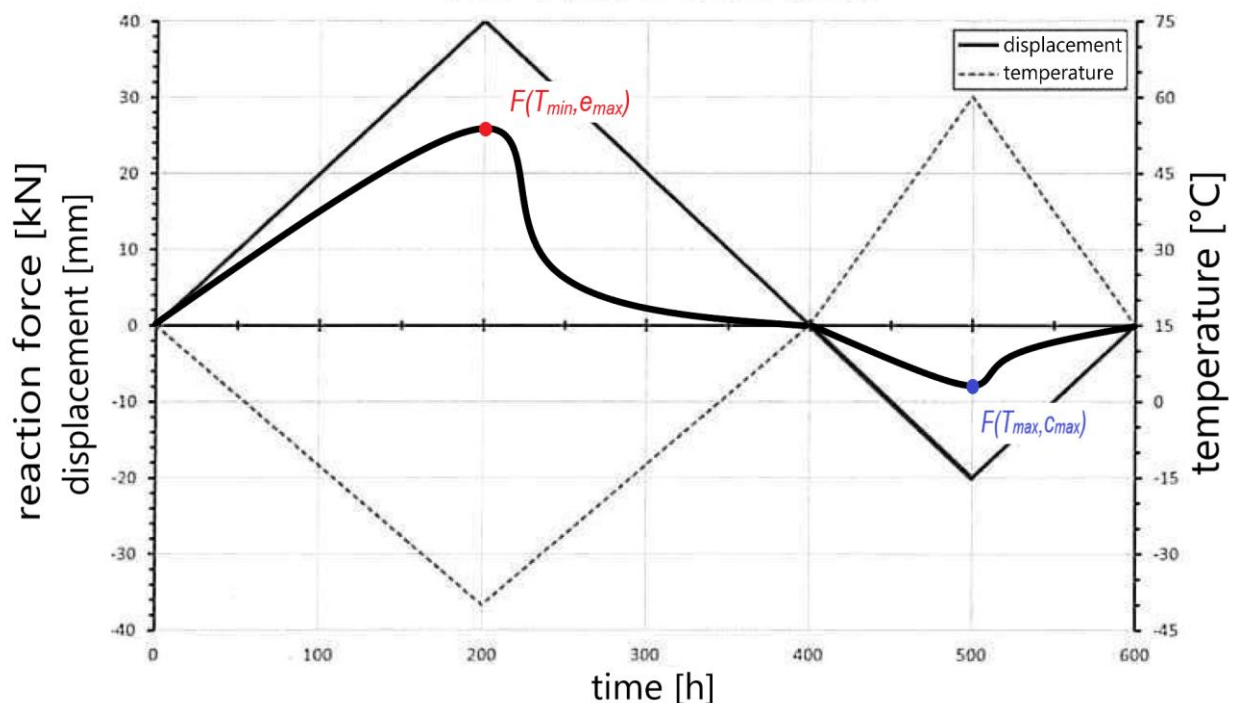


Figure C.5.4: Typical reaction force curve for testing with controlled temperature variation, example for $T_0 = 15^\circ\text{C}$, $T_{min} = -40^\circ\text{C}$ in combination with $e_{max} = 20\text{ mm}$ and $T_{max} = 60^\circ\text{C}$ in combination with $c_{max} = 40\text{ mm}$ – determination of $F(T_{max}, c_{max})$ and $F(T_{min}, e_{max})$

Assessment of performance shall include:

- Assessment criteria: Description of the adhesion and surface integrity (cracks or fissures) with respect to the Table 2.2.3.1 adhesion between joint filling mixture and its adjacent flanks (adjacent pavement) and cohesion in the joint filling mixture (debonding);
- Reaction forces $F(T_{min}, e_{max})$ and $F(T_{max}, c_{max})$ necessary to create the maximum displacements (maximum compression c_{max} ; maximum extension e_{max});
- Maximum vertical deformations ϵ_{min} and ϵ_{max} of surface (surface profile) at maximum extension e_{max} and maximum compression c_{max} compared to initial un-deformed situation.

