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MAT EXPANSION JOINTS FOR ROAD BRIDGES

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sv – svenska	
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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) No 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 mat expansion joints for road bridges.

Mat expansion joints for road bridges are used to ensure the continuity of the running surface and its load bearing capacity and the movement of the bridges whatever the nature of the structure constitutive material is.

Mat expansion joints use the elastic properties of a prefabricated elastomeric mat based on Polychloroprenerubber (CR), Ethylene-Propylene-Diene Material (EPDM), Styrol-Butadiene-Rubber (SBR) to allow for the expected movements of the structure. The elastomeric mat is fixed to the bridge structure (e.g. by bolts). The mat surface is flush with the running surface and carries the traffic loads. The movements take place by deformation (compression, elongation or shear) of the mat. The mat element can be made with or without metallic reinforcement.

Expansion joints for moveable bridges are not covered by this EAD.

Mat expansion joints consist of at least the following:

- an elastomeric element, the mat (reinforced or not reinforced), optionally including a bridging plate
- an anchorage system

In addition, the following optional components may be included in the kit to be assessed and subject of the ETA:

- support structure (e.g. support beam with bearing, sliding and prestress elements)
- sliding plate
- kerb elements
- connecting devices (e.g. to connect mat elements)
- gutter
- cover plates (e.g. for footpath)
- connections to the watertight membrane
- transition strip
- drainage device made of aluminium or stainless steel (defined in EAD 120109-00-0107, Annex D, Figure D.11)

Flexible gutters according to this EAD made of elastomer are based on Polychloroprenerubber (CR), Ethylene-Propylene-Diene Material (EPDM), Styrol-Butadiene-Rubber (SBR).

Rigid gutters according to this EAD made of plastics are based on PVC or PE or made of stainless steel or galvanized steel.

A transition strip according to this EAD is made of thermosetting or thermoplastics binder (as defined in EN ISO 472) or made of bituminous mixture or made of ready mixed concrete or resin mortar.

A succession of parallel mat elements placed on a (fixed or sliding) supporting structure is called a multiple mat expansion joint.

Examples for different types of mat expansion joints are given in Figure 1 to Figure 4 below.

Examples for single/multiple mat expansion joints on the basis of shear deformation are given in Figure 1a and Figure 1b.

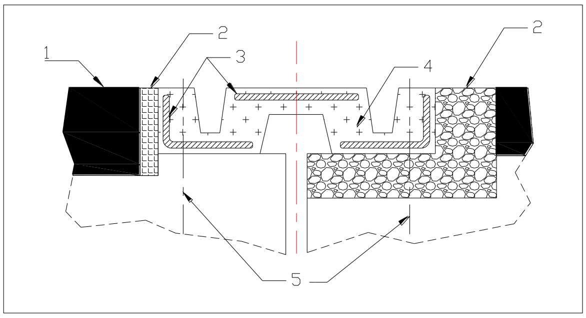


Figure 1a: Example for single Mat Expansion Joints on the basis of shear deformation

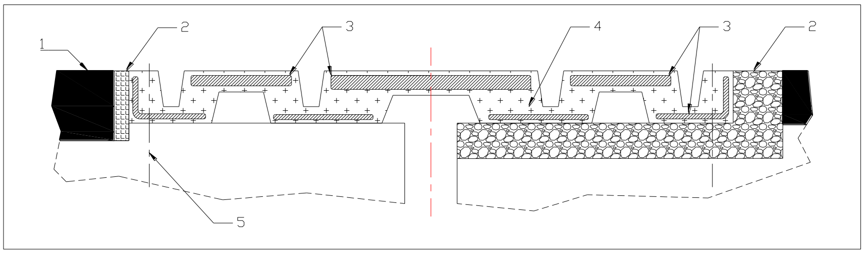


Figure 1b: Example for multiple Mat Expansion Joints on the basis of shear deformation

The principle for single Mat Expansion Joints on the basis of compression/tension deformation is given in Figure 2 and Figure 3.

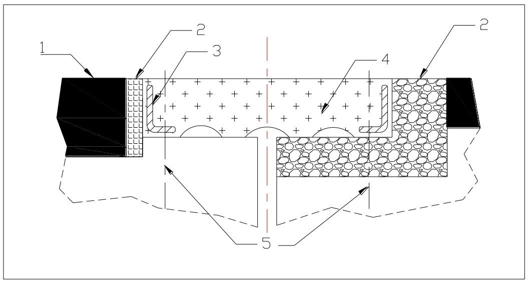


Figure 2: Example for single mat expansion joints on the basis of compression/tension deformation

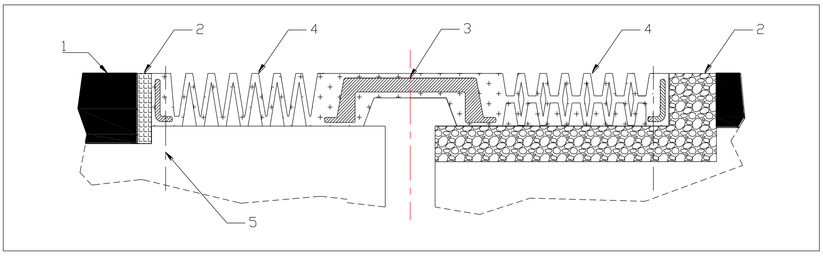


Figure 3: Example for single Mat Expansion Joints on the basis of compression/tension deformation including reinforcement/bridging plate

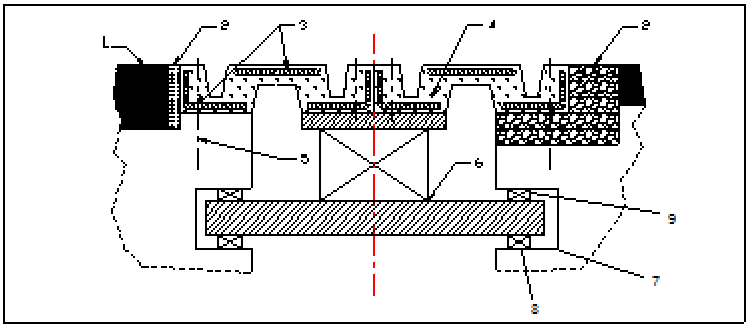


Figure 4: Example for supported multiple mat expansion joints

Key for Figures 1 – 4:

1 Pavement/Wearing course (not part of the kit)
2 (To left hand side) Sealant (not part of the kit)
2 (To right hand side) Transition strip
3 Reinforcement/insert/bridging plate
4 Elastomer mat
5 Anchorage system
6 Support beam
7 Joist box
8 Bearing
9 Prestress element

If relevant for the performance of the kit, the material used for connecting the joint to the substructure (e.g. concrete the anchorage system is fixed to in case of concrete bridges) considered in the assessment of the product shall be described in the ETA but is not forming a part of the product covered by the ETA.

In particular, if no sliding component between the product and its support is included in the kit, the conditions for roughness, evenness and the loading condition for the contact area shall be described in the ETA.

Mat expansion joints 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:

- Structural steel surfaces in contact with concrete have no coating. Only at the transitions an overlap of approximately 50 mm of the 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.4 and A.5.
- Aluminium alloys have a corrosion resistance of at least category “B” according to EN 1999-1-1, Table D1, 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 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.4 and A.5 needs to be considered.
- Sliding surfaces made of austenitic steel do not have a corrosion protection system.

The product is not covered by a harmonised European standard (hEN).

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 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.

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

1.2.1 Intended use(s)

The product according to this EAD is intended to be used for road bridges.

1.2.1.1 Operating temperature categories

The operating temperature is defined as the shade air temperature according to EN 1991-1-5, clause 1.5.2.

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

- Levels of minimum operating temperature categories: -10 °C, -20 °C, -30 °C, -40 °C
- Levels of maximum operating temperature categories: +35 °C, +45 °C

Operating temperature shall be stated in the ETA.

1.2.1.2 Use categories

The use categories to be stated in the ETA are specified with regard to the user and action categories.

1.2.1.2.1 User categories

- Vehicle
- Cyclist
- Pedestrian

1.2.1.2.2 Actions categories

- Standard action (traffic load action)
- Optional action (accidental effects of heavy wheel on footpath, seismic phenomena; wheel shock on the upstand)

Actions are defined in EAD 120109-00-0107, Annex D, Clause D.2.3 and D.2.4.

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 mat expansion joint for road bridges for the intended use according to the working life categories as given in Table 1 when installed in the works (provided that the mat expansion joint for road bridges 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 intended working life of the kit is based on the following working life categories, with N_{obs} = 0,5 million/year or (see EN 1991-2, Table 4.5 and EAD 120109-00-0107, Annex D, Clause D.2.3.3).

Table 1: Working life categories of the expansion joint kit

Working Life category	Years
1	10
2	15
3	25
4	50

Replaceable components which have a working life shorter than for the kit shall be indicated in the ETA.

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 works[1].

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.

1.3 Specific terms used in this EAD (if necessary in addition to the definitions in CPR, Art 2)

For definitions, abbreviations and symbols regarding the terminology applying for assessment of mechanical resistance, resistance to fatigue and seismic behaviour EAD 120109-00-0107, Annex D applies. For additional terms and definitions specific for this EAD, see below.

1.3.1 Elastomer mat

A supported load carrying elastomeric element with a succession of hollow parts allowing the movement of the joint.

1.3.2 Butt joint

Connection of two mat elements at their ends.

1.3.3 Groove

Specific type of recess in the surface finishing, but without significant change of its shape under deformation.

1.3.4 Insert/reinforcement

Element which is embedded in the elastomer and which may contribute to the load bearing capacity or to ease the fixing to the structure.

1.3.5 Support structure

Intermediate structure connecting surface elements and anchorage system to the main structure. Possibly consisting of a steel beam supporting the mat element and supported by one part of the bridge and the abutment and/or another part of the bridge respectively and bearing and prestress elements. The support structure transfers the loads from the mat element by centre beams and crossbeams to the main structure.

1.3.6 Secondary elements

Components of the kit not contributing to mechanical resistance and stability of the kit.

1 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.

1.3.7 Gutter

Component with the purpose of draining surface water from the expansion joint.

1.3.8 Transition strip

Material between the expansion joint and the adjacent surfacing.

1.3.9 Joist box

The joist box supports the beams of the support structure and ensures by its stiffness that the forces applied by the prestress elements are not susceptible to variation due to moving end supports surfaces.

The joist box is embedded in the main structure.

1.3.10 Bearing

Element transferring the (traffic and prestress) loads from the mat element to the beam of the support structure and/or to the main structure.

The bearing can be fixed or sliding, in all cases it enables rotations. Rotations can cause reaction moments from deformation or friction in curved sliding surfaces.

Bearings according to this EAD are made of elastomers (based on Polychloroprenerubber (CR), Ethylene-Propylene-Diene Material (EPDM), Styrol-Butadiene-Rubber (SBR), Natural rubber (NR) or mixture of SBR, CR and NR or plastics (Polyamide, Polyoxymethylene, Polyethylene (including UHMWPE)) possibly with steel inserts, eventually with polymer sliding surfaces.

Bearings transfer vertical loads, accommodating translations and rotations. The loading conditions are static (prestress) and dynamic (traffic) loads. Depending on the detailing, sliding and imposed rotations can take place and shear forces can occur.

1.3.11 Prestress element

A prestress element prevents uplift of the mat element to support beam connection and/or uplift in the support beam to main structure connection. A prestress element can be fixed or sliding and always has to allow rotations. Rotations can cause reaction moments from deformation or friction in curved sliding surfaces.

The prestress elements transfer forces generated by imposed prestress (static) and traffic loads (dynamic)

The prestress elements are made of NR or CR with steel inserts, eventually with PTFE or other sliding surfaces.

1.3.12 Anchorage system

Bars and/or rods that connect the expansion joint to the main structure or the abutment.

1.3.13 Batch

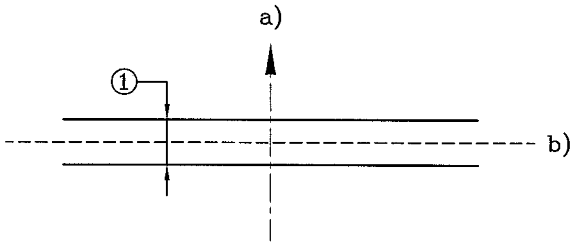
Quantity of product or components manufactured to the same specification within a determined period.

1.3.14 Gap

1.3.14.1 Expansion joint gap (surface gap (1))

Opening (generally defined by one dimension) with a great length and a relatively small width in the road surface between sub-components of the expansion joint (perpendicular distance between two straight edges or planes):

a) Traffic direction
b) Longitudinal axis of the expansion joint.

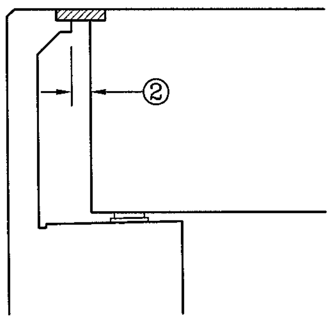


Note: In principle, the term gap is not restricted to straight border lines.

(See also EAD 120109-00-0107, Annex D, Clause D.2.2)

1.3.14.2 Bridge deck gap (structure gap (2))

Opening between two adjacent parts of the main structure, which is bridged by the expansion joint (distance between two structural elements) (See also EAD 120109-00-0107, Annex D, Clause D.2.2).



1.3.15 Kerb

The upstand which forms the boundary of the carriage way and the footpath.

1.3.16 Movement capacity

The range of the relative displacement between the extreme positions (e.g. maximum and minimum opening) of an expansion joint (See also EAD 120109-00-0107, Annex D, Clause D.2.2).

1.3.17 Replaceability

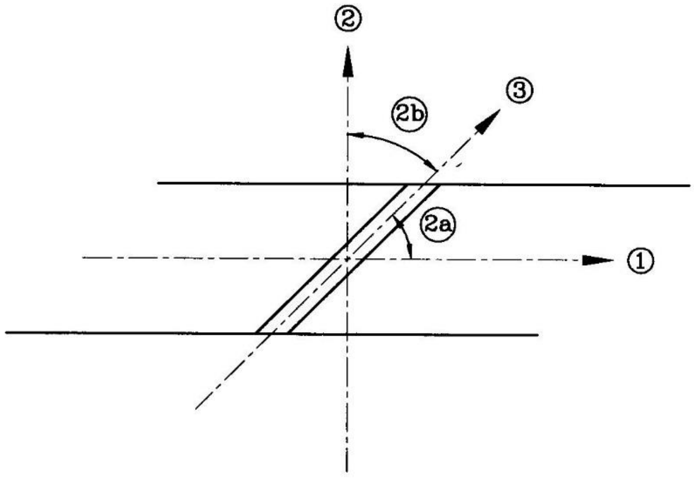
The ability to replace is given when a component, incorporated in the assembled expansion joint, can be exchanged during the intended working life of the expansion joint.

1.3.18 Skew angle (of the expansion joint)

Considering the existence of two interpretations of the skew of the bridge in Member States, it has two definitions:

a) the skew angle is the angle between the traffic direction and the longitudinal axis of the joint

b) the skew angle is the angle between the axis perpendicular to the road and the longitudinal axis of the joint



Legend

1: Road axis in traffic direction
2: Perpendicular to the road axis
2a and 2b: Skew angle
3: Longitudinal expansion joint axis

(See also EAD 120109-00-0107, Annex D, Clause D.2.2)

1.3.19 Void

An opening in the road surface (generally defined by two dimensions) with no load bearing capacity.

2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

All undated references to standards or to EADs in this Chapter are to be understood as references to the dated versions listed in Clause 4.

2.1 Essential characteristics of the product

Table 2 shows how the performance of the mat expansion joint for road bridges is assessed in relation to the essential characteristics.

Table 2 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	Clause 2.2.1	Description
2	Resistance to fatigue	Clause 2.2.2	Description
3	Seismic behaviour	Clause 2.2.3	Description Level
4	Movement capacity	Clause 2.2.4	Level
5	Cleanability	Clause 2.2.5	Description
6	Resistance to wear	Clause 2.2.6	Description Level (abrasion)
7	Watertightness	Clause 2.2.7	Description
8	Durability	Clause 2.2.8	Description
Basic Works Requirement 3: Hygiene, health and the environment			
9	Content, emission and/or release of dangerous substances	Clause 2.2.9	Level Description
Basic Works Requirement 4: Safety and accessibility in use			
10	Ability to bridge gaps and levels in the running surface	Clause 2.2.10	Level
11	Skid resistance	Clause 2.2.11	Level
12	Drainage capacity	Clause 2.2.12	Level Description

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

2.2.1 Mechanical resistance

Assessing the mechanical resistance of the mat expansion joint shall not lead to:

- collapse of the whole or a part of the works
- major deformations to an inadmissible degree
- damage by an event to an extent disproportionate to the original cause

Assessment shall be based on:

- Relevant load distribution and load model according to EAD 120109-00-0107, Annex D, Clause D.2
- Actions (according to Clause 1.2.1.2.2) considered according to EAD 120109-00-0107, Annex D, Clause D.2.3 and D.2.4
- Safety factors used and assessment criteria according to Table 3

Calculations shall be done according to the conditions in the Eurocodes mentioned thereafter as far as relevant due to materials used and shall include information on calculation models used, whereas conditions and criteria defined thereafter shall be considered. Input from testing for calculation shall be introduced in the calculation, where relevant.

