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**GUIDELINE FOR EUROPEAN TECHNICAL
APPROVAL**

of

EXPANSION JOINTS FOR ROAD BRIDGES

PART 5: MAT EXPANSION JOINTS

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BELGIUM

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ANNEXES TO THIS ETAG FAMILY PART

Annexes 5-A to 5-L for this family Part correspond to Annexes A – L in Part 1 of this ETAG N°32, if applicable.

FOREWORD

See Part 1 of this ETAG N° 032.

REFERENCE DOCUMENTS

See Part 1 of this ETAG N° 032.

In addition, for this part of the ETAG the following documents are of relevance which are not already mentioned in ETAG N° 032, Part 1:

List of ETAGs referred to in this family part

ETAG	Clause in this Part of ETAG	Title
ETAG N° 032, Part 8	2.1.2, 5.1.1.2, 5.1.1.3	Guideline for European Technical Approval of expansion joints for road bridges – Part 8: Modular expansion joints

Additional list of standards referred to in this family Part

Standard	Clause in this Part of ETAG	Title
EN 755-2	Table 4.2, Table 5.2	Aluminium and aluminium alloys – Extruded rod/bar, tube and profiles – Part 2: Mechanical properties
EN 1706	Table 4.2, Table 5.2, Table 6.2	Aluminium and aluminium alloys – Castings – Chemical composition and mechanical properties
EN 1990, Annex A2 (2002/A1)	5.M.4.3	Eurocode: Basis of structural design – Annex A2: Application for bridges
EN 1991-2 (2003)	5.P.1	Eurocode 1: Actions on structures – Part 2: Traffic loads on bridges
EN 1993-1-8 (2005)	Table 5.2	Eurocode 3: Design of steel structures – Part 1-8: Design of joints
EN 1999-1-3 (2007)	Table 4.2, Table 5.2	Eurocode 9: Design of aluminium structures – Part 1-3: Structures susceptible to fatigue
EN 10025	Table 4.2, Table 5.2, Table 6.2	Hot rolled products of structural steels – All parts
EN 10080	Table 4.2, Table 5.2, Table 6.2	Steel for the reinforcement of concrete – Weldable reinforcing steel – General
EN 10088	Table 4.2, Table 5.2, Table 6.2	Stainless steels – All parts
EN 10204 (2004)	Table 8.1, Table 8.3	Metallic products – Types of inspection documents
EN ISO 11358	Table 4.2, Table 5.2, Table 8.2	Plastics – Thermogravimetry (TG) of polymers – General principles
EN ISO 12944	Table 4.2, 5.1.7.1, Table 5.2	Paints and varnishes – Corrosion protection of steel structures by protective paint systems – All parts
EN ISO 13918	Table 4.2, Table 5.2, Table 6.2, Table 8.3	Welding – Studs and ceramic ferrules for arc stud welding
ISO 34-1 (2004)	Table 4.2, Table 5.2	Rubber, vulcanized or thermoplastic – Determination of tear strength – Part 1: Trouser, angle and crescent test piece
ISO 37	Table 4.2, Table 5.2	Rubber, vulcanized or thermoplastic – Determination of tensile stress-strain properties
ISO 48	Table 4.2, Table 5.2	Rubber, vulcanized or thermoplastic – Determination of hardness (Hardness between 10 IRHD and 100 IRHD)
ISO 188	Table 4.2, Table 5.2	Rubber, vulcanized or thermoplastic – Accelerated ageing and heat resistance tests