Method b) Movement capacity under fast occurring movements

The FPEJ specimen shall be horizontally deformed in x-direction (see Figure C.4.2.1) only by extension compared to its reference width of the FPEJ before testing $w_{i,ref}$ (see Figure 2.2.3.1 for definition of $w_{i,ref}$) with fast occurring dynamic repeated pulsating sinusoidal deformations with an amplitude of $w_{fast,min} = 0$ [mm] to $w_{fast,max}$ [mm] (as defined in the MPII) at constant temperature according to the possibilities given below. The deformations shall be applied with a frequency between 1 and 10 Hz.

Number of cycles n_{fast} :

Working life 10 years:

The number of load cycles at a test temperature T_{test} of +15 °C (tolerance ± 2 °C) shall be 5×10^6 . The number of load cycles can be reduced to $1,3 \times 10^6$ if the test is done at the minimum operating temperature T_{min} (tolerance ± 2 °C). The test temperature is defined as the ambient temperature (of the air), controlled through the climate chamber.

Temperature of the FPEJ specimen shall be measured (see Clause C.4.3) throughout the test. The test shall only be started when the temperature of the FPEJ specimen has reached the test temperature.

Working life 15 years:

The number of load cycles at a test temperature T_{test} of +15 °C (tolerance ± 2 °C) shall be $7,5 \times 10^6$. The number of load cycles can be reduced to $1,95 \times 10^6$ if the test is done at the minimum operating temperature T_{min} (tolerance ± 2 °C). The test temperature is defined as the ambient temperature (of the air), controlled through the climate chamber.

Temperature of the FPEJ specimen shall be measured (see Clause C.4.3) throughout the test. The test shall only be started when the temperature of the FPEJ specimen has reached the test temperature.

Minimum operating temperature T_{min} of -40 °C:

If the test for 10 years or 15 years working life as described above has been performed at +15 °C, for the assessment of minimum operating temperature T_{min} of -40 °C another $0,1 \times 10^6$ cycles at test temperature $T_{test} = -40$ °C (tolerance ± 2 °C) shall be performed using the same test specimen subject to testing at $T_{test} = +15$ °C. The test temperature is defined as the ambient temperature (of the air), controlled through the climate chamber.

Temperature of the FPEJ specimen shall be measured (see Clause C.4.3) throughout the test. The test shall only be started when the temperature of the FPEJ specimen has reached the test temperature.

Procedure

The test assembly shall be conditioned in the climate chamber until T_{test} is reached.

The pulsating sinusoidal deformation $w_{fast,min}$ [mm] to $w_{fast,max}$ [mm] shall then be applied and continuously measured together with the resulting maximum and minimum reaction forces $F_{fast,max}$ [kN] and $F_{fast,min}$ [kN] for the number of cycles as defined above. An example of a typical deformation curve is shown in Figure C.5.5. An example of a typical hysteresis curve and determination points for $F_{fast,max}$ and $F_{fast,min}$ is shown in Figure C.5.6.