In case of testing, either in addition to or instead of calculation, as defined in the sub clauses thereafter, relevant components/assembled kit shall be referred to.

Assessment criteria used and based on the detailing thereafter shall be defined for the calculation.

In the ETA the assessment shall be stated in terms of description for the relevant product to be addressed (dimensions, materials, welds or bolted connections etc.).

Conditions for the assessment shall be stated in the ETA as far as relevant:

- Anchor forces for load distribution to the adjacent parts of the expansion joint
- the load models
- adjustment factors
- load factors
- combination factors

Whereas:

External loads on mat expansion joints are generated by traffic. Further loads on expansion joints may be generated as internal loads from imposed deformations or displacements or change of temperature of the joint itself.

Table 3 gives details of the assessment criteria for concerned limit states.

Table 3: Limit state and assessment criteria

Limit State	Limit State requirement	Remark
ULS	Static equilibrium No collapse and no “brittle” failure of the expansion joint *)	The mat expansion joint includes its anchoring system. Detailing for supported multiple mat expansion joints (see Figure 4): Connection of mat to intermediate support • ULS plastic behaviour according to EN 1993-1-1 • Section forces and moments from Elastic analysis • Partial factor γ_{M0} = 1,0 Support structure • ULS plastic behaviour according to EN 1993-1-1 • Section forces and moments from Elastic analysis • Span in conjunction with combination rules in EAD 120109-00-0107, Annex D, Clause D.2.4.2.1 • Horizontal fixing and guide function • Partial factor γ_{M2} = 1,25 Bearing • Load bearing capacity (deformation criterion) • Section forces and moments from Elastic analysis • Partial factor γ_{M0} = 1,0 Prestress elements • Separation of contact surfaces allowed • Partial factor γ_{M0} = 1,0 Joist box • ULS plastic behaviour according to EN 1993-1-1 • Section forces and moments from Elastic analysis • Partial factor γ_{M0} = 1,0 Anchorage system (including that of the joist box) • ULS plastic behaviour according to EN 1993-1-1 • Section forces and moments from Elastic analysis • Reinforcement design in accordance with EN 1992 • Welding of studs in accordance with EN ISO 13918 • Partial factor γ_{M0} = 1,0
	No fatigue failure during the intended working life (see Clause 1.2.2). (Stress ranges below constant amplitude fatigue limit [CAFL] or cumulative damage assessment D<1,0).	The mat expansion joint includes its anchoring system. Detailing for supported multiple mat expansion joints (see Figure 4): Connection of mat to intermediate support • Partial factor γ_{Mf} = 1,15 Support structure • Partial factor γ_{Mf} = 1,35 Joist box • Partial factor γ_{Mf} = 1,15 Bearing • Partial factor to be determined in accordance with EN 1990 Prestress elements • Partial factor to be determined in accordance with EN 1990 Anchorage system (including that of the joist box) • Reinforcement design in accordance with EN 1992 • Studs in accordance with EN ISO 13918 • Welds in accordance with EN 1993-1-9 • Partial factor to be determined in accordance with EN 1990
SLS	Only reversible deformations (see also Clause 2.2.10.2), displacement or rotation (hysteresis effects or similar due to material behaviour are allowed).	Bearing (limits as defined in Annex F, Clause F.7) Prestress element (limits as defined in Annex F, Clause F.7)

*) This means that local cracks and deformations are allowed as long as the traffic loads are still carried by the joint under the conditions for opening and loading (this includes the ULS criteria for the mat expansion joint under imposed displacement at ULS of the main structure).

Note: Assessment criteria given in this EAD are related to the defined design situations in EAD 120109-00-0107, Annex D, Clause D.1.

EAD 120109-00-0107, Annex D, Clause D.2 is relevant for the product according to this EAD with the following precisions:

SLS conditions are related to the following two design situations:

SLS 1: 100 % load level with 60 % of the maximum opening position

SLS 2: 70 % load level with 100 % maximum opening position of the joint

ULS conditions are related to the following two design situations:

ULS 1: 100 % load level with 60 % of the maximum opening position

ULS 2: 70 % load level with 100 % maximum opening position of the joint

The actions, loads and combination in relation to the user and actions categories described in Clause 1.2.1.2 are given in EAD 120109-00-0107, Annex D, Clause D.2.

Assessment of the minimum operating temperature according to Clause 1.2.1.1 for metallic components of the kit is done according to EN 1993-1-10, Table 2.1.

For load distribution EAD 120109-00-0107, Annex D, Figure D.2 applies.

For mat expansion joints, mechanical resistance shall be assessed by full scale testing. Metallic parts shall be additionally assessed by calculation.

In addition for mat expansion joints with intermediate supports (see Clause 1.1, Figure 4):

The support of the pavement by the joist boxes and other plate elements acting as a steel deck shall have sufficient stiffness to prevent damage to the pavement. This is achieved when the deflection under SLS loads does not exceed 0,0025 x l or 0,0025 x b, where l and b are the spans for simply supported plates and 0,005 x l, where l is the length of the cantilevering part.

For rectangular plates supported by four edges, the smallest value for b and l applies; for plates supported by three edges, the smaller value for the simple span or the cantilever applies.

The relevant load combination on the support system shall be derived according to EAD 120109-00-0107, Annex D, Clause D.2.

The following details used for assessment shall be described in the ETA (as far as relevant):

- Fulfilment of the requirements given above and in Table 3
- Anchor forces for load distribution to the adjacent parts of the expansion joint shall be stated in the ETA
- the load models
- adjustment factors
- load factors
- combination factors

2.2.1.1 Calculation

Models used for calculation shall take into account relevant boundary conditions (e.g. actions, operating temperature, opening of the joint).

The partial factors γ_M shall be determined either:

- in accordance with Clause 6.3 of EN 1990 and,

- where relevant, using the recommended values given in the relevant Eurocode stated below, related to the materials.

In the ETA it shall be stated in terms of description that the product fulfils the mechanical resistance for the designs stated in the ETA and the partial factor γ_M values used for assessment shall be stated in the ETA.

Calculation of mechanical resistance, under the design situations stated in EAD 120109-00-0107, Annex D, Clause D.1 are following Eurocodes, in particular, those mentioned in Table 4:

- EN 1992-2
- EN 1993-1-4
- EN 1993-1-8
- EN 1993-1-10
- EN 1993-2
- EN 1994-2
- EN 1999-1-1
- EN 1999-1-4

Table 4: Guidance on assessment of mechanical resistance by calculation

Component	**Eurocode**	**Relevant clauses (exemplary)**
Inserts/reinforcement/bridging plate	EN 1993-1-1	6.2.1
Connection of mat to support structure	EN 1993-1-8	3.9.2, 4.5, 4.7
Support structure	EN 1993-1-1	6.2.1
Support structure to joist box connection	EN 1993-1-8	3.9.2, 4.5, 4.7
Anchorage system	EN 1992-1-1	6.5

For mat expansion joints with intermediate supports (see Clause 1.1, Figure 4), assessment of these supports shall be done under consideration of the specific partial factors given in Table 3.

The mechanical resistance of the steel inserts, if any, and of the anchorage system, shall be included.

If relevant, the load distribution and transfer shall be analysed, including the dynamic response effects for the kinematic conditions and the appropriate support conditions. Where internal spring systems play a role in the load transfer, proper analysis of their influence shall be made. Unevenness of the surface element (mat) of the joint shall be considered.

The influence of the traffic direction on the load transfer shall be considered for the maximum skew angle.

The support of the pavement by the joist boxes and other plate elements acting as a steel deck shall be assessed for the deflection under SLS loads.

The loads shall be derived from EAD 120109-00-0107, Annex D, Clause D.2.

2.2.1.2 Testing

Annex A of this EAD gives the test method for mechanical resistance for SLS and ULS.

In addition, for mat expansion joints with intermediate supports (see Clause 1.1, Figure 4), assessment according to Annex F applies for the bearing elements.

2.2.2 Resistance to fatigue

The mat expansion joint kit shall have sufficient fatigue resistance with respect to its intended working life category according to Clause 1.2.2 in this EAD. The requirements given in Table 3 for ULS apply.

The actions, loads and combinations are given in EAD 120109-00-0107, Annex D, Clause D.2.

Resistance to fatigue caused by bridge movements due to traffic

For bridge movements due to traffic (without consideration of traffic loads on the joint) no debonding in elastomeric parts and vulcanized connections is allowed.

Resistance to fatigue caused by traffic loads on the expansion joint

For mat expansion joints and their anchorage system, the resistance to fatigue with respect to traffic loads on the expansion joint the following requirements apply:

No cracks in elastomeric part, no debonding after the requested load cycles in conjunction with the corresponding loads according to Annex C. For the anchorage system no loosening, breaking or debonding of its elements shall occur.

The aspects dynamic amplification and number of cycles are covered in the loads and cycles, given in Annex C.

The amplification factor $\Delta\varphi_{fat}$ = 1,3 given in EAD 120109-00-0107, Annex D, Clause D.2 may be reduced, based on dynamic testing (rollover test) according to Annex H.

Upswing effects shall be taken into account. The assessment of upswing effects shall be done in order to assess the concerned deflection and to determine the related forces to be taken into account. The fatigue assessment shall be done with a fatigue load amplitude of +100 % and -30 % (this means a fatigue load interval of 1,3 times the fatigue load in EAD 120109-00-0107, Annex D, Clause D.2) of the load defined in EAD 120109-00-0107, Annex D, Clause D.2. The amplification factor $\Delta\varphi_{fat}$ and the values for consideration of upswing effects may be reduced based on dynamic testing (rollover test) according Annex H in this EAD.

Upswing U_v and U_h shall be considered by factored vertical loads for fatigue assessment according the following equations based on equations [D.5] and [D.6] in EAD 120109-00-0107, Annex D, Clause D.2.3.3.2:

$$Q_{1k,fat,mod} = \Delta\varphi_{fat} \times Q_{1k} \times 0{,}7 \times (1 + U_v)$$

$$Q_{1lk,fat,mod} = 0{,}2 \text{ x } \Delta\varphi_{fat,h} \text{ x } Q_{1k} \text{ x } 0{,}7 \times (1 + U_h)$$

Resistance to fatigue of mat expansion joints shall be assessed by testing. However, for metallic parts, such as anchors and inserts or bridging plates, the resistance to fatigue can be assessed by calculation, provided that all boundary conditions and loads are known in detail.

For load distribution EAD 120109-00-0107, Annex D, Figure D.2 applies.

The following details used for assessment shall be described in the ETA (as far as relevant):

- Fulfilment of the requirements given above and in Table 3
- Anchor forces for load distribution to the adjacent parts of the expansion joint shall be stated in the ETA
- the load models
- adjustment factors
- load factors
- combination factors

2.2.2.1 Calculations

Calculation is applicable for metallic parts.

Models used for calculation shall take into account relevant boundary conditions (e.g. actions, operating temperature, opening of the joint).

For fatigue detail classifications EN 1993-1-9, Clause 8, and EN 1993-2, Clause 9, apply.

The partial factors for fatigue shall be determined either:

- in accordance with Clause 6.3 of EN 1990 or,
- where relevant, using the recommended values given in the relevant Eurocode stated below, related to the materials.

For mat expansion joints with intermediate supports (see Clause 1.1, Figure 4), assessment of these supports shall be done under consideration of the specific partial factors given in Table 3.

In the ETA it shall be stated in terms of description that the product fulfils resistance to fatigue for the designs stated in the ETA and the partial factor γ_M values used for assessment shall be stated in the ETA.

Calculation of resistance to fatigue, under the design situations stated in EAD 120109-00-0107, Annex D, Clause D.2, are following Eurocodes, in particular, those mentioned in Table 5:

- EN 1992-2
- EN1993-1-9
- EN 1993-2
- EN 1994-2
- EN 1999-1-3

Table 5: Guidance on assessment of resistance to fatigue by calculation

Component	**Eurocode**	**Relevant clauses (exemplary)**
Inserts/reinforcement/bridging plate	EN 1993-2	9.5.1
Connection of mat to support structure	EN 1993-2	9.5.1
Support structure	EN 1993-2	9.5.1
Support structure to joist box connection	EN 1993-2	9.5.1
Anchorage system	EN 1992-1-1 / EN 1994-2	6.8.7 / 6.8

Note: $\Delta\sigma_{E2}$ according EN 1993-2, clause 9.5.1 relates to number of cycles equal to 2,0 x 10^6, while loads given by EAD 120109-00-0107, Annex D.2.3.3.2 for fatigue load model $FLM1_{EJ}$ relate to number of cycles equal to 5,0 x 10^6. Therefore stresses $\Delta\sigma_{FLM1,EJ}$ resulting from loads according EAD 120109-00-0107, Annex D.2.3.3.2 for fatigue load model $FLM1_{EJ}$ have to be increased by a factor of 1,356 (equal to $1/(2/5)^{1/3}$) to reach the equivalence level of $\Delta\sigma_{E2} = 1{,}356 \times \Delta\sigma_{FLM1,EJ}$.

2.2.2.2 Testing

The test specimen dimensions and the boundary conditions are selected in such a way that the structural behaviour complies with the behaviour in a real structure.

Assessment of resistance to fatigue due to traffic loads on the joint is carried out by means of full-scale testing according to Annex C.

Assessment of resistance to fatigue caused by bridge movements due to traffic on the bridge but without loads on the joint itself is given in Annex B.

In addition, for mat expansion joints with intermediate supports (see Clause 1.1, Figure 4), assessment according to Annex G applies.

For a transition strip, which is part of the kit, the following applies:

- if the transition strip is made of a mixture (as defined in EN ISO 472) based on a thermosetting binder the assessment method according to EN ISO 11357-2 shall be used, and the glass transition temperature shall be stated in the ETA as this is related to the plastic deformation expected in case it does not exceed the maximum operating temperature;

- if it is made of thermoplastics binder (as defined in ISO EN 472) the assessment method according to EN 12697-22 shall be used, considering the maximum operating temperature;
- if the transition strip is made of a bituminous mixture, the assessment method according EN 12697-22 shall be used, considering the maximum operating temperature.

For the second and third type of transition strip the resulting maximum deformation shall be stated in the ETA.

2.2.3 Seismic behaviour

The assessment of seismic behaviour is referred to the categories given in EAD 120109-00-0107, Annex D, Clause D.2.4.2.3.

The seismic behaviour shall be assessed by analysis of the design of the expansion joint in relation to the categories given in EAD 120109-00-0107, Annex D, Clause D.2.4.2.3 using the principles for the total design value of the displacement (dealt with in EAD 120109-00-0107, Annex D, Clause D.2.4.2.3.2) in the seismic design situation according to EN 1998-2, Clause 2.3.6.3.

The assessed category and the relevant indications according to EAD 120109-00-0107, Annex D, Table D.8 shall be stated in the ETA.

2.2.4 Movement capacity

The movement capacity of an expansion joint is the possibility to allow the displacement of the parts of the main structure under unloaded and loaded conditions.

The movement capacity shall be assessed for 3 directions: longitudinal, transversal and vertical.

Butt joints (if any) shall perform properly at all movements up to the most adverse position.

The movement capacity, including the minimum opening in closed position, may either be defined by the manufacturer or is an outcome of the assessment.

The influence of displacement velocity and the temperature is not relevant for products according to this EAD.

The movement capacity shall be assessed by testing. The test method for unloaded conditions is described in EAD 120109-00-0107, Annex D, Clause D.3.

Assessment of the movement capacity under loaded conditions is covered by testing according to Annex A.

The results of the assessment of the movement capacity for the concerned directions shall be stated in the ETA. The reaction forces shall be stated in the ETA. The minimum opening shall be stated in the ETA.

2.2.5 Cleanability

The ability for cleanability shall be assessed based on the design of the mat expansion joint.

Cleanability is assessed by means of accessibility to the relevant part of the expansion joint (including the gutter, if part of the kit).

The following results of assessment apply: Cleanable; Not cleanable.

Cleanable means that debris can be removed manually.

Not cleanable means it cannot be cleaned manually for all opening positions.

2.2.6 Resistance to wear

The intended working life of the kit shall not be affected by wear which is caused by movements either between two parts of the joint or between parts of the joint and the main structure.