ISO 527-1	Table 4.2, Table 5.2	Plastics – Determination of tensile properties – Part 1: General principles
ISO 812 (2006)	Table 4.2, 5.1.7.2, Table 5.2, Table 6.2	Rubber, vulcanized or thermoplastic – Determination of low-temperature brittleness
ISO 815	Table 4.2, Table 5.2	Rubber, vulcanized or thermoplastic – Determination of compression set at ambient, elevated or low temperatures
ISO 1183-1	Table 4.2, Table 5.2	Plastics – Methods for determining the density of non-cellular plastics – Part 1: Immersion method, liquid pycnometer method and titration method
ISO 1431-1	Table 4.2, Table 5.2	Rubber, vulcanized or thermoplastic – Resistance to ozone cracking – Part 1: Static and dynamic strain testing
ISO 1817	Table 4.2, Table 5.2	Rubber, vulcanized – Determination of the effect of liquids
ISO 2039-1	Table 4.2, Table 5.2	Plastics – Determination of hardness – Part 1: Ball indentation method
ISO 2781 Technical corrections 1	Table 4.2, Table 5.2	Rubber, vulcanized – Determination of density – Technical Corrigendum 1
ISO 3417	Table 4.2, Table 5.2	Rubber – Measurement of vulcanization characteristics with the oscillating disc curemeter
ISO 4649	5.1.1.7, 6.1.1.7	Rubber, vulcanized or thermoplastic – Determination of abrasion resistance using a rotating cylindrical drum device
ISO 6502	Table 4.2, Table 5.2	Rubber – Guide to the use of curemeters
ISO 7619-2	Table 4.2, Table 5.2	Rubber, vulcanized or thermoplastic – Determination of indentation hardness – Part 2: IRHD pocket meter method
ISO 9924	Table 4.2, Table 5.2	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 Part 2: Acrylonitrile-butadiene and halobutyl rubbers
ASTM D 6370	Table 4.2, Table 5.2	Standard Test Method for Rubber – Compositional Analysis by Thermogravimetry (TGA)

Note: Some of these standards are also referred to in Part 1.

Section one: INTRODUCTION

PRELIMINARIES

1.1 LEGAL BASIS

See Part 1 of this ETAG N° 032.

1.2 STATUS OF ETAG

See Part 1 of this ETAG N° 032.

This document shall be used in conjunction with ETAG N° 032, Expansion joints for road bridges, Part 1. If the text in Part 1 applies to this family of products then reference will be made to the appropriate clause in Part 1.

2. SCOPE

2.1 SCOPE AND DEFINITION

2.1.1 General

This Part of the ETAG N° 032 specifies the product performance characteristics, methods of verification and assessment procedures for Mat Expansion Joints for road bridges to ensure the fitness of the products for their intended use.

2.1.2 Definitions

The following definition details the general definition given in 2.1.2.2 of Part 1.

Explanation to the definition in ETAG N° 032, Part 1:

A mat expansion joint consists of an elastomeric element (mat), e.g. including a bridging plate, and the accessory anchorage system. 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.

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

The principles for single/multiple Mat Expansion Joints on the basis of shear deformation are given in Figures 1a and 1b.

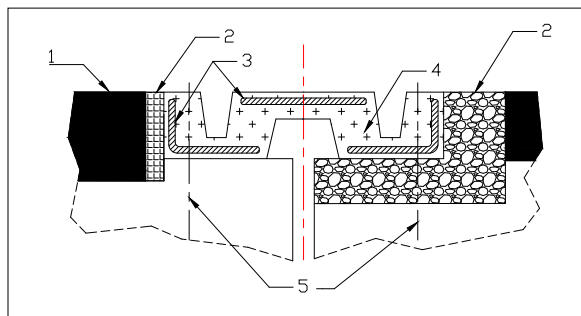


Figure 1a: Principles for single Mat Expansion Joints on the basis of shear deformation