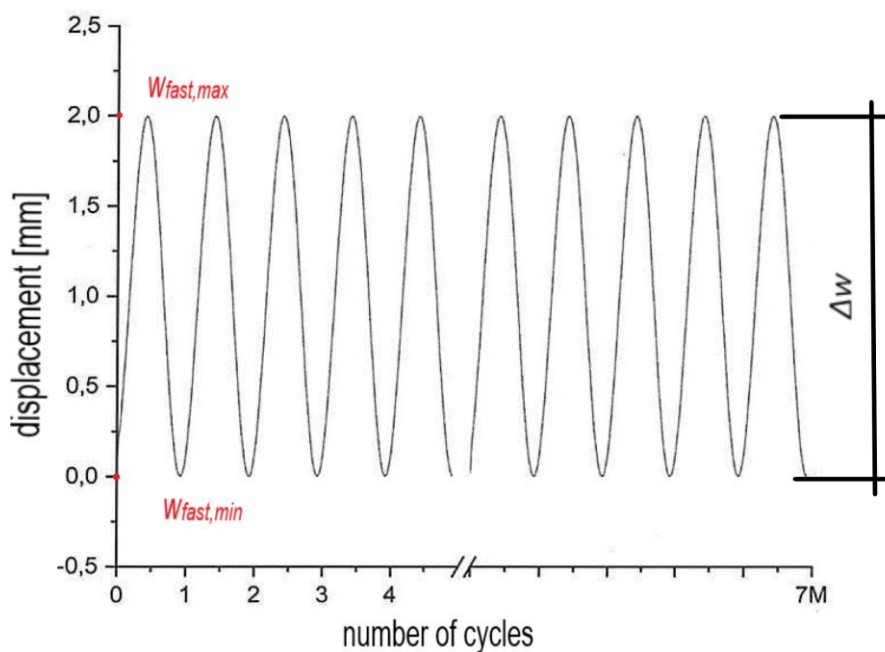


Figure C.5.5: Example of a typical deformation curve with $w_{fast,max} = 2,0$ mm

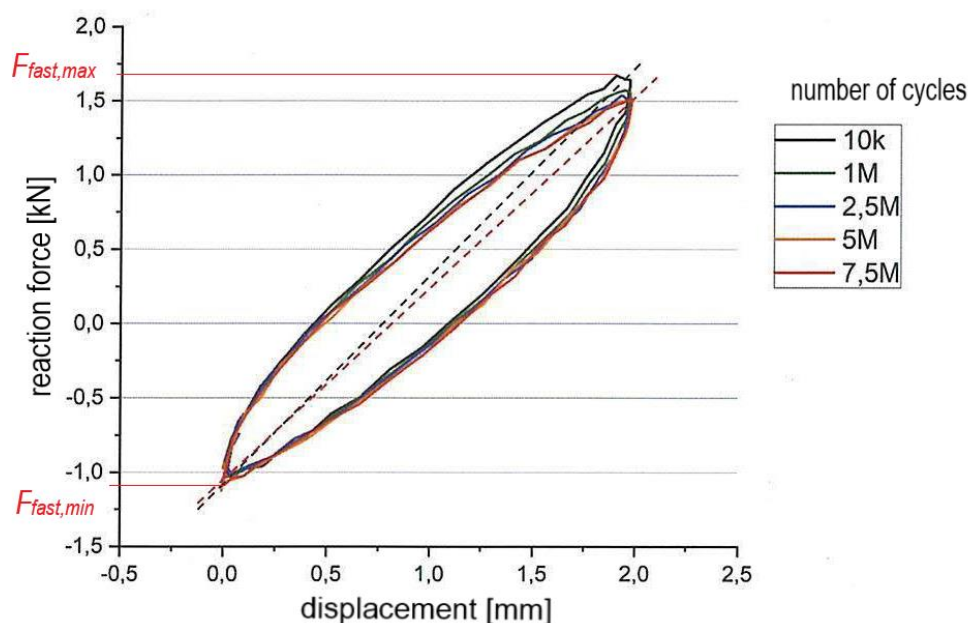


Figure C.5.6: Example of a typical hysteresis curve and determination points for $F_{fast,max}$ and $F_{fast,min}$

The stiffness value $\Delta F / \Delta w$ for every 250 000 load cycles shall be calculated with ΔF (difference between maximum and minimum reaction force measured during testing the movement capacity under fast occurring movements, see Figure C.5.6) calculated according to equation (C.5.1) and Δw (dynamic amplitude, see Figure C.5.5) calculated according to equation (C.5.2).

$$\Delta F = F_{fast,max} - F_{fast,min} \quad (C.5.1)$$

With:

$F_{fast,max}$ [kN]	Maximum reaction force measured during testing the movement capacity under fast occurring movements
$F_{fast,min}$ [kN]	Minimum reaction force measured during testing the movement capacity under fast occurring movements

$$\Delta w = w_{fast,max} - w_{fast,min} \quad (C.5.2)$$

With:

- $w_{fast,max}$ [mm] Maximum displacement applied during testing the movement capacity under fast occurring movements
- $w_{fast,min}$ [mm] Starting position for the displacement to be applied during testing the movement capacity under fast occurring movements

Assessment of performance shall include:

- Assessment criteria: Description of the adhesion and surface integrity (cracks or fissures) with respect to the Table 2.2.3.1 adhesion between joint filling mixture and its adjacent flanks (crossheads) and cohesion in the joint filling mixture (debonding);
- The reaction forces necessary to create each pulsating sinusoidal deformation (documentation of reaction forces as hysteresis curves; documentation of peak values $F_{fast,max}$, $F_{fast,min}$, $w_{fast,max}$ and $w_{fast,min}$ and of discontinuities over test duration);
- After demolition of the FPEJ, expose moving part(s) and check for evidence of wear, if necessary (e.g., different to the example shown in Figure C.5.6, points of discontinuity of the force graph indicate damage in the test specimen, i.e., sudden decrease of the measured reaction forces, special visual indications during testing etc.).

C.6 – EXPRESSION OF RESULTS

Displacements are expressed in [mm] and the forces in [kN].

At least the following results shall be recorded and expressed using charts or figures, photographs and description.

Method a) Movement capacity under slow occurring movements

- Details of specimen preparation
- Temperature of specimen or temperature/movement profile as appropriate and temperature of the climate chamber
- Reaction force generated during the whole movement cycle (e.g., as load/deformation graph)
- Movement capacity M , maximum compression c_{max} and maximum extension e_{max}
- Condition of specimen surface (e.g., cracking, hogging, dishing)
- Surface profile at initial state before testing, ϵ_{min} at maximum extension e_{max} and ϵ_{max} at maximum compression c_{max}
- Adhesion between adjacent pavement and joint filling mixture and within the joint filling mixture (debonding/cracking)
- Details of test assembly considering Clause C.4.3

Method b) Movement capacity under fast occurring movements

- Details of specimen preparation
- Number of test cycles n_{fast}
- Movement capacity under fast occurring movements (dynamic amplitude Δw)
- Mean deformation rate
- Test frequency
- Temperature of specimen and temperature of the climate chamber
- Max. reaction forces generated during the movement cycles (e.g., the report shall include a load/deformation graph (Hysteresis curve) over the complete test duration)
- Stiffness values $\Delta F / \Delta w$ for every 250 000 load cycles
- Loss of stiffness of the FPEJ specimen over the test period
- Condition of specimen surface (e.g., cracking, hogging, dishing)
- Adhesion between crossheads and joint filling mixture and within the joint filling mixture (debonding/cracking)
- the extent of damage due to wear
- Details of test assembly considering Clause C.4.3

C.7 – TEST REPORT

The test report shall refer to this annex and test procedure and include at least:

- The test method and test parameters used to test the product
- The origin of the FPEJ: name of manufacturer and source of the specimen tested and how sampled including details of specimen preparation
- The product model identity, batch number, description, date of manufacture, date of sampling
- Mass and size of sample
- Test results as required above including graphs, photo documentation and description of specimen behaviour during testing (e.g., position of bridging plate, lateral contraction etc.)
- Date of tests
- Date of report
- Identification of test authority and credentials of the test laboratory

ANNEX D – EXPOSURE PROCEDURE FOR ACCELERATED AGEING BY HEAT⁹

D.1 Scope

This Annex specifies the exposure procedure for accelerated ageing by heat, equipment and the procedure for conditioning specimens in order to assess the possible effect of this exposure on essential characteristics as defined in Clause 2.2.13 by comparative testing.

D.2 Principle

The conditioning of samples is performed by exposing the samples to a defined temperature during a specified period of time (70°C, 28 d, see also Clause 2.2.13).