Resistance to wear is of relevance for mat joints with sliding mat surfaces on support only. The accumulation of wear of the sliding surfaces shall not result in one or more of the conditions mentioned below:

- Insufficient mechanical resistance to meet the requirements of Clause 2.1.1,
- Change in kinematic conditions (e.g. loss of original contact pressure in the sliding surface),
- Complete vanishing of the original cover layer leading to insufficient protection against corrosion,

as far as relevant.

For assessment due to traffic loads on the expansion joint, Annex C applies.

For assessment due to bridge movement without traffic loads on the expansion joints, Annex B applies.

In addition, for mat expansion joints with intermediate supports (see Clause 1.1, Figure 4), assessment according to Annex G applies.

In addition, for the elastomeric mat, the abrasion shall be assessed according to ISO 4649 (method B) with the precisions stated below.

Precisions to ISO 4649:

Amendment to Clause 6.1 Type and preparation

The test specimen is prepared in the same specific devices (e.g. mould) used to manufacture the elements of the expansion joint.

If possible, test specimen may be taken from the product. Where the required thickness for the test is not reached, use the possibility proposed at the end of clause 6.1 of the standard.

Amendment to Clause 6.3 Time interval between vulcanization or forming and testing

For all test purposes, the minimum time interval between vulcanization or forming and testing shall be 24 h.

Amendment to Clause 6.4 Conditioning

24 h instead of 16 h.

Amendment to Clause 7 Test temperature

The test temperature shall be 23 °C ± 3 °C.

Amendment to Clause 8.1 General test procedure

The vertical force shall be 10 N. Reduction to 5 N is not permissible.

Amendment to Clause 9 Expression of results

The results shall be expressed as a relative volume loss according to 9.2.

For the formula, the value of Δm_{const} is constant and equal to 250 mg.

The standard reference compound is defined as follows:

Ingredient	Part in weight
Natural rubber (SMR 5)	100,0
Disulphide of dibenzothiazyle	1,2
N – isopropyl – N' – phenyl – p – phenylenediamine	1,0
Zinc Oxide	50,0
Furnace Black (N 330 – HAF)	36,0
Sulphur	2,5
Total	190,7

The preparation is according to Annex B of ISO 4649.

Amendment to Clause 11 Test report

The test report shall indicate whether the test was made with a surface with a “skin moulding” or not.

The value for abrasion, expressed in mm³ (according to ISO 4649, including precisions given above) shall be stated in the ETA.

2.2.7 Watertightness

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

Watertightness of mat expansion joints is achieved either by a watertight joint itself or by a sub-surface drainage system (gutter).

For the assessment of the watertightness of the mat expansion joint without a gutter, the test method is described in EAD 120109-00-0107, Annex D, Clause D.4.

For the test method according to EAD 120109-00-0107, Annex D, Clause D.4, the value of opening used for testing is defined by the worst condition which is the minimum contact pressure between the mat expansion joint and the adjacent part and the conditions of any but joint (if part of the kit).

In addition:

Where a watertight connection between the waterproofing system of the main structure and the mat expansion joint is foreseen as component of the expansion joint, for the assessment according to EAD 120109-00-0107, Annex D, Clause D.4.4.1 applies in addition.

The type of the connection shall be described in the ETA.

The result of the assessment of the watertightness (moisture under the joint) shall be stated in the ETA, whereas the following results of assessment apply: Watertight; Not watertight.

Where watertightness is ensured by a sub-surface drainage system (gutter), EAD 120109-00-0107, Annex D, Clause D.4, does not apply. The durability of the gutter and its drainage capacity are considered to be the crucial aspects and have to be assessed. For durability aspects of the gutter, the concerned requirements and assessment methods, given in Clause 2.2.8, apply. For the assessment of the drainage capacity, Clause 2.2.12 applies.

2.2.8 Durability

2.2.8.1 Corrosion

For metallic surfaces of components, the climatic classification in accordance with EN ISO 9223 (see Clause 1.1) with respect to the intended use of the product is taken into account.

It shall be assessed whether the corrosion protection layout for the concerned kit conforms with the conditions given in the scope of the EAD (possibly using the technical documentation of the manufacturer).

Galvanic corrosion is not assessed.

Based on the manufacturer's technical documentation for the corrosion protection system the durability class in relation to the corrosivity class according to the standards given in Clause 1.1 shall be given in the ETA.

2.2.8.2 Chemicals

Assessment of the resistance to de-icing salts for the mat and gutter made of elastomer shall be done according to ISO 1817 (immersion for 14 days 23 °C, 4 % sodium- chloride solution or equivalent).

The mat/gutter shall show no decrease of hardness exceeding 5 points and no increase of volume exceeding 10 %.

2.2.8.3 Loss of performance due to ageing resulting from temperature and ozone

The performance of the mat expansion joint shall not be affected by ageing. For the product according to this EAD this applies to the mat/gutter made of elastomer, gutter made of plastics and bearing element, sliding plate and prestress element made of elastomer or plastics (if part of the kit, see Clause 1.1, Figure 4).

2.2.8.3.1 Resistance to ageing resulting from temperature

To assess the sensitivity of the components made of elastomer to elevated temperature, the material shall be subjected to test method ISO 188 (Method A). The conditions of exposure are the following: at least 14 days at a temperature of 70 °C.

The hardness before and after ageing is measured according to ISO 48-2 or ISO 48-4 respectively, the tensile strength and the elongation at break are measured according to ISO 37.

To assess the sensitivity of the components made of plastics to elevated temperature, the material shall be subjected to test method EN ISO 2578 and EN ISO 11403-3, Clause 6.5 respectively at +50°C.

The hardness before and after ageing is measured according to EN ISO 2039-1, the tensile strength and the elongation at break are measured according to EN ISO 527-2.

After ageing of the elastomer, the change in hardness and the change of tensile properties of the aged specimen shall be within:

Hardness ≤ + 7 points

Tensile strength ≥ -20%

Elongation at break ≥ -30%

For plastics, assessment shall be done in equivalence to the values for elastomers.

These values apply for all working life categories.

For the assessment of the resistance of the components made of elastomer to low temperatures, the brittleness test according to ISO 812, Method B, applies.

With respect to the operating temperature according to Clause 1.2.1, for the execution of the brittleness test for components made of elastomer the following temperatures apply:

-25 °C for operating temperatures down to -20 °C,

-40 °C for operating temperature equal to -30 °C,

-55 °C for operating temperature equal to -40 °C.

For bearings and prestress elements made of elastomer the brittleness test is carried out according to ISO 812, Method B at -35 °C.

With respect to the operating temperature according to Clause 1.2.1, for the execution of the brittleness test of components made of plastics the following temperatures apply:

-25 °C for operating temperature down to -20 °C,

-40 °C for operating temperature equal to -30 °C and -40 °C.

For bearings, sliding elements and prestress elements, if relevant according to their design, adhesion is assessed according to ISO 813 (peel at 90 °C).

Resistance to hot bitumen is assessed for the elastomer of the mat if the contact surface to the adjacent pavement is not protected by an appropriate transition strip or similar.

Assessment is carried out in analogy to ISO 1817 applying the following conditions:

30 min, 220 °C, bitumen 85/25

After the test the mat material shall show no decrease of tear resistance exceeding 20 % and no decrease of elongation at tear exceeding 20 % in respect to the unconditioned material.

2.2.8.3.2 Resistance to ageing resulting from ozone

To assess the sensitivity to ozone of the components made of elastomer, the material shall undergo a test. 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.

After the test no cracks shall occur.

2.2.8.3.3 Resistance against freeze thaw

If relevant, the degradation of porous materials (e.g. mortar), to freeze-thaw shall be assessed by testing. Test specimen(s) of the material or component shall be subjected to freeze/thaw cycles in accordance with EN 13687-1. According to the use of the product, the number of cycles shall be 50 (see EN 1504-2, Tables 5, line 9 and Table 1, 1.3 and 5.1).

After the test, no degradation shall be observed.

2.2.9 Content, emission and/or release of dangerous substances

The performance of the product related to 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 manufacturer[2] after identifying the release scenarios (in accordance with EOTA TR 034) taking into account the intended

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2 The manufacturer may be asked to provide to the TAB the REACH related information which he must accompany the DoP with (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
- to 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.

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

use of the product and the Member States where the manufacturer intends his product to be made available on the market.

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

2.2.9.1 Leachable substances

For the intended use covered by the release scenario S/W2 the performance of the mat made of elastomer and gutter made of elastomer or plastics concerning leachable substances has to be assessed. A leaching test with subsequent eluate analysis must take place, each in duplicate. For the leaching tests of the mat made of elastomer and gutter made of elastomer or plastics EAD 120109-00-0107, Annex D, Clause D.6 applies.

2.2.10 Ability to bridge gaps and levels in the running surface

2.2.10.1 Allowable surface gaps and voids

The maximum dimensions of the gaps and voids of the joint at the surface level depend on the three user categories.

For the range of the skew angle β (see Figure 5) to be assessed for all user categories the following requirements shall be met and the chosen approach according to Clause 1.3.18 shall be stated in the ETA.

For vehicles and cyclists categories the expansion joint shall not allow a vertical displacement of more than the radius of a 10,0 cm diameter sphere placed anywhere on the running surface level.

a) Vehicles

The expansion joint shall not allow a vertical displacement of 1,0 cm or more of the following bodies, in conjunction with the traffic direction:

- a horizontal prism with plan dimensions 10,0 cm by 20,0 cm placed horizontally anywhere and in any direction,
- a horizontal prism with plan dimensions 6,5 cm by 22,0 cm placed horizontally anywhere with a deviation from the traffic direction α of -20° to +20°,
- a horizontal prism with plan dimensions 4,5 cm by 35,0 cm placed horizontally anywhere with a deviation from the traffic direction α of -20° to +20°.

b) Cyclists

The expansion joint shall not allow a vertical displacement of 1,0 cm or more of the following bodies, in conjunction with the traffic direction:

- a horizontal prism with plan dimensions 2,0 cm by 22,0 cm placed horizontally everywhere with a deviation from the traffic direction α of -20° to +20°,
- a horizontal prism with plan dimensions 10,0 cm by 20,0 cm placed horizontally everywhere and in any direction.

The design of the expansion joint for the carriageway can be adapted by special measures to fulfil the above requirement (see Clause 1.1).

c) Pedestrians

The expansion joint shall not allow a vertical displacement of 2,0 cm or more of a disk with a diameter of 8,0 cm placed horizontally everywhere.

Assessment shall be carried out by analysis of the technical file and, when needed, by use of measurements tools given above.

The ETA shall state the maximum skew angle β (relative to the traffic direction) in relation to the maximum opening related to the concerned user category.

The definition of the skew angle used for the assessment shall be stated in the ETA (see Clause 1.3.18 for different possibilities).

The design of the expansion joint for the carriageway can be adapted by special measures to fulfil the above requirement (see Clause 1.1).

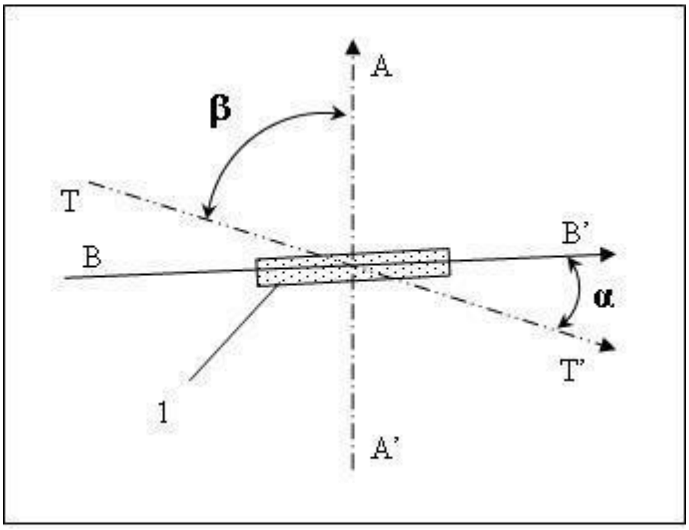


Figure 5: Assessment of the allowable gaps and voids

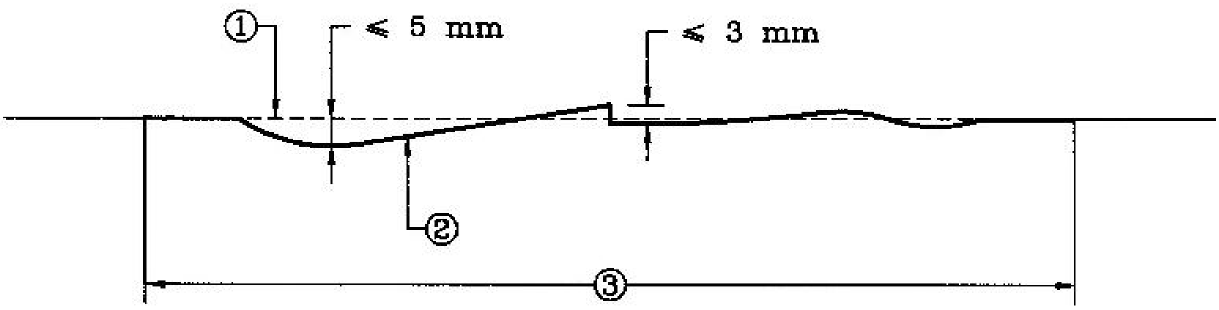
Key to Figure 5:

TT': Traffic direction
AA': Expansion joint axis
BB': Orientation of the measuring prism
1: Measuring prism
α: Deviation from traffic direction
β: Skew angle

2.2.10.2 Level differences in the running surface

Without any imposed horizontal deformations and in unloaded condition the difference in the levels of the running surface of the joint from the ideal connection line between the two adjacent pavements in the traffic direction shall not be greater than 5 mm. Steps shall not be greater than 3 mm (without considering surface texture and discontinuities due to gaps and voids). See Figure 6.

This rule is applied in a horizontal position.



① Ideal connection line
② Running surface of the joint

③ Expansion joint
Note: The level differences could be in the opposite direction.

Figure 6: Example of level differences in the running surface under unloaded conditions

Assessment for the unloaded condition shall be undertaken on the basis of analysis of the technical file and drawings. The maximum dimension of steps and the difference of the running surface levels shall be stated in the ETA.

In the deformed condition (maximum contraction and maximum elongation) but without load on the expansion joint, simulating bridge movement, the difference of the running surface level of the mat joint shall not be greater than 12 mm and steps shall not be greater than 8 mm.

Assessment under deformed conditions (maximum contraction and maximum elongation) shall be carried out by measuring during the movement test according to EAD 120109-00-0107, Annex D, Clause D.3. In addition to the expression of test results according to EAD 120109-00-0107, Annex D, Clause D.3.5 the following results have to be recorded:

- Measurement of deflections, if any,
- Measurement of steps, if any.

For loaded conditions (without deformation), level differences shall not be more than 12 mm in total and, in addition, steps shall not be greater than 8 mm. The dimensions of the steps and differences in the running surfaces shall be assessed for 70 % of the SLS-level, considering the difference between static and dynamic stiffness of the materials, if any.

Assessment for the loaded conditions shall be carried out by testing according to Annex A. The vertical displacement of a twin axle wheel may be considered as the vertical deflection of the running surface.

The maximum dimension of steps and the difference of the running surface levels for the deformed and loaded condition shall be stated in the ETA.

2.2.11 Skid resistance

This essential characteristic only applies for expansion joints with flat running surfaces larger than 150 mm x 150 mm square and with surface textures less than ± 1,2 mm (possibly met by special design, e.g. chequered plate). This applies to the carriageway and footpath.

The skid resistance of the mat expansion joint shall be assessed by the portable skid resistance pendulum tester as described in EN 13036-4, clause 9.2 using the 57 Rubber slider for carriageways and the 96 rubber slider for footpaths. For both, the normal slider width of 76.2 mm shall be used.

The PTV values assessed shall be stated in the ETA.

2.2.12 Drainage capacity

Where relevant due to the mat expansion joint kit is including a gutter, the drainage capacity shall be assessed by calculation using the following formula based on EN 12056-3:

$$Q_0 = k_0 * D^2 * h^{0.5} /15000 \text{ [l/s]}$$

Where:
k_0 = 1,0 for free down pipe and 0,5 for downpipes with dirt filter [-]
D= Flow diameter [mm]
h=Pressure height (depending on planned target water height) [mm]

The value for Q_0 shall be stated in the ETA.

Where relevant due to the mat expansion joint kit is including a drainage device according to EAD 120109-00-0107, Annex D, Figure D.11, the drainage capacity shall be assessed according to the assessment method described in EAD 120109-00-0107, Annex D, Clause D.5.