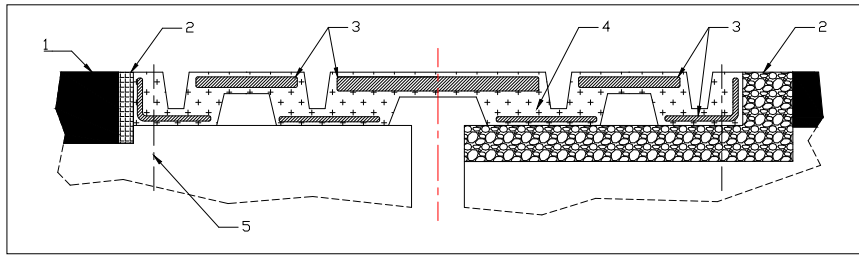
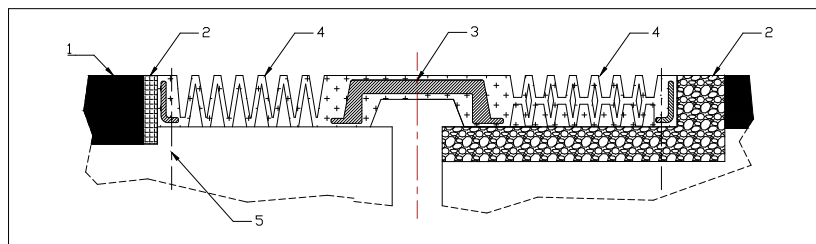
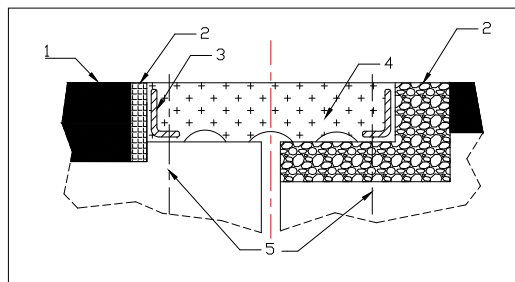


Figure 1b: Principles for multiple Mat Expansion Joints on the basis of shear deformation

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



Figures 2 – 3: Principles for single Mat Expansion Joints on the basis of compression/tension deformation

For Mat Expansion Joints with intermediate supports (see Figure 4) for the mat itself this part of the ETAG applies, for the intermediate supports the conditions given in the ETAG N° 032, Part 8: Modular expansion joints are of relevance.

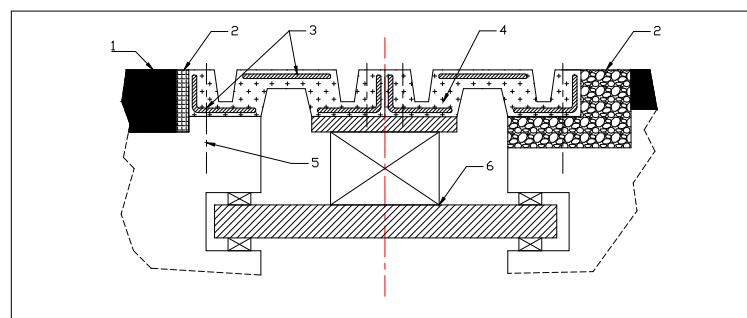


Figure 4: Principles for supported multiple Mat Expansion Joints

Key for Figures 1 – 4:

- 1 Pavement/Wwaring course
- 2 (To left hand side) Sealant
- 2 (To right hand side) Transition strip
- 3 Reinforcement/insert
- 4 Elastomer
- 5 Anchoring
- 6 Support beam

2.2 USE CATEGORIES AND KITS

2.2.1 Use categories

See Part 1 of this ETAG N° 032.

2.2.2 Kits

See Part 1 of this ETAG N° 032.

Mat expansion joints consist of at least the following:

- mat (reinforced or not reinforced),
- anchorage system.

In addition, the following precision is given for optional devices, which may be included in the design for the mat expansion joint kit:

- support structure,
- sliding plate,
- bridging plate,
- kerb elements,
- connecting devices (e.g. to connect mat elements),
- drainage devices (e.g. gutter),
- cover plates (e.g. for footpath),
- connections to the watertight membrane.

Note: This list is considered as an elaboration of the general description, given in 2.2.2 of ETAG N° 032, Part 1.