D.3 Apparatus

D.3.1 Oven

With forced air circulation and with temperature regulation to a range of 50°C to 100°C with an accuracy of $\pm 2^\circ\text{C}$. The internal dimensions are such to contain the frame (see Clause D.3.2).

D.3.2 Shelf

To support the test sample and enabling a uniform heating with dimensions to fix the test specimens.

D.4 Test specimen

The test specimens are made from the joint filling mixture as defined in Clause 1.3.1.

The preparation of the test specimens is under the responsibility of the manufacturer. Check of appropriate documentation of the specimen preparation to be provided by the manufacturer is task of the testing body.

D.5 Procedure

D.5.1 Bring the oven to the required temperature

D.5.2 Place the test specimens on the supporting frame in the oven.

D.5.3 Maintain the required temperature during the specified period of time.

D.5.4 After the exposure period remove the sample from the oven, bring it back to ambient temperature ($+25 \pm 5^\circ\text{C}$) and maintain it at that temperature for 24 hours, make a visual observation of the conditioned specimen and describe changes between before and after conditioning before further testing.

D.5.5 Prepare the test specimens according to the test methods for evaluation of any exposure effects (change of related values of material characteristics) as defined in Clause 2.2.13.

D.6 Test report

The test report shall include at least the following information:

- a. reference to this Annex of this EAD;
- b. the name of the testing laboratory;
- c. date/period of exposure;
- d. description of the test specimen, including shape and dimensions;
- e. type of exposure, temperature and period of time;
- f. all visual observations;
- g. results of evaluation of exposure effects;

⁹ This Annex completely transposes the provisions of EOTA TR 11

ANNEX E – MOUNTING AND FIXING PROVISIONS FOR THE REACTION TO FIRE TESTS

E.1 EN ISO 9239-1 (Radiant panel test)

This test method is relevant for reaction to fire classes A2_{fi} to D_{fi} according to EN 13501-1.

E.1.1 Dimensions of the test specimens

The dimension of the test specimens shall be as prescribed in the test standard.

E.1.2 Substrate

The test specimens shall be mounted onto an appropriate standard substrate according to EN 13238 representing the substrates in end use applications.

E.1.3 Test specimens

The following parameters shall be considered when preparing the test specimens:

- Composition of the joint filling mixture (as defined by a certain combination of raw materials and other additives and produced according to the MPII) and assembly (e.g., number, type and dimensions of the layers of the joint filling mixture, application of surface dressing if part of the kit) shall be considered within the tests,
- Thickness – the highest as well as the lowest thickness *D* of the joint filling mixture shall be tested,
- Primer – if a primer is foreseen in the end-use it shall be considered within the tests of the joint filling mixture.

The results of tests taking into consideration completely the aforementioned parameters are valid for:

- the same defined product and assembly as tested,
- any thickness between those evaluated.

At least one test with any of the identified specimen configurations (based on the aforementioned parameters) shall be performed as basis for the classification.

E.2 EN ISO 11925-2 (Small ignition source test)

This test method is relevant for reaction to fire classes B_{fi} to E_{fi}, according to EN 13501-1.

E.2.1 Dimensions of the test specimens and preparation

The dimension of the test specimens shall be as prescribed in the test standard.

E.2.2 Substrate

The test specimens shall be mounted onto an appropriate standard substrate according to EN 13238 representing the substrates in end use applications.

Other substrate (deviating from EN 13238) may also be used for testing purposes. However, in this case the test results will only be valid for the use of the joint filling mixture on this specific substrate.

E.2.3 Test specimens

The following parameters shall be considered when preparing the test specimens:

- Composition of the joint filling mixture (as defined by a certain combination of raw materials and other additives and produced according to the MPII) and assembly (e.g., number, type and dimensions of the layers of the joint filling mixture, application of surface dressing if part of the kit) shall be considered within the tests,
- Thickness – the highest as well as the lowest thickness *D* of the joint filling mixture shall be tested,
- Primer – if a primer is foreseen in the end-use it shall be considered within the tests of the joint filling mixture.