The drainage capacity in mm³/sec together with definition of the porous pavement as defined according to the assessment method in EAD 120109-00-0107, Annex D, Clause D.5, 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: Decision 2001/19/EC

The system is: 1

The performance of any kit component which is obtained from a component manufacturer and is CE marked on the basis of a hEN or an EAD will, (for the purposes of verification of constancy of performance) be considered to be the performance declared by the component manufacturer in his DoP. The component does not need to be re-assessed regarding this performance aspect.

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 6

In case of components manufactured by separate manufacturers, the FPC as indicated in the Table below is related to relevant documentation provided by the manufacturer of the expansion joint.

Table 6 Control plan for the manufacturer; 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[3] *)
Factory production control (FPC) including testing of samples taken at the factory in accordance with a prescribed test plan					
Mat - elastomer (including kerb elements) - first possibility					
1	Density	ISO 2781	Laid down in the control plan	According to the relevant standard.	Each batch or certificate according to EN 10204, type 3.1 Each lot (sequence of batches with identical composition), or certificate type 3.1 according to EN 10204 at each delivery.
2	Hardness	ISO 48-2, ISO 48-4			
3	Tensile strength	ISO 37			
4	Elongation at break	ISO 37			
5	Rheometric characteristics	ISO 6502-2			
6	Compression set (24 h at 70°C and 25% constant deflection)	ISO 815-1 (type B specimen)	≤ 30%		
7	Thermogravimetric analysis (TGA)	ISO 9924-1 or ISO 9924-3	Laid down in the control plan		Once per year
Mat - elastomer (including kerb elements) - second possibility					
8	Hardness	ISO 48-2, ISO 48-4	Laid down in the control plan	According to the relevant standard.	Each lot (sequence of batches with identical composition), or certificate type 3.1 according to EN 10204 at each delivery.
9	Tensile strength	ISO 37			
10	Elongation at break	ISO 37			
11	Abrasion	2.2.6			
12	Compression set (24 h at 70°C and 25% constant deflection)	ISO 815-1 (type B specimen)	≤ 30%		
13	Thermogravimetric analysis (TGA)	ISO 9924-1 or ISO 9924-3	Laid down in the control plan		Once per year

[3] "Each batch or certificate …" means: Either tested for each batch or verified by certificate according to EN 10204, type 3.1.

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[3] *)
Elastomer, plastics (for the gutter)					
14	Relevant parameters laid down in the control plan	Laid down in the control plan	Laid down in the control plan	Laid down in the control plan	Each delivery or certificate type 2.1 according to EN 10204
Steel, stainless steel (for the gutter)					
15	Resistance to corrosion	Laid down in the control plan	Laid down in the control plan	Laid down in the control plan	Each delivery certificate type 3.1 according to EN 10204
Components made of steel / stainless steel (reinforcement for mats, cover plates; components for support structure)					
16	Geometry	EN 10025 or EN 10088	Laid down in the control plan	According to the relevant standard.	Certificate type 3.1 according to EN 10204 at each delivery.
17	Yield point				
18	Tensile strength				
19	Elongation at break				
20	Chemical composition (C-eq) / or grade or quality class (according to the type of component)				
21	Energy absorption (Charpy V) (if dynamically loaded)				
Components of the mat made of metal (inserts)					
22	Tensile strength	EN 10025 or EN 10088	Laid down in the control plan	According to the relevant standard.	Certificate type 3.1 according to EN 10204 at each delivery.
23	Elongation at rupture				

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[3] *)
Reinforcement bars / loops for support structure					
24	Geometry	EN 10080	Laid down in the control plan	According to the relevant standard.	Certificate type 3.1 according to EN 10204 at each delivery.
25	Yield strength				
26	Tensile strength				
27	Ductility				
28	Weldability				
29	Bendability				
30	Bond propriety				
Components made of stainless steel as bearing elements (support structure)					
31	Chemical composition	EN 10088	Laid down in the control plan	According to the relevant standard.	Certificate type 3.1 according to EN 10204 at each delivery.
Steel dowels					
32	Relevant parameters laid down in the control plan	EN ISO 13918	Laid down in the control plan	According to the relevant standard.	Certificate type 3.1 according to EN 10204 at each delivery.
Anchorage devices: steel bolts, screws, nuts, washers including resins (for dynamically loaded connections)					
33	Geometry	Laid down in the control plan	Laid down in the control plan	According to the relevant standard.	Certificate type 3.1 according to EN 10204 at each delivery.
34	Steel grade or quality class (according to the type of component)				
35	Tensile strength				
36	Yield strength				
Anchorage devices: threaded rod with nut and washers including resins, bonded anchors and resin mortar, stud bolts					
37	Relevant parameters laid down in the control plan	Laid down in the control plan	Laid down in the control plan	According to the relevant standard.	Certificate type 3.1 according to EN 10204 at each delivery.

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[3] *)
Connecting devices: metallic bolt, screws, nuts, washers, profiles					
38	Relevant parameters laid down in the control plan	Laid down in the control plan	Laid down in the control plan	According to the relevant standard.	Certificate type 2.1 according to EN 10204 at each delivery.
Connecting devices: bonding agents / sealants, sockets					
39	Relevant parameters laid down in the control plan	Laid down in the control plan	Laid down in the control plan	According to the relevant standard.	Delivery note with indication of material grade and standard at each delivery
PTFE for sliding bearings, prestress elements and guides					
40	Material/Compound number	Laid down in control plan	Laid down in control plan	Laid down in control plan	Certificate at each delivery
41	Density	EN ISO 1183			Each batch
42	Hardness (Ball indentation hardness)	EN ISO 2039-1			Each batch
43	Tensile characteristics [N/mm²] and Elongation at break [%]	EN ISO 527-1			Each batch
Ready mixed concrete for transition strip if part of the product					
44	According to the relevant technical specification. E.g. EN 206	Laid down in control plan.	Laid down in control plan.	Laid down in control plan.	Identification according to the standard at each delivery.
Transition strip made of thermosetting or thermoplastics binder (according to EN ISO 472) or bituminous mixture					
45	Details to be laid down in the control plan	Laid down in control plan.	Laid down in control plan.	Laid down in control plan.	Identification according to the standard at each delivery.

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[3] *)
Resin mortar for transition strip and cement mortar for transition strip if part of the product					
According to the agreement between TAB and manufacturer specification, define e.g.:					Frequencies shall be defined according to the agreement between TAB and the manufacturer in function of the quantity used and in order to guarantee a correct level of quality.
46	Resin - Elongation at break - Compressive strength - Modulus of elasticity	Laid down in control plan.	Laid down in control plan.	Laid down in control plan.	
47	Aggregate and fillers: - Type - Grading - Resistance to fragmentation - Polished Stone Value (PSV)	EN 932-3	Laid down in control plan.	Laid down in control plan.	
		EN 933-1	Laid down in control plan.	Laid down in control plan.	
		EN 1097-2	Laid down in control plan.	Laid down in control plan.	
		EN 1097-8	Laid down in control plan.	Laid down in control plan.	
48	Mortar: Compressive strength	Laid down in control plan.	Laid down in control plan.	Laid down in control plan.	
Components made of stainless steel or aluminium for drainage device, if part of the kit (see EAD 120109-00-0107, Annex D, Figure D.11)					
49	Parameters laid down in the control plan	Laid down in the control plan	Laid down in the control plan	Laid down in the control plan	Laid down in the control plan
Stainless steel for sliding elements					
50	Material	EN 10088	Laid down in control plan	Laid down in control plan	Inspection document 3.1 in accordance with EN 10204 for each delivery
51	Hardness	EN ISO 6507-2	EN 1337-2	Laid down in control plan	
52	Roughness	EN ISO 4287	EN 1337-2	Laid down in control plan	
53	Chemical composition	EN ISO 14284	EN 1337-2	Laid down in control plan	

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[3] *)
Components made of elastomer (e.g. in bearings, prestress elements)					
54	Material/ Compound number	Laid down in the control plan	Laid down in the control plan	Laid down in the control plan	Inspection document 3.1 according to EN 10204 at each delivery.
55	Density	ISO 2781			Each batch
56	Hardness IRHD/Shore hardness	ISO 48-2, ISO 48-4			Each batch
57	Tensile strength and Elongation at break (if subject to tensile stress)	ISO 37			Each batch
58	Tear resistance	ISO 34-1 Method A			Once per year
59	Shear stiffness (if subject to tensile stress)	ISO 1827			Once per year
60	Compression set (if subject to shear)	ISO 815-1 24 h and 70 °C constant deflexion 25 %			Once per year
61	Resistance to ageing	ISO 188, ISO 48, ISO 37 (7 days hot air 70 °C)	With respect to un-aged material: Change of hardness: ≤ +7 reduction of tensile strength: ≤ 20 reduction of elongation at break: ≤ 30	Laid down in the control plan	Once per year
62	Resistance to ozone	ISO 1431-1, Test procedure A (20 % Elongation, 72 hrs (+0/-2) at 40 (± 2)°C. Ozone concentration 50 (±5) pphm)	No cracks		Once per year

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[3] *)
Components made of polyamide (PA), polyoxymethylene (POM) and polyethylene (PE) (including UHMWPE)					
63	Material/Compound number	Laid down in control plan	Laid down in control plan	Laid down in control plan	Inspection document 2.2 according to EN 10204 at each delivery.
64	Density	EN ISO 1183	Max. 5 % deviation from initial value		Each batch
65	Hardness Shore D	EN ISO 868	Laid down in control plan		Each batch
66	Tensile characteristics (if subject to tension)	EN ISO 527	Laid down in control plan		Each batch
67	Shear strength (if subject to shear)	ISO 1827	Laid down in control plan		Each batch
68	E modulus in tension (if subject to tension)	EN ISO 527	Laid down in control plan		If relevant
69	Compressive strength (if subject to pressure)	EN ISO 604	Laid down in control plan		If relevant
70	E modulus in compression (if subject to pressure)	EN ISO 604	Laid down in control plan		If relevant
71	Elongation at break	EN ISO 527	Laid down in control plan		Each batch
72	Energy absorption (Charpy test)	EN ISO 179	Laid down in control plan		Each batch

*) In case of irregular production it is possible to agree different frequency between manufacturer and notified body.

Table 7 Control plan for the manufacturer – control during and at the end of production; cornerstones

Component	Aspect	Procedure	Frequency	Remarks
Mat elements				
Reinforcement, inserts	Surface characteristics	Internal procedure	Random sampling	
Elastomer materials	-	-	-	See Table 6
Vulcanizing	Pressure time; temperature	Internal procedure	Each element	
Manufacturing of each mat element	Dimensions, cover thickness	Internal procedure	Each element	Conformity to the drawings
	Bonding quality		Regularly during production process	
Assembly of mat elements to a mat expansion joint unit, if assembled at the factory	Durability and capacity to cope with tension and compression	Internal procedure	Regularly during production process	
Support structure, anchorage devices and kerb elements				
Plates, profiles, steel beam grid	Surface characteristics, manufacturing tolerances	Internal procedure	Each part	
	Weld method statements, weld method qualifications	Internal procedure + welder certificates	Each part	
	Corrosion protection, including layer thickness measurement	Internal procedure + supplier specifications	Each part	
Drainage devices				
Gutter and fixings	Dimensional check		Each delivery	Conformity to the drawings

Components with certificates according to EN 10204, types 3.1 and 2.1 respectively, do not need separate consideration.

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 mat expansion joints for road bridges are laid down in Table 8.

The performance of the components covered by hENs regarding those characteristics declared already by the component manufacturers in their DoP should not be assessed when the product (the kit) will be assessed by the TAB. The performance of those components for the purpose of issuing the ETA will be considered to be the performance declared by the manufacturers of the component. TABs may only assess the performance of the components only for essential characteristics not declared by the manufacturer of the component in his DoP.

Table 8 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	Ascertain that the factory production control with the staff and equipment are suitable to ensure a continuous and orderly manufacturing of the expansion joint.	As defined in the control plan.	As defined in the control plan.	As defined in the control plan.	1
Continuous surveillance, assessment and evaluation of factory production control					
2	Continuous surveillance, assessment and evaluation of factory production control carried out by the manufacturer (parameters according to Table 6 and 7 of this EAD).	As defined in the control plan.	As defined in the control plan.	As defined in the control plan.	At least once a year

4 REFERENCE DOCUMENTS

The following documents, in whole or in part, are normatively referenced in this European Assessment Document and are indispensable for its application. Only the specified edition applies.

EN 206:2013+A1:2016	Concrete - Specification, performance, production and conformity
EN 932-3:1996 + A1:2003	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 1097-2:2010	Tests for mechanical and physical properties of aggregates - Part 2: Methods for the determination of resistance to fragmentation
EN 1097-8:2009	Tests for mechanical and physical properties of aggregates - Part 8: Determination of the polished stone value
EN 1337-2:2004	Structural bearing : Part 2: Sliding elements
EN 1504-2:2004	Products and systems for the protection and repair of concrete structures - Definitions, requirements, quality control and evaluation of conformity - Part 2: Surface protection systems for concrete
EN 1990:2002 + A1:2005 + A1:2005/AC:2010	Eurocode: Basis of structural design
EN 1991-1-5:2003 + AC:2009	Eurocode 1: Actions on structures - Part 1-5: General actions - Thermal actions
EN 1991-2:2003 + AC:2010	Eurocode 1: Actions on structures - Part 2: Traffic loads on bridges
EN 1992-2:2005 + AC:2008	Eurocode 2: Design of concrete structures - Part 2: Concrete bridges - Design and detailing rules
EN 1993-1-4:2006 + A1:2015	Eurocode 3: Design of steel structures - Part 1-4: General rules - Supplementary rules for stainless steels
EN 1993-1-8:2005 + AC:2009	Eurocode 3: Design of steel structure - Part 1-8: Design of joints
EN 1993-1-9:2005 + AC:2009	Eurocode 3: Design of steel structures - Part 1-9: Fatigue
EN 1993-1-10:2005 + AC:2009	Eurocode 3: Design of steel structures - Part 1-10: Material toughness and through-thickness properties
EN 1993-2:2006 + AC:2009	Eurocode 3: Design of steel structures - Part 2: Steel Bridges
EN 1994-2:2005 + AC:2008	Eurocode 4: Design of composite steel and concrete structures - Part 2: General rules and rules for bridges
EN 1998-2:2005 + A1:2009 + A2:2011 + AC:2010	Eurocode 8: Design of structures for earthquake resistance - Part 2: Bridges
EN 1999-1-1:2007 + A1:2009 + A2:2013	Eurocode 9: Design of aluminium structures - Part 1-1: General structural rules
EN 1999-1-3:2007 + A1:2011	Eurocode 9: Design of aluminium structures - Part 1-3: Structures susceptible to fatigue
EN 1999-1-4:2007 + AC:2009	Eurocode 9: Design of aluminium structures - Part 1-4: Cold-formed structural sheeting

EN 10025-2:2004	Hot rolled products of structural steels - Part 2: Technical delivery conditions for non-alloy structural steels
EN 10025-3:2004	Hot rolled products of structural steels - Part 3: Technical delivery conditions for normalized/normalized rolled weldable fine grain structural steels
EN 10025-4:2004	Hot rolled products of structural steels - Part 4: Technical delivery conditions for thermomechanical rolled weldable fine grain structural steels
EN 10025-5:2004	Hot rolled products of structural steels - Part 5: Technical delivery conditions for structural steels with improved atmospheric corrosion resistance
EN 10025-6:2004 + A1:2009	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 10080:2005	Steel for the reinforcement of concrete - Weldable reinforcing steel - General
EN 10088-2:2014	Stainless steels - Part 2: Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for general purposes
EN 10088-3:2014	Stainless steels - Part 3: Technical delivery conditions for semi-finished products, bars, rods, wire, sections and bright products of corrosion resisting steels for general purposes
EN 10088-4:2009	Stainless steels - Part 4: Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for construction purposes
EN 10088-5:2009	Stainless steels - Part 5: Technical delivery conditions for bars, rods, wire, sections and bright products of corrosion resisting steels for construction purposes
EN 10204:2004	Metallic products - Types of inspection documents
EN 12056-3:2000	Gravity drainage systems inside buildings - Part 3: Roof drainage, layout and calculation
EN 12697-22:2003 + A1:2007	Bituminous mixtures - Test methods for hot mix asphalt - 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 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 ISO 179:2010	Plastics: Determination of Charpy impact properties
EN ISO 472:2013	Plastics - Vocabulary
EN ISO 527-1:2012	Plastics - Determination of tensile properties - Part 1: General principles
EN ISO 527-2:2012	Plastics - Determination of tensile properties - Part 2: Test conditions for moulding and extrusion plastics
EN ISO 604:2003	Plastics: Determination of compressive properties
EN ISO 868:2003	Plastics and ebonite: Determination of indentation hardness by means of a durometer (Shore hardness)
EN ISO 1183-1:2012	Plastics - Methods for determining the density of non-cellular plastics - Part 1: Immersion method, liquid pyknometer method and titration method