2.3 ASSUMPTIONS

See Part 1 of this ETAG N° 032.

2.3.1 Main structure

See Part 1 of this ETAG N° 032.

2.3.2 Temperatures

See Part 1 of this ETAG N° 032.

All ranges of operating temperatures according to ETAG N° 032, Part 1, apply.

To demonstrate that materials are fit for the use over the temperature range chosen by the manufacturer, appropriate test(s)/verification (i.e. brittleness test for rubber at low temperature, appropriate steel or aluminium alloy for low temperature) shall be made.

2.3.3 Installation

See Part 1 of this ETAG N° 032.

2.3.4 Working life

See Part 1 of this ETAG N° 032.

All categories according to ETAG N° 032, Part 1, 2.3.4, apply.

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

3. TERMINOLOGY

3.1 COMMON TERMINOLOGY AND ABBREVIATIONS

See Part 1 of this ETAG N° 032.

3.2 TERMINOLOGY AND ABBREVIATIONS SPECIFIC TO THIS ETAG

3.2.1 Terminology

See Part 1 of this ETAG N° 032.

For additional terms and definitions specific for this family product, see the following list.

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

Butt joint: Connection of two mat elements at their ends.

Cover: Plated element to be used on the surface, not contributing to the reinforcement of the joint.

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

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

Support structure: Intermediate structure connecting surface elements and anchorage system to the main structure.

3.2.2 Abbreviations

See Part 1 of this ETAG N° 032.

No specific abbreviation for this family Part.

Section two: GUIDANCE FOR THE ASSESSMENT OF THE FITNESS FOR USE

GENERAL NOTES

See Part 1 of this ETAG N° 032.

4. REQUIREMENTS

For the works and their relationship to the Road Bridge Expansion Joint characteristics

See Part 1 of this ETAG N° 032.

4.0 TABLE LINKING THE ESSENTIAL REQUIREMENTS TO ROAD BRIDGE EXPANSION JOINT PERFORMANCE

Comprehensive table

See Part 1 of this ETAG N°32 but the clauses in the last column in the table refer to this Part of the ETAG.

4.1 KITS

4.1.1 Mechanical resistance and stability

4.1.1.1 General

See Part 1 of this ETAG N° 032.

4.1.1.2 Mechanical resistance

The general requirements for the external load and imposed deformation conditions related to the fundamental combination ULS and the characteristic combination SLS are given in Part 1, 4.1.1.2. 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.

The detailed criteria for reversible deformations according to Table 4.1.1 in ETAG N° 032, Part 1, are given in 4.1.4.1.2.

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.

For ULS the following detailed requirements apply:

No collapse and no “brittle” failure of the expansion joint kit shall occur.

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.

Note: This includes the ULS criteria for the mat expansion joint under imposed displacement at ULS of the main structure according to Table 4.1.1 in ETAG N° 032, Part 1.

4.1.1.3 Resistance to fatigue

4.1.1.3.1 General

The mat expansion joint kit shall have sufficient fatigue resistance for the intended working life. The general requirements are given in 4.1.1.3 of ETAG N° 032, Part 1.

Note: Resistance against repeated movements due to temperature movements of the main structure is not considered to be relevant for Mat Expansion Joints. Traffic induced movements of the main structure may cause fatigue in specific parts (e.g. connectors, anchorage system) due to the imposed deformations to the expansion joint and is covered by 4.1.1.3.1.1.

4.1.1.3.2 Resistance to fatigue caused by bridge movements under traffic

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

4.1.1.3.3 Resistance to fatigue caused by traffic loads on the expansion joint

For Mat Expansion Joints and their anchorage system, the fatigue resistance with respect to traffic loads 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 5.O. For the anchorage system no loosening, breaking or debonding of its elements shall occur.

4.1.1.4 Seismic behaviour

See Part 1 of this ETAG N° 032.