The results of tests taking into consideration completely the aforementioned parameters are valid for:

- the same defined product and assembly as tested,
- any thickness between those evaluated.

The test specimens shall be tested with surface exposure.
At least two tests with any of the identified specimen configurations (based on the aforementioned parameters) shall be performed as basis for the classification.

ANNEX F (INFORMATIVE) – BACKGROUND FOR CALCULATIONS FOR MECHANICAL RESISTANCE

Characteristic axle load plastic resistance $Q_{1k,pl}$ [kN] according to equation (2.2.1.1) is based on the following:

Wheel print according to Figure 2.2.2.1 (right picture).

- ⇒ Resulting in a maximum effective width of double wheel equal to:

$$250 + 100 + 250 = 600 \text{ mm and length of } 300 \text{ mm}$$

Tandem system (TS) arrangement according to Figure 2.2.2.1 (left picture).

- ⇒ Resulting in an effective width of two adjacent double wheels of $600 + 100 + 600 = 1300 \text{ mm}$, while due to symmetry halve equal to 650 mm is considered in the following.

The assessment considers the load distribution in the joint filling mixture and adjacent pavement with $\theta = 45^\circ$ (see Figure 2.2.1.2).

- ⇒ Considering the above outlined symmetry and thickness of the joint filling mixture of 60 mm the distribution is limited on one side to 50 mm (nothing to be added), while on the other side the minimum thickness of the joint filling mixture D shall be added for the total effective width on bridging plate level for the load distribution resulting in “ $2 \cdot (650 \text{ mm} + D [\text{mm}])$ ” total effective width for the contact pressure.
- ⇒ Regarding the length the minimum thickness of the joint filling mixture D shall be added for the total effective length on both sides resulting in “ $300 \text{ mm} + 2 \cdot D$ ” total effective length for the contact pressure.

Mechanical basis translates a resulting force to a contact pressure for the axle load considering (on the safe side) that on both lane numbers the same maximum axle load applies resulting by the above outlined effective width and length for the line load (pressure times the effective width) to the bridging plate like the following:

$$q = \frac{Q_{1k} \cdot 2 \cdot (650 + D)}{2 \cdot (650 + D) \cdot (300 + 2 \cdot D)} = \frac{Q_{1k}}{(300 + 2 \cdot D)} \quad (\text{F.1})$$

Applying mechanical basics for the simple supported beam (here bridging plate) with uniform distributed line load, see Figure F.1 (compare e.g., Schneider Bautabellen, 22nd revision, clause 4 A, 1.1.1 “simple supported beam”), considering that the span length l is equal to the gap width g the following results:

$EI = \text{konst.}$ 	Auflagerkräfte 		M-Linie 	Biegelinie 
	$\frac{ql}{2}$	$\frac{ql}{2}$	$\frac{ql^2}{8}$ bei $\xi_0 = 0,5$	$\frac{ql^4}{76,8 EI}$

Translation:

“konst” = constant

“Auflagerkräfte” = reaction force

“M-Linie” = moment diagram

“Biegelinie” = bending line

“bei” = at

“Mitte” = middle

Figure F.1: Mechanical basics for the simple supported beam – maximum moment M_{max}

$$M_{max} = \frac{q \cdot l^2}{8} = \frac{Q_{1k} \cdot g^2}{8 \cdot (300 + 2 \cdot D)} \quad (\text{F.2})$$

The design resistance for bending about one principal axis of a cross-section is determined according to EN 1993-1-1:2022, clause 8.2.5 “Bending moment” and clause 8.2.2.6 “Section properties for the characteristic resistance”, as follows, as the bridging plate is facing pure bending about one principal axis

and the bridging plate shall be considered as class 1 on cross section (compare EN 1993-1-1:2022, Table 7.3):

$$M_{c,Rd} = M_{pl,Rd} = \frac{W_{pl} \cdot f_y}{\gamma_{M0}} \quad (F.3)$$

The marked section indicated in Schneider Bautabellen, 22nd revision, clause 4, equation (12) represents w_{pl} for rectangular cross-section like the bridging plate:

$$M_{pl} = 2\sigma_F b \frac{d}{2} \cdot \frac{d}{4} = 2\sigma_F \frac{bd^2}{8} = \sigma_F \frac{bd^2}{4}; \quad M_{El} = \sigma_F \frac{bd^2}{6} \quad (12)$$