EN ISO 1183-2:2004	Plastics - Methods for determining the density of non-cellular plastics - Part 2: Density gradient column method
EN ISO 1183-3:1999	Plastics - Methods for determining the density of non-cellular plastics - Part 3: Gas pyknometer method
EN ISO 2039-1:2003	Plastics - Determination of hardness - Part 1: Ball indentation method
EN ISO 2081:2018	Metallic and other inorganic coatings - Electroplated coatings of zinc with supplementary treatments on iron or steel
EN ISO 2578:1998	Plastics - Determination of time-temperature limits after prolonged exposure to heat
EN ISO 3506-1:2009	Mechanical properties of corrosion-resistant stainless steel fasteners - Part 1: Bolts, screws and studs
EN ISO 4287:1998 + AC:2008 + A1:2009	Geometrical Product Specifications (GPS) - Surface texture: Profile method. Terms, definitions and surface texture parameters
EN ISO 6507-2:2018	Metallic materials — Vickers hardness test — Part 2: Verification and calibration of testing machines
EN ISO 9223:2012	Corrosion of metals and alloys - Corrosivity of atmospheres - Classification, determination and estimation
EN ISO 10684:2004 + AC:2009	Fasteners - Hot dip galvanized coatings
EN ISO 11357-2:2014	Plastics - Differential scanning calorimetry (DSC) - Part 2: Determination of glass transition temperature and glass transition step height
EN ISO 11403-3:2014	Plastics - Acquisition and presentation of comparable multipoint data - Part 3: Environmental influences on properties
EN ISO 12944-1:2017	Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 1: General introduction
EN ISO 13918:2018	Welding - Studs and ceramic ferrules for arc stud welding
EN ISO 14284:2002	Steel and iron: Sampling and preparation of samples for the determination of chemical composition
EN ISO 14713:2017	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 34-1:2015	Rubber, vulcanized or thermoplastic - Determination of tear strength - Part 1: Trouser, angle and crescent test pieces
ISO 37:2017	Rubber, vulcanized or thermoplastic - Determination of tensile stress-strain properties
ISO 48-2:2018	Rubber, vulcanized or thermoplastic -- Determination of hardness (hardness between 10 IRHD and 100 IRHD)
ISO 48-4:2018	Rubber, vulcanized or thermoplastic - Determination of hardness - Part 4: Indentation hardness by durometer method (Shore hardness)
ISO 188:2011	Rubber, vulcanized or thermoplastic - Accelerated ageing and heat resistance tests
ISO 812:2017	Rubber, vulcanized or thermoplastic - Determination of low-temperature brittleness
ISO 813:2016	Rubber, vulcanized or thermoplastic - Determination of adhesion to a rigid substrate - 90° peel method
ISO 815-1:2014	Rubber, vulcanized or thermoplastic - Determination of compression set - Part 1: At ambient or elevated temperatures

ISO 1431-1:2012	Rubber, vulcanized or thermoplastic - Resistance to ozone cracking - Part 1: Static and dynamic strain testing
ISO 1817:2015	Rubber, vulcanized or thermoplastic - Determination of the effect of liquids
ISO 1827:2016	Rubber, vulcanized or thermoplastic - Determination of shear modulus and adhesion to rigid plates - Quadruple-shear methods
ISO 2781:2018	Rubber, vulcanized or thermoplastic - Determination of density
ISO 4649:2017	Rubber, vulcanized or thermoplastic - Determination of abrasion resistance using a rotating cylindrical drum device
ISO 6502-2:2018	Rubber - Measurement of vulcanization characteristics using curemeters - Part 2: Oscillating disc curemeter
ISO 9924-1:2016	Rubber and rubber products - Determination of the composition of vulcanizates and uncured compounds by thermogravimetry - Part 1: Butadiene, ethylene-propylene copolymer and terpolymer, isobutene-isoprene, isoprene and styrene-butadiene rubbers
ISO 9924-3:2009	Rubber and rubber products - Determination of the composition of vulcanizates and uncured compounds by thermogravimetry - Part 3: Hydrocarbon rubbers, halogenated rubbers and polysiloxane rubbers after extraction
EOTA TR034	General BWR3 Checklist for EADs/ETAs - Dangerous substances
EAD 120109-00-0107	Nosing expansion joints for road bridges
EAD 120111-00-0107	Cantilever expansion joints for road bridges
EAD 120113-00-0107	Modular expansion joints for road bridges

ANNEX A – ASSESSMENT OF MECHANICAL RESISTANCE OF THE MAT EXPANSION JOINT

A.1 General

This annex describes the method for assessing the mechanical resistance of mat expansion joints and related deformations in one testing procedure.

The principle of this test is to apply a load by means of a reference tyre, representing the design situations, and to measure the deflections.

The test specimen shall include the anchorage.

One specimen of each type has to be tested.

If there is a range with the same type and the movement capacity is above 240 mm, then take one test at each border of the range and one test in the middle of the range.

If the model of expansion joint is an element of a range with the same design, the same components and the same functional and the same functional principle and the movement capacity is less than or equal to 240 mm one specimen shall be tested. The product is chosen in the middle of the range.

A.2 Specimen and preparation of test specimens

The test specimen shall correspond to the complete design including all features. Butt joints (e.g. perpendicular and bevelled horizontal as well as vertical designed) shall be included if they are part of the kit.

The preparation of the test specimen is under the responsibility of the manufacturer.

The length of the test specimen shall be at least 400 mm enlarged with an addition of the load dispersal effect, representative for the transfer of the reaction forces.

A smaller length of the test specimen is allowed, when an analysis demonstrates that sufficiently reliable test results can be obtained.

A.3 Load arrangements

A.3.1 Arrangement of the loads

The load arrangement shall be derived from EAD 120109-00-0107, Annex D, Table D.2.

A.3.2 Position of loads to be applied

The loads shall be applied in the most adverse position.

> **Note**: Whether the test has to be carried out under maximum opening position is related to the combination rules, given in EAD 120109-00-0107, Annex D, Clauses D.2.4.2 and D.2.4.3.

A.3.3 Test load

The vertical test load for assessment of characteristic combinations of actions is 150 kN acting on a twin wheel or 75 kN acting on a single wheel with an inflation pressure of 9,4 bar (see EAD 120109-00-0107, Annex D, Clause D.2: 150 kN on a fictitious wheel print of 300 mm x 250 mm; with a contact pressure of 1,00 N/mm²). The horizontal load in the traffic direction (longitudinal) is 0,4 times the vertical test load (according to EAD 120109-00-0107, Annex D, Clause D.2.3.2.1) and the horizontal load perpendicular to the traffic direction (transverse direction) is 0,2 (according to EAD 120109-00-0107, Annex D, Clause D.2.3.2.2) of the vertical test load. If the test specimen is subjected to a combination of vertical and horizontal loads, the combination factors ψ as given in EAD 120109-00-0107, Annex D, Table D.6 apply.

Note: For those expansion joints that are rigid in the transverse direction to the traffic this horizontal load can be omitted. Rigid means no influence on the kinematic behaviour of the system.

The vertical test load for the fundamental combinations of actions is 1,35 x 150 kN acting on a twin wheel or 1,35 x 75 kN acting on a single wheel with an inflation pressure of 13,5 bar (see EAD 120109-00-0107, Annex D, Clause D.2: 150 kN on a fictitious wheel print of 300 mm x 250 mm; with a contact pressure of 1,35 N/mm²). The horizontal load in the traffic direction (longitudinal) is 0,4 of the vertical test load and the horizontal load perpendicular to the traffic direction (transverse direction) is 0,2 of the vertical test load. If the test specimen is subjected to a combination of vertical and horizontal loads, the combination factors ψ as given in EAD 120109-00-0107, Annex D, Table D.6 apply.

Note: For those expansion joints that are rigid in the transverse (perpendicular to) direction to the traffic this horizontal load can be omitted.

A.4 Testing arrangement

The support of the test specimen shall simulate realistic support conditions, including anchorage etc. The test rig shall be able to control the tolerance on the forces within deviations of ±5 %. The test load shall be applied with an appropriate device.

A.5 Execution of the test

According to Clause A.3.2, the test shall be carried out at two opening positions:

For the assessment of the characteristic combinations of actions, in the test procedure 100 % load level shall be combined with 60 % of the maximum opening position, derived from the load according to Clause A.3.3. In another test procedure 70 % load level shall be combined with 100 % of the maximum opening position.

For the assessment of the fundamental combinations of actions, in the test procedure 100 % load level shall be combined with 60 % of the maximum opening position, derived from the load according to Clause A.3.3. In another test procedure 70 % load level shall be combined with 100 % of the maximum opening position.

The 60 % of opening position is related to the complete range of movement, which corresponds to 20 % of the elongation capacity with respect to the middle position of the joint and 100 % of the SLS-level.

As an alternative simplified testing procedure one test may be carried out with 100 % load level and 100 % maximum opening position for assessment of characteristic combinations. The same applies for assessment of fundamental combinations.

Note: For general information Annex E applies, in particular for alternative simplified testing procedure see Annex E, Clause E.5.

A.5.1 Test conditions

In principle the testing temperature shall be within the range of +5 °C to +30 °C.

The load shall be increased and decreased respectively with a rate within a range of 2,5 to 5 kN/sec.

In order to calibrate the test equipment and for correct positioning of the test specimen, two preloading cycles shall be executed.

A.5.2 Test procedures

The load shall be applied in increments of 20 % with 4 dwell periods of 15 minutes.

At 100 % of the SLS-load level the following assessments shall be carried out:

- visual inspection during applying the load,

- measurement of the vertical displacement under loaded conditions after 15 minutes, compared to the vertical displacement on a rigid base,
- in case of surface steps measurement by appropriate tools (e.g. optical measurement, drag needle recorder),
- apply the maximum load for 30 minutes.

Remove of the load after 30 minutes.

- after removal of the test load, the remaining displacement shall be recorded every 15 minutes. When two succeeding values remain within 1 %, recovery is considered to be completed,
- visual inspection.

For assessment of the behaviour at the fundamental combinations, the load shall be re-applied in increments of 20 % with dwell periods of 15 minutes until maximum test load for assessment of fundamental combinations and shall be kept at this level for 30 minutes.

The following assessments shall be carried out:

- visual inspection for identifying the failure modes, if any,
- after removal of the test load, the remaining displacement shall be recorded every 15 minutes. When two succeeding values remain within 1 %, recovery is considered to be completed.

Note: Test loading may be further increased until collapse if the equipment allows and to identify the behaviour.

In case of test procedure for the 70 % load level, the load shall be applied in increments of 17,5 % with 3 dwell periods of 15 minutes.

In case of using the alternative simplified testing procedure, the load shall be applied in increments of 20 % with 4 dwell periods of 15 minutes until 100 % of the load level.

A.6 Expression of test results

At every dwell period the following phenomena shall be monitored and recorded (using figures or graph(s) as applicable) for all test procedures:

- Applied loads (kN) and loading rate,
- Values of the displacement (mm),
- Values of the surface steps (mm),
- Debonding, cracks, exceptional behaviour, e.g. excessive deformations,
- Failure mode (characteristic of failure, failure progress, location) shall be described.

A.7 Test report

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

- Name of the manufacturer and production centre;
- Name and signature of testing body;
- Model identification (type, theoretical movement capacity, N° of batch);
- Description of the test equipment, and a description of how the criteria and guidance of this annex were respected;
- Date of the preparation of specimens, the date of test and the mean test temperature;
- Dimensions of test specimens and characteristics which allow for unique identification of the product tested;
- Expression of monitored phenomena according to Clause A.6

ANNEX B – ASSESSMENT OF WEAR OF SLIDING SURFACES OF THE MAT AND RESISTANCE TO FATIGUE BY FULL SCALE TESTING CAUSED BY BRIDGE MOVEMENTS

B.1 General

This annex describes the method for assessing the resistance to fatigue of mat expansion joints to bridge movements with no traffic loads on the expansion joint. The test method includes the assessment of effects of the accumulation of wear of sliding surfaces of the mat.

The principle of this test procedure is to apply a simulation of the imposed movements, caused by bridge movements with no traffic loads on the expansion joint. These conditions are considered to represent the design situations.

One specimen of each type has to be tested.

If there is a range with the same type and the movement capacity is above 240 mm, then take one test at each border of the range and one test in the middle of the range.

If the model of expansion joint is an element of a range with the same design, the same components and the same functional and the same functional principle and the movement capacity is less than or equal to 240 mm one specimen shall be tested. The product is chosen in the middle of the range.

B.2 Test specimen and preparation

The test specimen shall correspond to the complete design including all features. A butt joint shall be included if it is part of the kit.

The preparation of the test specimen is under the responsibility of the manufacturer.

The length of the test specimen (perpendicular to the movement direction) shall be at least 400 mm.

B.3. Load and movement arrangements

This test phase describes the imposed bridge movements, leading to wear in the sliding surfaces and fatigue.

B.4 Test arrangement

The support of the test specimen shall simulate realistic support conditions, including anchorage, etc.

The testing arrangement shall allow the application of the forces within a tolerance of ±5 % and shall include a suitable device for counting the number of cycles.

The actuators shall be calibrated and the actuating system shall not cause inaccuracies in the measurements.

The test arrangement shall show no resonance effects.

B.5 Execution of the test

The test shall be carried out at ambient temperature[4].

Horizontal translations:

Phase 1a: Expansion joint at minimum opening position; 2 500 cycles of 1/3 of movement capacity.
Phase 1b: Expansion joint at maximum opening position; 2 500 cycles of 1/3 of movement capacity.

[4] Low and high operating temperatures according to Clause 1.2.1.1, are covered by the concerned test of the elastomer mat according to Clause 2.2.8.3.

Condition for phase 1a and 1b:

1. One cycle shall take at least half a minute in order to avoid inadmissible heating of the test specimen.
2. For joints accommodating translations in two horizontal directions, the cycles in phase 1 shall be applied in the resulting transversal and longitudinal direction.

Vertical translation:

Phase 2: Expansion joint set to 125 % of nominal opening position; 2 500 cycles of vertical translation Δh = 5 mm.

For phases 1 – 2 the reaction forces shall be measured.

B.6 Expression of the results

For the expansion joint the following shall be monitored and recorded in steps of five hundred load cycles:

- Reaction forces during and at the end of the test,
- Debonding,
- Abrasion on sliding surfaces.

For its anchorage system the following shall be monitored and recorded: loosening, breaking, debonding of its elements.

B.7 Test report

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

- Name of the manufacturer and production centre;
- Name and signature of testing body;
- Model identification (type, theoretical movement capacity, N° of batch);
- Description of the test equipment;
- Date of the preparation of specimens, the date of test and the mean test temperature (according to Clause B.5);
- Dimensions of test specimens and characteristics which allow for unique identification of the product tested;
- Expression of monitored phenomena according to Clause B.6.

ANNEX C – ASSESSMENT OF RESISTANCE TO FATIGUE BY FULL SCALE TESTING AND ASSESSMENT OF WEAR OF SLIDING SURFACES CAUSED BY TRAFFIC LOADS ON THE JOINT

C.1 General

This annex describes the method for assessing the resistance to fatigue of mat expansion joints by full scale testing. The test method includes the assessment of effects of the accumulation of wear of sliding surfaces of the mat.

The principle of this test procedure is to apply a simulation of the traffic loads. These conditions are considered to represent the design situations.

One specimen of each type has to be tested.

If there is a range with the same type and the movement capacity is above 240 mm, then take one test at each border of the range and one test in the middle of the range.

If the model of expansion joint is an element of a range with the same design, the same components and the same functional and the same functional principle and the movement capacity is less than or equal to 240 mm one specimen shall be tested. The product is chosen in the middle of the range.

C.2 Test specimen and preparation

The test specimen shall correspond to the complete design including all features. A butt joint shall be included if it is part of the kit.

The preparation of the test specimen is under the responsibility of the manufacturer.

The length of the test specimen (perpendicular to the movement direction) shall be at least 400 mm enlarged with an addition of the load dispersal effect (see Figure C.1), representative for the transfer of the reaction forces.