No partial safety factor γ_{M0} applies for the characteristic plastic bending resistance and σ_F equals to f_y for the maximum. Considering in addition d by the plate thickness t and that b equals the effective width of the sliding plate ("2 * (650 + D)") the following concludes:

$$M_{pl,Rk} = W_{pl} \cdot f_y = \frac{2 \cdot (650 + D) \cdot t^2}{4} \cdot f_y = \frac{Q_{1k} \cdot g^2}{8 \cdot (300 + 2 \cdot D)} = M_{max} \quad (F.4)$$

Solving for Q_{1k} results to the equation (2.2.1.1):

$$Q_{1k,pl} = \frac{4 \cdot (650 + D) \cdot (300 + 2 \cdot D) \cdot t^2 \cdot f_y}{g^2} \quad (F.5 = 2.2.1.1)$$

Characteristic axle load elastic resistance $Q_{1k,el}$ [kN] according to equation (2.2.1.2) is based on the following:

The marked section indicated in Schneider Bautabellen, 22nd revision, clause 4, equation (12) represents w_{pl} and w_{el} for rectangular cross-section like the bridging plate:

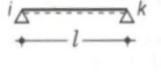
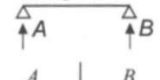
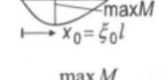
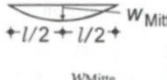
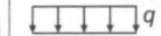
$$M_{pl} = 2\sigma_F b \frac{d}{2} \cdot \frac{d}{4} = 2\sigma_F \frac{bd^2}{8} = \sigma_F \frac{bd^2}{4}; \quad M_{El} = \sigma_F \frac{bd^2}{6} \quad (12)$$

Considering that all other basic outline for the characteristic axle load plastic resistance according to equation (2.2.1.1) remains and w_{pl} versus w_{el} deviate only regarding the dominator the following applies:

$$Q_{1k,el} = \frac{4 \cdot Q_{1k,pl}}{6} = \frac{2 \cdot Q_{1k,pl}}{3} \quad (F.6 = 2.2.1.2)$$

Elastic deflection of the bridging plate $w_{1k,el}$ [mm] according to equation (2.2.1.3) is based on the following:

Applying mechanical basics for the simple supported beam (here bridging plate) with uniform distributed line load (compare e.g. Schneider Bautabellen, 22nd revision, clause 4 A, 1.1.1 "simple supported beam") considering that the span length l is equal to the gap width g , the line load q equals to $Q_{1k,el}$ divided by the effective length ("(300+2*D)") and 76,8 can be expressed as 384 divided by 5 the following results:

$EI = \text{konst.}$ 	Auflagerkräfte 	M-Linie 	Biegelinie 
	$\frac{ql}{2}$ $\frac{ql}{2}$	$\frac{ql^2}{8}$ bei $\xi_0 = 0,5$	$\frac{ql^4}{76,8 EI}$

Translation:

"konst" = constant

"Auflagerkräfte" = reaction force

"M-Linie" = moment diagram

"Biegelinie" = bending line

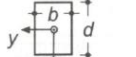
"bei" = at

"Mitte" = middle

Figure F.2: Mechanical basics for the simple supported beam – bending line

$$w_{1k,el} = \frac{Q_{1k,el} \cdot g^4 \cdot 5}{(300 + 2 \cdot D) \cdot 384 \cdot E \cdot I} \quad (\text{F.7})$$

Applying mechanical basics for moment of inertia I applying for the rectangular section of the bridging plate (compare e.g. Schneider Bautabellen, 22nd revision, clause 4.28, Table 2.1.2 "table cross-section values") considering d by the plate thickness t and that b equals the effective width of the sliding plate ("2*(600 + D)") the following concludes:

	Querschnitt	A	I_y	I_z	W_y	W_z
1		bd	$\frac{bd^3}{12}$	$\frac{db^3}{12}$	$\frac{bd^2}{6}$	$\frac{db^2}{6}$

Translation:

"Querschnitt" = cross-section

Figure F.3: Cross-sectional values

$$w_{1k,el} = \frac{Q_{1k,el} \cdot g^4 \cdot 5 \cdot 12}{(300 + 2 \cdot D) \cdot 384 \cdot E \cdot 2 \cdot (650 + D) \cdot t^3} \quad (\text{F.8} = 2.2.1.3)$$

ANNEX G (INFORMATIVE) – BACKGROUND FOR CALCULATIONS FOR RESISTANCE TO FATIGUE

Characteristic axle load fatigue resistance $Q_{1k,fat}$ [kN] according to equation (2.2.2.1) is based on the following:

Applying mechanical basics for the simple supported beam (here bridging plate) with uniform distributed line load (compare e.g. Schneider Bautabellen, 22nd revision, clause 4 A, 1.1.1 “simple supported beam”) considering that the span length l is equal to the gap width g the following results:

$EI = \text{konst.}$ 	Auflagerkräfte 	M-Linie 	Biegelinie
q	$\frac{ql}{2}$ $\frac{ql}{2}$	$\frac{ql^2}{8}$ bei $\xi_0 = 0,5$	$\frac{ql^4}{76,8 EI}$

Translation:

“konst” = constant

“Auflagerkräfte” = reaction force

“M-Linie” = moment diagram

“Biegelinie” = bending line

“bei” = at

“Mitte” = middle

Figure G.1: Mechanical basics for the simple supported beam – maximum moment M_{max}

$$M_{max} = \frac{q \cdot l^2}{8} = \frac{Q_{1k} \cdot g^2}{8 \cdot (300 + 2 \cdot D)} \quad (G.1)$$

The marked section indicated in Schneider Bautabellen, 22nd revision, clause 4, equation (12) represents W_{el} for rectangular cross-section like the bridging plate:

$$M_{Pl} = 2\sigma_F b \frac{d}{2} \cdot \frac{d}{4} = 2\sigma_F \frac{bd^2}{8} = \sigma_F \frac{bd^2}{4}; \quad M_{El} = \sigma_F \frac{bd^2}{6} \quad (12)$$

A single double wheel according to Figure 2.2.1.1 shall be considered for the assessment of the bridging plate resulting in an effective width of “600 + 2·D” with halve the axle load.

Considering d (above equation) by the plate thickness t and that b equals the effective width of the bridging plate as outlined above the following concludes for the elastic bending moment at maximum bending moment:

$$M_{max} = \frac{0,5 \cdot Q_{1k} \cdot g^2}{8 \cdot (300 + 2 \cdot D)} = \sigma_F \frac{(600 + 2 \cdot D) \cdot t^2}{6} \quad (G.2)$$

Considering the above the characteristic constant amplitude fatigue limit stress $\Delta\sigma_D$ shall be applied for the effective strength representing the characteristic axle load fatigue resistance of the bridging plate $Q_{1k,fat}$, which results to the following:

$$\frac{0,5 \cdot Q_{1k,fat} \cdot g^2}{8 \cdot (300 + 2 \cdot D)} = \Delta\sigma_D \frac{(600 + 2 \cdot D) \cdot t^2}{6} \quad (G.3)$$

Solving for $Q_{1k,fat}$ results to the equation (2.2.2.1):

$$Q_{1k,fat} = \Delta\sigma_D \frac{8 \cdot (300 + 2 \cdot D) \cdot (600 + 2 \cdot D) \cdot t^2}{3 \cdot g^2} \quad (G.4 = 2.2.2.1)$$