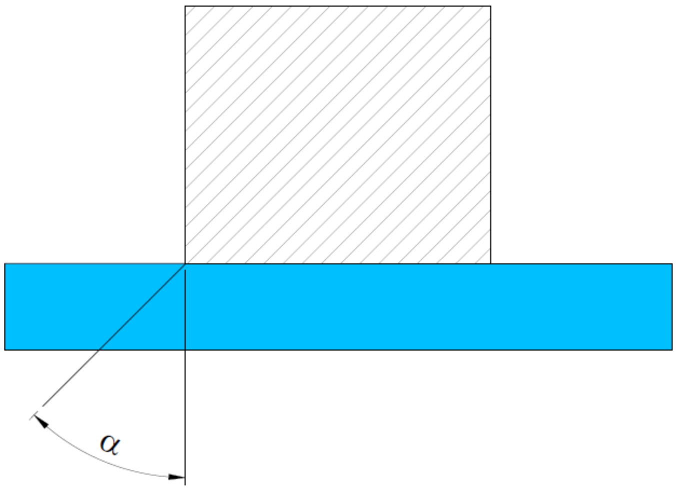


Figure C.1: Load dispersal effect (the angle α is depending on the material and combination of materials)

C.3 Load and movement arrangements

C.3.1 Traffic loads and number of cycles

The test loads are to be derived from $FLM1_{EJ}$ and/or $FML2_{EJ}$ for a contact pressure of 0,8 N/mm² and 1,0 N/mm² respectively, in accordance with EAD 120109-00-0107, Annex D, Clause D.2.3.3. According to this, the conditions in Table C.1 apply:

Table C.1: Load cycles for assessment of different fatigue lives in relation to the working life categories

Mat expansion joint		**Number of cycles**				
		FLM2$_{EJ}$				**FLM1$_{EJ}$**
Test description		**10 years**	**15 years**	**25 years**	**50 years**	**Unlimited**
Contact pressure: 0,8 N/mm²	1st stage: vertical and horizontal loads simultaneously applied	1,7 x10^6	2,5 x 10^6	4,2 x 10^6	7,4 x 10^6 (FLM1$_{EJ}$ applies)	7,4 x 10^6
	2nd stage: vertical loads only applied	1,1 x 10^6	1,7 x 10^6	2,9 x 10^6	--	--
	Envelope: vertical and horizontal loads simultaneously applied	2,8 x 10^6	4,2 x 10^6	7,1 x 10^6	7,4 x 10^6 (FLM1$_{EJ}$ applies)	7,4 x 10^6
Contact pressure: 1,0 N/mm² (alternatively to 0,8 N/mm²)	1st stage: vertical and horizontal loads simultaneously applied	0,87 x 10^6	1,3 x 10^6	2,2 x 10^6	3,8 x 10^6 (FLM1$_{EJ}$ applies)	3,8 x 10^6
	2nd stage: vertical loads only applied	0,57 x 10^6	0,87 x 10^6	1,5 x 10^6	--	--
	Envelope: vertical and horizontal loads simultaneously applied	1,44 x 10^6	2,17 x 10^6	3,7 x 10^6	3,8 x 10^6 (FLM1$_{EJ}$ applies)	3,8 x 10^6

Minimum vertical test load per wheel = A_{min} x 0,8 = 300 x 250 x 0,8 = 60 x 10^3 N = 60 kN (for contact pressure and contact area see Annex D).

Corresponding horizontal test load per wheel = (0,2/1,3) x 60 = 9,2 KN.

The partial factor $\gamma_{F,f}$ = 1,0.

C.3.2 Position of load to be applied

The load shall be applied in the most adverse position considering also the location of any butt joint.

C.4 Testing Conditions

The test load shall be derived from Clause C.3 and distributed according to EAD 120109-00-0107, Annex D, Clause D.2.1. It shall be applied with an angle according to the vertical and horizontal load ratio given in EAD 120109-00-0107, Annex D, Clause D.2 in the direction of the expansion joint gap.

The test is carried out under the following conditions:

- Test temperature:
  The ambient temperature during the test shall be between +5 °C and +35 °C.
- Number of load cycles:
  The number of load cycles is determined according to the specified categories of working life (see Table 1 and Clause C.3).
- Positioning of the sample:
  The test shall be carried out at 60 % of the maximum opening position. The relative positioning of the travelling loads on the sample in the most unfavourable loading condition shall be used for testing.
- Frequency:
  The frequency shall be determined such to avoid failure of the specimen by overheating, whereas the frequency shall be not less than 0,5 Hz.

C.5 Testing Equipment

The support of the test specimen shall simulate realistic support conditions, including anchorage etc.

The testing arrangement shall allow the application of the forces within a tolerance of ±5 % and shall include a suitable device for counting the number of cycles.

The actuators shall be calibrated and the actuating system shall not cause inaccuracies in the measurements.

The test arrangement shall show no resonance effects. A dynamic analysis of the test arrangement shall show that no resonance effects are to be expected.

Devices for counting the number of cycles shall be adapted to the maximum frequency of the test while allowing the recording of the data of the test.

The measuring tolerances on load shall be ±1 kN

C.6 Execution of the test

The test shall be carried out at 60 % of the maximum opening position at ambient temperature (see Clause C.4) with the number of cycles according to Clause C.3.1. It shall be observed during test execution that the operating temperature of the specimen does not increase in a way which influences the performance.

60 % is related to the complete range of movement (maximum movement capacity).

One cycle includes loading and unloading of the specimen.

In case of an over-rolling test, each loaded stroke is counted as one cycle. The vertical and horizontal loads shall be applied simultaneously during each cycle.

During the test, at the stages corresponding to 10 000, 100 000 and every 500 000 load cycles and at the end of test:

- Record by visual inspection the behaviour of the joint,
- Record the appearance of any damage (e.g. cracking of elastomer, defect of the fixing of the elastomer profile in his groove, plastic deformations, debonding effects).

C.7 Expression of the results

The following shall be monitored and recorded:

- Applied loads (kN) and corresponding deformations,
- Determination of the dynamic stiffness at least at the beginning and at the end of the test period,
- Debonding (supported by photographs),
- Cracks (supported by photographs),
- Abrasion on sliding surfaces,
- Any other changes (e.g. with respect to the butt joint).

For its anchorage system the following shall be monitored and recorded: loosening, breaking, debonding of its elements.

C.8 Test report

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

- Name of the manufacturer and production centre;
- Name and signature of testing body;
- Model identification (type, theoretical movement capacity, N° of batch);
- Description of the test equipment, and a description of how the criteria and guidance of this annex were respected;
- Test frequency according to C.4;
- Date of the preparation of specimens, the date of test and the mean test temperature;
- Dimensions of test specimens and characteristics which allow for unique identification of the product tested;
- Expression of monitored phenomena according to Clause C.7.

ANNEX D – EXAMINATION OF REQUESTED LOAD CYCLES AND REQUESTED LOADS FOR ASSESSMENT OF FATIGUE RESISTANCE FOR A FATIGUE LIFE OF 10, 15, 25 AND 50 YEARS AND UNLIMITED FATIGUE LIFE

D.1 General

The objective of this annex is to give sufficient background information on the loads and load cycles used in Annex C in conjunction with EAD 120109-00-0107, Annex D, Clause D.2 and Eurocode EN 1991-2.

Sources: EAD 120109-00-0107, Annex D, Clause D.2.3.3.3 $FLM2_{EJ}$, Table D.5 + N_{obs} according to EN 1991-2, Table 4.5.

Precondition: If for mat expansion joints or parts of them (e.g. reinforcements, anchorage) unlimited fatigue life is of relevance, $FLM1_{EJ}$ according to EAD 120109-00-0107, Annex D, Clause D.2 applies. If limited fatigue life is of relevance, $FLM2_{EJ}$ according to EAD 120109-00-0107, Annex D, Clause D.2 applies.

This annex is based on a slope of maximum 4 %.

Method: According to the damage equivalent method used for steel and elastomer ($n_{equivalent}$ with highest loads).

Note: Fatigue life is the contribution to the working life governed by the fatigue endurance.

D.2 Equivalent number of axle rates for mat expansion joints and anchorage systems, if any

Table D.1: Idealisation of axle load histogram to maximum axle loads with equivalent numbers of cycles

$Q_{1k,fat}$ Vertical axle load kN	$Q_{1lk,fat}$ Horizontal axle load kN in traffic direction	Axle number rate	Equivalent number of axle rates for vertical loads	Equivalent number of axle rates for horizontal loads	Axle type
100	-	1,1	0,16	-	A
120	-	1,25	0,31	-	C
150	20	0,20	0,10	0,07	B
170	24	0,45	0,32	0,28	B
190	28	0,45	0,45	0,45	B
190	28	Σn_{equ}	1,34	0,80	

Background:

$0{,}16 = 1{,}1 \times (100/190)^3$
$0{,}07 = 0{,}20 \times (20/28)^3$
Exp3 – see Miner (Fictitious: m = 3)
$Q_{1k,fat}$ according to EAD 120109-00-0107, Annex D, Table D.5, including $\Delta\varphi_{fat} = 1{,}3$
$Q_{1lk,fat}$, including $\Delta\varphi_{fat,h} = 1{,}0$
Axle number rate according to EAD 120109-00-0107, Annex D, Table D.5

Background: 500 000 lorries per year >> see N_{obs}

10 = 10 years assumed working life acc. to category 1 in Table 1 (10 years)
15 = 15 years assumed working life acc. to category 2 in Table 1 (15 years)
25 = 25 years assumed working life acc. to category 3 in Table 1 (25 years)
50 = 50 years assumed working life acc. to category 4 in Table 1 (50 years)

D.3 Conclusion for requested load cycles for mat expansion joints

1. Load cycle derived from vertical axle load 190 kN:

$$\Sigma n = (1{,}34 - 0{,}80) \times 500\,000 \times 10 = 2{,}7 \times 10^6$$

2. Load cycle derived from vertical axle load (190 kN) in combination with horizontal axle load 28 kN:

$\Sigma n = 0{,}80 \times 500\,000 \times 10 = 4 \times 10^6$

Note: Resulting load: $(190^2 + 28^2)^{0,5}$ = 192 kN. Inclination of load application: 8,4°.

D.4 Test load (F) for Mat Expansion Joints, based on FLM2$_{EJ}$

1. According to EAD 120109-00-0107, Annex D, Clause 2.3.3.3 the maximum vertical axle load (190 kN) for FLM2$_{EJ}$ is related to an axle with two dual tyres.

2. The wheel print area of 300 mm x 250 mm according to EAD 120109-00-0107, Annex D, Clause D.2 substitutes a dual tyre print with a related load of 190/4 = 47,5 kN.

3. The related theoretical contact pressure = 47 500/(300 x 250) = 0,63 N/mm².

4. The contact pressure for wheels of lorries in practice = 0,8 N/mm² (8 bar internal tyre pressure).

Remark: Number 4 is related to an axle with two twin tyres.

Consequence for the test load to be used:

Due to the behaviour of reinforced elastomeric materials and therefore the need to consider realistic strain intervals, for mat expansion joints the contact pressure is considered as the most relevant aspect for fatigue behaviour. In order to assess this, the contact pressure of 0,8 N/mm² needs to be taken into account.

Consequently, the requested vertical test load F_{Tv} has to be calculated, using a mean contact pressure (0,8 N/mm²) and a contact area not smaller than 300 mm x 250 mm.

5. In order to achieve a reduced number of cycles for testing it is allowed to increase the contact pressure to a maximum of 1,0 N/mm². In such cases, a reduction of load cycles can be calculated as follows: $((0{,}8/p_{requested})^3)$ x load cycles.

Example for $p_{requested}$ = 1: $(0{,}8/1{,}0)^3$ = 0,5 x load cycles.

The horizontal test load F_{Th} is calculated as follows: $F_{Th} = (28/190) \times F_{Tv}$..

D.5 Test load (F) for mat expansion joints, based on FLM1$_{EJ}$

1. According to EAD 120109-00-0107, Annex D, Clause D.2.3.3.2, the maximum vertical axle load is 273 kN for FLM1$_{EJ}$. This is related to a theoretical wheel print of 300 mm x 250 mm.

2. According to EAD 120109-00-0107, Annex D, Clause D.2.3.3.2 the maximum horizontal axle load is 42 kN for FLM1$_{EJ}$.

3. The wheel print area of 300 mm x 250 mm according to EAD 120109-00-0107, Annex D, Clause D.2 is assumed to represent a dual tyre print with a related load of 273/4 = 68,3 kN. According to this the theoretical vertical test load per wheel = 68 kN.

4. The related theoretical contact pressure = 68 300/(300 x 250) = 0,91 N/mm². In principle, this covers the contact pressure in practice. If for FLM 1 EJ the contact pressure is reduced from 0,91 N/mm², the associated number of cycles is $(0{,}91/0{,}8)^3 \times 5\,000\,000 = 7{,}4 \times 10^6$.

5. In order to achieve a reduced number of cycles for testing it is allowed to increase the contact pressure. Whereas increasing the contact pressure to 1,0 N/mm² is considered appropriate in general. In such cases, a reduction of load cycles can be calculated as follows: $((0{,}91/p_{requested})^3)$ x load cycles.

Example for $p_{requested}$ = 1,0: $(0{,}91/1{,}0)^3$ = 0,75 x load cycles.

Consequence for the test load to be used: The requested vertical test load F_{Tv} has to be calculated, using the internal tyre pressure (0,91 N/mm²) and a contact area not smaller than 300 mm x 250 mm.

The horizontal test load F_{Th} is calculated according to EAD 120109-00-0107, Annex D, Clause D.2.3.3.2 as follows:

F_{Th} = (0,2/1,3) x F_{Tv}.

D.6 Summarizing table of calculated load cycles for different fatigue lives

For limited fatigue life the accumulated number of cycles is stated in relation to a working life in years according to EAD 120109-00-0107, Annex D, Clause D.2.

For unlimited fatigue life the contact pressure and number of cycles is stated in relation to EAD 120109-00-0107, Annex D, Clause D.2 and EN 1991-2.

Table D.2: Calculated load cycles

Item		**$FLM2_{EJ}$**				**$FLM1_{EJ}$**
		10 years	**15 years**	**25 years**	**50 years**	**Unlimited**
Mat expansion joints including anchorage system (Contact pressure: 0,8 N/mm²)	n_{v+h}	$1,7 \times 10^6$	$2,5 \times 10^6$	$4,2 \times 10^6$	$8,4 \times 10^6$	**$7,4 \times 10^6$**
	n_v	$1,1 \times 10^6$	$1,7 \times 10^6$	$2,9 \times 10^6$	$5,8 \times 10^6$	
Mat expansion joints including anchorage system (Contact pressure: 0,91 N/mm²)	n_{v+h}			-	-	**5×10^6**
Remarks					Number of cycles exceeds those for $FLM1_{EJ}$ (unlimited fatigue life) >> $FLM1_{EJ}$ applies.	

Boundary assumptions for the derivation of test loads and test cycles in conjunction with the Eurocode traffic load models:

1. No cut-off limits used for the determination of equivalent numbers of cycles and increased loads,
2. For steel m=3,
3. 1,30 according to dynamic amplification factor ($\Delta\varphi_{fat}$),
4. n = 5×10^6 according to EN 1991-2 for constant amplitude fatigue limit $\Delta\sigma_D$,
5. V = Vertical axle load, H = Horizontal axle load.

Remark: The 2×10^6 load cycles are normally used as a reference level for classification of fatigue for non-elastomeric parts (Wöhler).

Comment on comparison between limited fatigue life of 50 years and unlimited fatigue life according to EN 1991-2: due to the simplification of the S-N-line in conjunction with the axle load histogram the limited fatigue life testing conditions approach the conditions for unlimited fatigue life for fatigue design lives of approximately 20 years for mats, comprising steel parts.

D.7 Number of load cycles for different fatigue lives

Table D.3: Load cycles for assessment of different fatigue lives in relation to the working life categories

Mat expansion joints **(including anchorage system)**		**Number of cycles**				
Test description		**$FLM2_{EJ}$**				**$FLM1_{EJ}$**
		10 years	**15 years**	**25 years**	**50 years**	**Unlimited**
Contact pressure: 0.8 N/mm²	1st stage: vertical and horizontal loads simultaneously applied	$1,7 \times 10^6$	$2,5 \times 10^6$	$4,2 \times 10^6$	$FLM1_{EJ}$ applies	$7,4 \times 10^6$
	2nd stage: vertical loads only applied	$1,1 \times 10^6$	$1,7 \times 10^6$	$2,9 \times 10^6$	--	--
	Envelope approach: vertical and horizontal loads simultaneously applied	$2,8 \times 10^6$	$4,2 \times 10^6$	$7,1 \times 10^6$	$7,4 \times 10^6$ ($FLM1_{EJ}$ applies)	$7,4 \times 10^6$
Contact pressure: 1.0 N/mm² (alternatively to 0,8 N/mm²)	1st stage: vertical and horizontal loads simultaneously applied	$0,87 \times 10^6$	$1,3 \times 10^6$	$2,2 \times 10^6$	$3,8 \times 10^6$ ($FLM1_{EJ}$ applies)	$3,8 \times 10^6$
	2nd stage: vertical loads only applied	$0,57 \times 10^6$	$0,87 \times 10^6$	$1,5 \times 10^6$	--	--
	Envelope approach: vertical and horizontal loads simultaneously applied	$1,44 \times 10^6$	$2,17 \times 10^6$	$3,7 \times 10^6$	$3,8 \times 10^6$ ($FLM1_{EJ}$ applies)	$3,8 \times 10^6$

ANNEX E – PRINCIPLES FOR THE ASSESSMENT METHOD GIVEN IN ANNEX A

E.1 General

The objective of this annex is to give sufficient background information on the selected design situations in Annex A in conjunction with EAD 120109-00-0107, Annex D, Clause D.2.

E.2 SLS/ULS 1: 60 % of the maximum opening in combination with 100 % SLS/ULS load level

The 60 % opening position is related to the conditions, described with ψ_{Od} = 0,6 for C_{ULS} = 1 according to EAD 120109-00-0107, Annex D, Clause D.2.4.2.1 and D.2.4.3.1.

The 60 % of the maximum opening position (maximum movement capacity) is related to the complete range of movement.

The 100 % ULS load level is related to the conditions, described with ψ_{OT} = 1,0 for C_{ULS} = 1 according to EAD 120109-00-0107, Annex D, Clause D.2.4.2.1 and D.2.4.3.1.

Note: The design situation for C_{SLS} is considered to be analogous to C_{ULS} (see also EAD 120109-00-0107, Annex D, Clause D.2.4.3).

E.3 SLS/ULS 2: 100 % of the maximum opening in combination with 70 % SLS/ULS load level

The 100 % opening position is related to the conditions, described with ψ_{Od} = 1,0 for C_{ULS} = 2 according to EAD 120109-00-0107, Annex D, Clause D.2.4.2.1 and D.2.4.3.1.

The 70 % ULS load level is related to the conditions, described with ψ_{OT} = 0,7 for C_{ULS} = 2 according to EAD 120109-00-0107, Annex D, Clause D.2.4.2.1 and D.2.4.3.1.

Note: The situation for C_{SLS} is considered to be analogous to C_{ULS} (see also EAD 120109-00-0107, Annex D, Clause D.2.4.3).

E.4 Situation according to EAD 120109-00-0107, Annex D, Clause D.2.4.3.2 (Frequent combination)

This situation is covered by SLS 1 and 2 with an increased deformation criterion of 12 mm for level differences in the running surface and 8 mm for steps respectively, given in Clause 2.2.10.2.

E.5 Alternative testing procedure

This assessment procedure may apply in agreement between manufacturer and TAB.

(Instead of following testing procedure according to E.2 and E.3): Opening position: 100 % in combination with 100 % SLS/ULS load level (Ψ_{OD} and Ψ_{OT} = 1,0)

According to EAD 120109-00-0107, Annex D, Clause D.2.4.3.1, SLS/ULS 1 and 2 can be covered by an envelope approach with the condition ψ_{Od} and ψ_{OT} = 1,0.

ANNEX F – STATIC TESTING – MECHANICAL RESISTANCE OF THE PRODUCT REPRESENTED BY TEST METHOD FOR COMPONENTS

F.1 Scope

This annex describes the testing method for assessing the mechanical resistance of the product according to Clause 1.1, Figure 4 represented by components for mat expansion joints in relation to ULS and SLS load combinations, giving consideration to creep and relaxation where relevant.

F.2 Principles

The principle of this test is that a component is subjected to a load configuration (or imposed deformation) derived from the relevant static load combinations. The boundary conditions are modified in time so as to integrate creep and relaxation in one testing procedure, where relevant.

F.3 Samples and preparation of test specimens

One specimen of each type has to be tested.

If there is a range with the same type, then take one test at each border of the range and one test in the middle of the range.

The test specimen shall be full-scale components.

The preparation of the test specimen is under the responsibility of the manufacturer.

F.4 Load arrangements

The component related load and deformation arrangements on the specimens shall be derived from the appropriate load combinations (including the partial factors) as given in EAD 120109-00-0107, Annex D, Clause D.2.4.2. The test load shall include the prestress effect F_{ik}, if any, and predicted creep and relaxation effects.

F.5 Testing arrangement and conditions

The component shall be mounted in a test frame in order to ensure that the imposed loads, deformations and rotations (which can be achieved using wedges) are compatible with the most adverse position for the as-built situation. The test frame shall be suitable to allow the build up of the forces during all test phases, and, if desired, to allow the impose deformations and rotations if needed.

The temperature of testing shall be between +15°C and +45°C.

If the mechanical properties of the material are affected by the temperature variation, this variation has to be defined in such a way that the properties for other temperatures can be derived by calculation.

F.6 Execution of the test

Due attention shall be given to rotations, eccentricities, imposed deformations and constraint effects, if they affect the load transfer at the sliding surfaces and through the component.

For creep testing, due attention shall be given to the continuous long-term load and the accuracy of the measuring equipment.

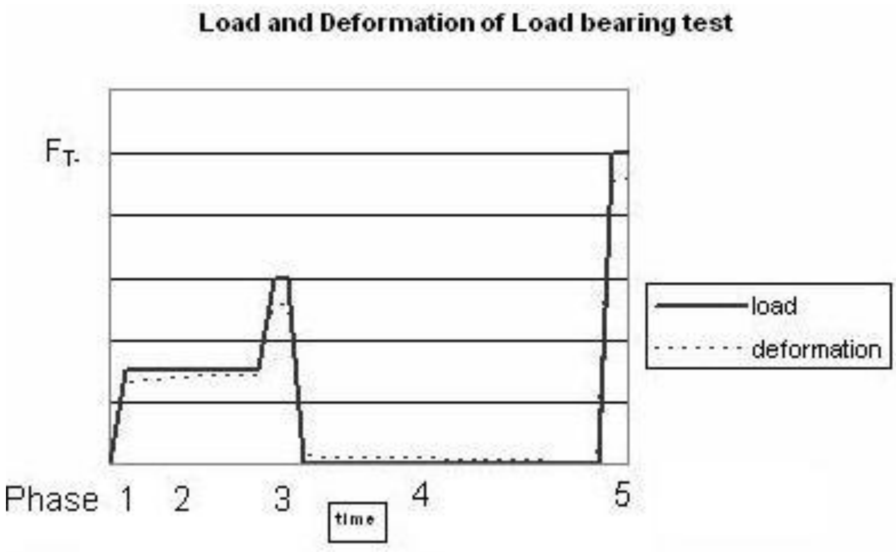
Phases 1 – 2 do not necessarily need to be carried out in the same testing rig with the same equipment as the phases 3 – 6 as given in Table F.1.

Table F.1: Test phases

Phase	Load configuration	Load level on specimen determined from:	Time period
1	Application of prestress with quasi static traffic loads	1,2 x F_{ik} + 0,3 (Q_{1k} + Q_{2k} + Q_{3k}) Opening position: 60%	< 5 min.
2	Constant loads (Creep test)	See Phase 1	> 48h *) See comment 1 See comment 2
3	Application of Serviceability Limit State loads	C_{SLS} as given in EAD 120109-00-0107, Annex D, Clause D.2	< 5 min.
4	Release the load	0	72 hrs. See comment 3
5	Application of Ultimate Limit State loads	C_{ULS} as given in EAD 120109-00-0107, Annex D, Clause D.2	< 5 min.
6	Post-critical behaviour at Ultimate Limit State loads	See Phase 5	1 hr.

*) Creep respectively relaxation shall be defined as ended, if the change in height (respectively protrusion if applicable) or change in load by prescribed deformation per hour in relation to the initial value is less than 0,5%.

Comment 1: Typical load and deflection curves are given in Figure F.1. Time period to be established for the individual material in order to assess the creep behaviour (see Figure F.1).
Comment 2: Creep testing is only relevant for bearings and prestress elements of the support structure for mat expansion joints according to Clause 1.1, Figure 4.
Comment 3: Record the recovery behaviour of the component.



F_T: Load level according to Table F.1

Figure F.1: Typical Load-Deformation curves

Measurements, inspections and evaluations for all phases:

- Deflections (maximum, minimum and mean values) with 5 % accuracy,
- Applied loads and loading rate with 5 % accuracy,
- At phase 3 and 4, the specimen shall be inspected for plastic deformations,

- Creep ratio with 5 % accuracy,
- Debonding effects, if any,
- Cracks, if any,
- Exceptional behaviour,
- Failure mode, if any,
- Determine the load-deflection curves.

F.7 Assessment

In terms of assessment criteria given in Clause 2.2.1 the following applies:

- The measured deformations, creep and relaxation shall not influence the performance of the kit in a negative way.
- No plastic deformations at SLS level (plastic behaviour not influencing the performance of the kit in negative way allowed).
- Cracks and/or debonding effects at ULS shall not cause damage to the joint.
- No brittle behaviour at ULS.

F.8 Test report

The test report shall include at least the following:

- Name of the manufacturer and production centre,
- Name and signature of testing body,
- Model identification (type, theoretical movement capacity, N° of batch),
- Drawings,
- Material specifications,
- Reference to this annex,
- Description of the test equipment,
- Date of the preparation of specimens, the date of test and the test temperature,
- Dimensions of test specimens,
- Report of observed phenomena according to F.6 and F.7,
- Photos of relevant components and test set up at least before and after testing situations.

ANNEX G – DYNAMIC TESTING – RESISTANCE TO FATIGUE AND WEAR OF THE PRODUCT REPRESENTED BY COMPONENTS

G.1 Scope

This annex describes the method for assessing the resistance to fatigue and wear of the product according to Clause 1.1, Figure 4 represented by components for mat expansion joints. The test method includes the effects of the accumulation of wear of the sliding surfaces of the support structure.

G.2 Principles

The principle of this test is to apply movement (Phase 1) and load cycles (Phase 2) on the components. The movements and loads are derived from reference movements and loads considered as simulations of movements and traffic loads in practice.

Hereafter, a general dynamic testing procedure is described. Analysis of the load transfer of the joint shall indicate whether all tests have to be carried out or whether specific phases shall be disregarded.

G.3 Samples and preparation of test specimens

One specimen of each type has to be tested.

If there is a range with the same type, then take one test at each border of the range and one test in the middle of the range.

The specimen shall be full-scale components.

The preparation of the test specimen is under the responsibility of the manufacturer.

G.4 Movement and load arrangements

The component related load and deformation arrangements on the specimens shall be derived from the appropriate load combinations (including the partial factors) as given in EAD 120109-00-0107, Annex D, Clause D.2.4.2.

G.4.1 Bridge movement due to temperature on the bridge (Phase 1)

The total slide path for the test procedure in relation to a working life of “a” years of a component is derived from:

a x 365 x 0,33 x maximum movement capacity = 120 x a cycles with maximum movement capacity of the joint.

The wear test on the component shall be carried out with the prestress of the built-in component taking account of creep and relaxation if any.

G.4.2 Traffic loads (Phase 2)

Depending on the composition of the components, a choice shall be made between applied loads derived from $FLM1_{EJ}$ or $FLM2_{EJ}$. The loads shall be applied for the most adverse boundary conditions in conjunction with a 60 % opening position of the joint.

1. Fatigue Load Model for expansion joints $FLM1_{EJ}$ to assess an unlimited life with respect to fatigue.

The test parameters shall be derived from:

- Vertical axle load: $\Delta\varphi_{fat}^{(1)}$. $0,7.Q_{1k}$ =1,3 x 0,7 x 300 = 273 kN
- Horizontal axle load: $\Delta\varphi_{fath}$· $0,7.0,2.Q_{1k}$ =1,0 x 0,7 x 0,2 x 300 = 42 kN
- Minimum number of cycles: 5×10^6
- Wheel print l x b (mm): 300 x 250

[1]) The dynamic amplification factor can be reduced based on field tests according to Annex H.

or:

2. Fatigue Load Model for expansion joints $FLM2_{EJ}$ to establish an S-N relationship from which a related working life category according to Clause 1.2.2 can be derived.

The test parameters shall be derived from the distribution and the combinations of vertical and horizontal axles loads as given in EAD 120109-00-0107, Annex D, Table D.5.

The dynamic amplification factor, included as a factor 1,3 in the axle loads of EAD 120109-00-0107, Annex D, Table D.5, can be reduced based on field tests according to Annex H.

The test loads for fatigue include a partial factor γ_{Ff} = 1,0.

G.5 Execution of the test

A specimen shall be subjected to Phase 1 and subsequently to Phase 2.

Due attention shall be given to rotations, eccentricities, imposed deformations and constraint effects, if they affect the load transfer at the sliding surfaces and through the component.

Phase 1, wear and friction test

- Apply a load F_{ik} with 5 % accuracy.
- Apply cyclic movements with a minimum mean velocity of 4 mm/s on the test specimen. The amplitudes shall be derived from amplitudes of ±33 % of the total movement capacity of the joint (one complete cycle corresponds to 67 % of the total movement capacity of the joint).
- The required number of cycles is derived from the working life of the component.
- The test shall be carried out at 23 °C ± 2 °C
- If the temperature of the specimen exceeds 35 °C, the test may be interrupted.

Measurements during phase 1

- Measure the (initial) static and dynamic friction coefficients during 10 cycles, at the beginning of the test, at intervals of 1 000 m slide path and after every dwell period.
- Measure the wear of the specimen after each phase by weighing of the specimen and measuring the dimensions of the specimen before and after the test phases. Inspect the sliding surfaces.

Phase 2, Fatigue test

The test shall be carried out at ambient temperature (between +5 °C and +35 °C) and the test loads shall be derived for an opening position of the joint, which is 60 % of the maximum opening position of the joint.

Apply the cyclic loads resulting from a structural analysis in accordance with the procedure given in G.4.2 and, where relevant, consider the effect of preload on the component.

Note: Resulting loads can be: Compression only, Alternating or Tension only.

Approach 1, Unlimited fatigue life

If, after being subjected to 5 x 10^6 cycles, the component has not collapsed or does not show damage, it can be assumed that the fatigue life of the component is unlimited.

Approach 2, Limited fatigue life

After being subjected to the relevant load cycles for the envisaged working life category and defined in EAD 120111-00-0107, Annex F, the component has not collapsed or does not show damage, it can be assumed that the fatigue life of the component is fulfilled for the selected working life category.

G.6 Expression of the results

The following results shall be reported:

Phase 1

- The (initial) static and dynamic friction coefficients during 10 cycles, at the beginning of the test, at intervals of 1 000 m slide path and after every dwell period,
- The loss of mass of the specimen after each phase, the dimensions of the specimen before and after the test phases,
- The condition of the sliding surfaces,
- Reaction forces during the test,
- Deformations,
- Debonding,
- Cracking,
- Displacements,
- Changes in preload if any.

Phase 2

- Applied loads,
- Deflection and deformations,
- Cracks,
- Exceptional behaviour,
- Mode of failure,
- Expected working life.

G.7 Test report

- The test report shall include at least the following:
- Name of the manufacturer and production centre,
- Name and signature of testing body,
- Model identification (type, theoretical movement capacity, N° of batch),
- Drawings,
- Material specifications,
- Reference to this annex,
- Description of the test equipment,
- Date of the preparation of specimens, the date of test and the test temperature,
- Dimensions of test specimens,
- Report of observed phenomena according to G.6,
- Photos of relevant testing situations.

ANNEX H – DYNAMIC ASSESSMENT AND FIELD TESTING

H.1 Introduction

An expansion joint is a kit, assembled from components. In addition, the field-testing allows the determination of the dynamic behaviour of the kit or single components of joints.

This annex describes how field tests of the kit shall be arranged and carried out and how the dynamic behaviour can be evaluated. Here, field-testing means that tests are carried out on full-scale joints which can be situated in an existing road or at testing facilities.

H.2 Objective

The objective of this test method is to derive the dynamic properties, dynamic factors for vertical and horizontal loads, system and material damping, free vibration, the (dynamic) loads for the kit and boundary conditions for the component testing, where necessary.

H.3 Principles

The principle of this test is that a full-scale joint is subjected to moving loads exerted by a reference lorry (over rolling test) and that the measurements, e.g. carried out by accelerometers, strain gauges and recordings of laser signals enable a proper dynamic analysis.

One test specimen, subjected to two passing test lorries with different speeds, is sufficient.

The results of the test and analyses apply for joints of the same type, but with other dimensions, provided the calculated vertical, horizontal and rotation natural frequencies do not fall below 90% of those of the originally tested and analysed expansion joint.

Dynamic amplifications and upswing shall be directly calculated from strains.

H.4 Scope and range of application

The evaluation of test results based on this annex is applicable for joints loaded by one axle in the traffic direction only (expansion joint width approximately 1 200 mm). For larger joints the test results can be used in conjunction with additional analyses.

The dynamic assessments described in this annex are based on joints positioned perpendicular to the traffic direction and perpendicular to the main axis of the bridge.

Joints not perpendicular to the traffic direction will show a smoother load application effect and therefore can be considered included. Skew joints are considered covered by investigations on perpendicular joints, if their dynamic properties are equal to perpendicular joints.

H.5 Samples and preparation of test specimens for over rolling tests

The test pieces shall be full-scale joints. The type, which is the most susceptible against dynamic influences, shall be tested (e.g. longest cantilever, worst relations of geometries).

The evenness of the joint shall meet the manufacturer’s design specifications. The evenness of the adjacent pavement shall be of medium quality (See EN 1991-2, 4.2.1, Note 3). The alignment shall be smooth, without discontinuities.

One specimen of each type has to be tested.

The preparation of the test specimen is under the responsibility of the manufacturer.

H.6 Testing arrangement and conditions

H.6.1 Location and conditions

The joint is located in a road and installed similarly to real “built-in” situations. The opening positions of the joint shall be at 60 % of movement capacity (middle position +/- 5 mm). The tests are carried out at ambient temperatures (between +5 °C and +35 °C).

H.6.2 Instrumentation

The instrumentation of the expansion joint shall consist of a combination of accelerometers, strain gauges and displacement sensors on e.g. bolts and reinforcements/bridging plates (see Figure H.1).

The instrumentation shall allow a clear analysis of vertical bending, horizontal bending, torsion and/or tilting. The sampling frequency of the instrumentation shall allow a proper analysis of the dynamic behaviour. The accuracy of measured variable shall be at least 5% of the maximum measured value.

The vehicle (see H.7.2) does not need to be instrumented.

A minimum sampling frequency of 10 to 15 times the highest relevant natural frequency (e.g. 1 500 Hz) is recommended for the data acquisition. In addition a minimum sampling frequency shall correspond to 10 times the inverse of the loading time (equal to the sum of length of the wheel print and length of a single contact surface, divided by the vehicle speed).

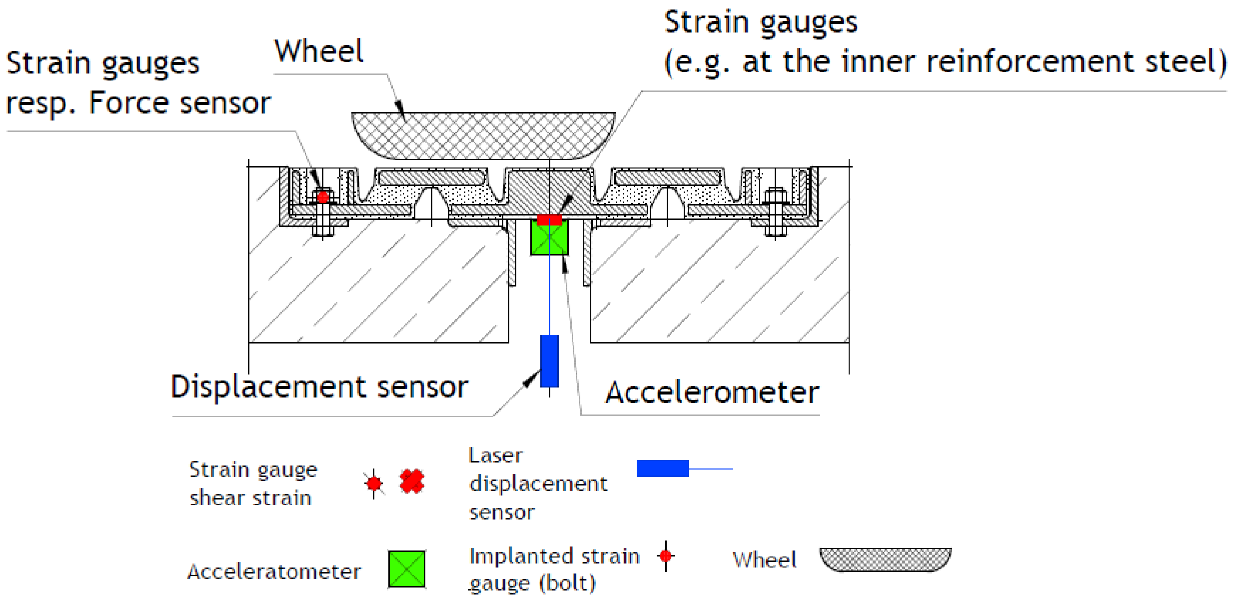


Figure H.1: Position of measuring devices

H.6.3 Joint extremities (cantilevers) and other discontinuities

The joint extremities with cantilevering parts larger than 0,3 times the intermediate spans (free cantilevering parts etc.) and other discontinuities shall be assessed with additional accelerometers. The results (Frequencies, natural vectors, accelerations) shall be used for calibration of calculation models used for the assessments according to Clauses 2.2.1 and 2.2.2.

H.6.4 Positioning of measuring devices

The position (see Figure H.1) and the type of measuring devices in order to assess shall be reported in a plan, which also shows the over rolling positions of the wheels. The plan shall also indicate the channel numbers etc. in order to allow full traceability of the records during interpretation and evaluation. For mat joints according to Clause 1.1, Figure 4, the position of measuring devices and transverse position for over rolling shall be selected in equivalence to EAD 120113-00-0107, Annex E, Figures E.1 and E.2.

H.7 Load arrangements and execution of over rolling tests

H.7.1 Excitation

Prior to the over rolling test, the natural frequencies and natural vectors of the joint shall be determined.

H.7.2 Over-rolling test

Prior to the over-rolling tests, a static measurement of the axle (wheel) loads shall be carried out. The geometry of the wheel prints shall be recorded. This can be achieved with a special measuring device, but also with a contour, drawn on a piece of paper. The static measurement shall be carried out with the same transverse slope as the expansion joint. The tyre inflation shall be recorded.

Subsequently the over-rolling tests are carried out:

A reference lorry travels over the expansion joint with the following speeds:

Table H.7.2: Lorry speeds and positions

Sequence	Speed (km/h)
1	≤ 5
2	50*
3	70*
4	90*

* Determination of test speed by axle spacing and natural frequency

$40 \text{ km/h} < v = (a_i * f_1 * 3{,}6) / n_{v2} <= 60 \text{ km/h}$
$60 \text{ km/h} < v = (a_i * f_1 * 3{,}6) / n_{v3} <= 80 \text{ km/h}$
$80 \text{ km/h} < v = (a_i * f_1 * 3{,}6) / n_{v4} <= 100 \text{ km/h}$
$v = l_{wheel\ print} \times f_1 <= 120 \text{ km/h}$

Where
a_i [m] minimum axle spacing of the test lorry
f_1 [Hz] first natural frequency (in vertical and/or horizontal direction)
n_{v2}, n_{v3}, n_{v4} integer
$l_{wheel\ print}$ length of the wheel print
v Lorry speed [km/h]

Sequence 1 simulates a static load transfer through the joint. Sequences 2 – 4 generate dynamic load transfer through the joint.

For each speed and each transverse position, the number of over-rolling with the vehicle is at least 3.

For mat expansion joints according to Figure 4, the transverse position shall be:
At least one wheel of every axle (left or right) passes the midspan of the field with a tolerance of 10 % of the span length.

For all other mat expansion joints according to Clause 1, the transverse position of the wheel shall be the same as a measuring device.

The vehicle speeds may be achieved by cruise control (tempomat) or manually and shall be recorded.

The (transverse) position of the over rolling wheels shall be reported.

The as-built drawings of the joint (and its components) are part of the documentation of the test set up.

The following lorry types are recommended:

- Two axle lorry with axle loads as EN 1991-2 FLM4 Type 1: Front axle 70 kN and rear axle 130 kN.
- Five axle lorry with axle loads as EN 1991-2 FLM4 Type 3: Tractor: Front axle 70 kN, Rear axle 150 kN, Trailer tridem 3 x 90 kN.

H.8 Measurements and analyses

The following aspects shall be measured for further interpretation.

H.8.1 Lorry

1. Wheel print geometry (static) (5% accuracy),
2. Tyre pressures (5% accuracy),
3. Travelling speed of the lorry above the joint (5% accuracy),
4. Travelling position in transverse direction (10% accuracy).

H.8.2 Expansion joint

The following shall be measured:

1. Width of the relevant component,
2. Gap width (5% accuracy),
3. Strains (with gauge) (5% accuracy),
4. Accelerations (5% accuracy),
5. Distance (with laser) (5% accuracy).

Interference effects and phase shifts between vertical, horizontal and rotation movements shall be filtered, prior to further analysis.

H.8.3 Over-rolling tests

H.8.3.1 Effects in the vertical plane

H.8.3.1.1 Initial dynamic impact factor

The vertical dynamic impact factor $\Delta\varphi_{fat}$ shall be derived from the vertical section moments. The section moments shall be derived from the section moments at the strain gauge locations, taking into account the transversely distributed load introduced by the wheel print and offsets, if relevant. The moments shall be summed for the determination of the dynamic impact factors. The vertical dynamic impact factor $\Delta\varphi_{fat}$ [-] for the considered velocity is the vertical moment interval (sum of support and midspan moments) for sequence “i” M_{Svi} [kNm], divided by the vertical moment interval for sequence 1 (v = 0) M_{Sv0} [kNm].

Analysis:

- Vertical support moment: M_{sv} [kNm],
- Vertical moment interval static: M_{Sv0} [kNm],
- Vertical moment interval at sequence “i” with ($v \neq 0$): M_{Svi} [kNm],
- Dynamic impact factor: $\Delta\varphi_{fat} = M_{Svi}/M_{Sv0} \geq 1.0$. The dynamic impact factor shall be calculated with the 95%-fractile of the test results.

H.8.3.1.2 Upswing

Derive in the same way the vertical moment interval (M_{Svu} [kNm] = M_{svu} [kNm] + M_{mvu} [kNm]) after unloading.

The vertical Upswing ratio U_v [-] = M_{Svu}/M_{Sv}
The vertical upswing ratio shall be calculated with the 95%-fractile of the test results.

H.8.3.1.3 Combined dynamic vertical effect

The dynamic load (moment etc.) design interval ($E_{d,dyn}$) to be used for fatigue assessments shall be based on:

$$E_{dv,dyn} = E_{dv0} \text{ x } \Delta\varphi_{fat} \text{ x } (1 + U_v) \text{ [kN]}$$

H.8.3.2 Effects in the horizontal plane

The section moments shall be derived from the section moments at the strain gauge locations, taking into account the transversely distributed load introduced by the wheel print. The moments shall be summed for the determination of the transfer factor. The transfer factor “tr” for the considered velocity is the measured horizontal moment interval for sequence “i” M_{Sh}, divided by the vertical M_{Sv0}.

Analysis:

- Vertical support moment for a static load (v=0km/h): M_{sv0} [kNm],
- Vertical moment interval for a static load (v=0km/h): $M_{Sv0} = M_{sv0} + M_{mv0}$ [kNm],
- Horizontal moment interval for a moving load (v_i > 0km/h): $M_{Shi} = M_{shi} + M_{mhi}$ [kNm],
- Transfer factor V/H incl. $\Delta\varphi_{fat}$: tr = $M_{Shi}/M_{Sv0} \geq 1.0$ [-]. The transfer factor shall be calculated with the 95%-fractile of the test results.

H.8.3.3 Response ratio

Derive in the same way the vertical moment interval ($M_{Svu} = M_{svu} + M_{mvu}$) after unloading.

The horizontal response ratio $U_h = M_{Shu}/M_{Sh}$ [-].

Without further analyses U_h shall be taken as 1,0.

H.8.3.4 Combined dynamic vertical effect

The dynamic load (moment etc.) design interval ($E_{dh,dyn}$) to be used for fatigue assessments shall be based on:

$$E_{dh,dyn} = E_{dh0} \text{ x } \Delta\varphi_{fat} \text{ x } (1 + U_h) \text{ [kN]}$$

H.9 Calculations

Parallel to the over-rolling test a calculation shall be carried out of the full-scale test expansion joint with a 3-D model.

H.9.1 General

The overall dimensions of the model shall be such that all relevant frequencies and natural vectors are found; therefore the model shall include the relevant features e.g. offsets, inflexion points (bends), cantilevering parts. The model shall enable the calculation of the relevant section forces and bending moment at all cross sections with locations susceptible to fatigue; e.g. butt joint locations.

H.9.2 Calculation results

The natural frequencies and natural vectors shall be calculated. The results shall be compared with the measured natural frequencies and natural vectors that can be derived from the measurements.

For the assessment of the model the measured natural frequencies and mode shapes shall be compared with calculated ones. The strains and deflections due to walking speed over-rolling (according to sequence 1 in Table H.7.2) shall be compared with the simulated ones.

Note: The full-scale test results only allow the derivation of the natural frequencies, whereas the model allows the derivation of natural frequencies and 2nd harmonics. Further small deviations in geometry can give rise to differences between the measurements and the model calculations.

If the model results do not deviate more than 10 %, no further action has to be taken. If the results deviate more than 10 %, additional analyses are needed for a better adjustment, or modifications of the model.

Note: No response calculations need to be carried out if: For upswing effects less than 2% of the quasi static load it can be considered no upswing, for dynamic amplification effects responses not larger than 1.05 the quasi static response can be considered no additional amplification.

H.9.3 Combination of effects

Without further analyses the dynamic stress intervals from vertical loads shall be combined with the dynamic stress intervals from horizontal loads.

For stresses at a specific location from both load effects into the same direction applies:

$$\Delta\sigma_{comb} = \Delta\sigma_v + \Delta\sigma_h \text{ [N/mm}^2\text{]}$$

If needed, the combined stress interval may include the phase shift between vertical and horizontal vibrations, based on additional analyses.

H.10 Test report

The test report shall comprise at least:

- Description of the joint, including the adjacent pavement over 30 m before and after the joint, slopes in traffic direction and perpendicular to the traffic direction;
- Drawing of the joint (dimensions, dimensions of components, material specifications etc.);
- Test lorry (configuration and static wheel loads, wheel print dimensions, inflation pressure of tyres, wheel and axle distances, position relative to the joint in transverse direction during over-rolling, over-rolling speed);
- Measuring devices (types, accuracy) and their locations (detailed sketches, related to the joint dimensions);
- Sampling frequency of measuring devices;
- Natural frequencies (vertical, horizontal, torsional);
- Vertical dynamic amplification factor $\Delta\varphi_{fat}$ for each crossing and 95% quantile;
- Transfer effects tr for each crossing;
- Upswing effect U_v, and horizontal response effect U_H for each crossing and 95% quantile;
- Date of test execution (environmental aspects: air temperature etc.).

H.11 Keys

v	[km/h]	lorry speed
a_i	[m]	minimum axle spacing of the test lorry
$l_{wheel\ print}$	[m]	length of the wheel print
f_1	[Hz]	first natural frequency in vertical and/or horizontal direction
d	[-]	damping ratio
n_{vi}	[-]	integer
$\Delta\varphi_{fat}$	[-]	vertical dynamic impact factor

M_{sv0}	[kNm]	Static vertical support moment (v = 0km/h)
M_{mv0}	[kNm]	Static vertical midspan moment (v = 0km/h)
M_{Sv0}	[kNm]	Static vertical moment interval (v = 0km/h)
M_{Svi}	[kNm]	Vertical moment interval at sequence i (v_i > 0km/h)
M_{svu}	[kNm]	vertical support moment after unloading (v_i > 0km/h)
M_{mvu}	[kNm]	vertical midspan moment after unloading (v_i > 0km/h)
M_{Svu}	[kNm]	vertical moment interval after unloading (v_i > 0km/h)
M_{Shi}	[kNm]	Horizontal moment interval (v_i > 0km/h)
M_{shi}	[kNm]	Horizontal support moment (v_i > 0km/h)
M_{mhi}	[kNm]	Horizontal midspan moment (v_i > 0km/h)
U_v	[-]	vertical upswing ratio
U_h	[-]	horizontal response ratio
$E_{d,dyn}$	[kN, kNm or N/mm^2]	vertical dynamic load (moment etc.) design interval
E_{dv0}	[kN, kNm or N/mm^2]	vertical static load (moment etc.) design interval (v = 0km/h)
$E_{dh,dyn}$	[kN, kNm or N/mm^2]	horizontal dynamic load (moment etc.) design interval
E_{dh0}	[kN, kNm or N/mm^2]	horizontal static load (moment etc.) design interval (v = 0km/h)
tr	[-]	transfer factor
$\Delta\sigma_{comb}$	[N/mm^2]	combined stress interval
$\Delta\sigma_v$	[N/mm^2]	vertical stress interval
$\Delta\sigma_h$	[N/mm^2]	horizontal stress interval
A_n	e.g. [µm/m]	response Amplitude "n"