4.1.1.5 Movement capacity

See Part 1 of this ETAG N° 032.

The influence of displacement velocity and the temperature is not relevant for this product family.

The butt joints shall perform properly at all movements up to the most adverse position.

Requirements caused by rotations are not relevant for Mat Expansion Joints.

4.1.1.6 Cleanability

See Part 1 of this ETAG N° 032.

4.1.1.7 Resistance to wear

Resistance to wear is of relevance for mat joints with sliding surfaces on support only. The accumulation of wear of the sliding surfaces during the declared working life shall not result in:

- Insufficient mechanical resistance in accordance with 4.1.1.1,
- 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.

4.1.1.8 Watertightness

See Part 1 of this ETAG N° 032.

When watertightness for Mat Expansion Joints is achieved by a separate system of the main element (e.g. gutter) this system shall be included in the kit.

4.1.2 Safety in case of fire

According to Part 1 of this ETAG: not relevant.

4.1.3 Hygiene, health and environment

See Part 1 of this ETAG N° 032.

4.1.4 Safety in use

4.1.4.1 Ability to bridge gaps and levels in the running surface

4.1.4.1.1 Allowable surface gaps and voids

See Part 1 of this ETAG N° 032.

4.1.4.1.2 Level differences in the running surface

For the unloaded condition and without any imposed horizontal deformation, see Part 1 of this ETAG N° 032.

In the deformed condition by 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.

For loaded conditions, see Part 1 of this ETAG N° 032 and, in addition, steps shall not be greater than 8 mm.

4.1.4.2 Skid resistance

See Part 1 of this ETAG N° 032.

4.1.4.3 Drainage capacity

Where relevant due to the design of the mat expansion joint, see Part 1 of this ETAG N° 032.

4.1.5 Protection against noise

According to Part 1 of this ETAG N° 032: not relevant.

4.1.6 Energy economy and heat retention

According to Part 1 of this ETAG N° 032: not relevant.

4.1.7 Aspects of durability, serviceability and identification of the products

See Part 1 of this ETAG N° 032.

4.1.7.1 Aspects of durability

See Part 1 of this ETAG N° 032.

4.1.7.1.1 Corrosion

See Part 1 of this ETAG N° 032. In particular, for the following metallic components made out of steel, durability against corrosion is affected:

- Support structures,
- Anchorage devices, where relevant,
- Kerb elements,
- Connecting devices (e.g. between elements),
- Drainage devices (where relevant),
- Covers.

4.1.7.1.2 Chemicals

For the elastomer of Mat Expansion Joints the resistance to de-icing agents and the resistance to hot bitumen are considered (see 4.2). If there is a transition strip, consideration of hot bitumen is not relevant.

Note 1: Resistance to de-icing agents is only relevant if increase of volume influences the functioning of the product.

Note 2: Resistance to hot bitumen is relevant for contact surface to the adjacent pavement only in where the surface is not protected by an appropriate transition strip or similar.

Resistance to oil, petrol, fuel oil are not of relevance for Mat Expansion Joints where the mat is made on the basis of the following materials: Polychloroprene rubber [CR], Ethylene-Propylene-Diene Material [EPDM], Styrol-Butadiene-Rubber [SBR].

For materials not listed above, the requirement according to ETAG N° 032, Part 1, applies.

4.1.7.1.3 Loss of performance due to ageing resulting from temperature, UV radiation and ozone

For the elastomer of Mat Expansion Joints the resistance to ozone and the resistance to ageing caused by heating are considered (see 4.2).

In addition, compression set and for low temperatures for the rubber brittleness temperature are considered, depending on the range of temperature (see 4.1.7.2 and 4.2).

For plastics (for bearing and sliding elements) compression set and resistance to low temperature are considered (see 4.2).

4.1.7.1.4 Resistance against freeze-thaw

Not relevant.

4.1.7.2 Aspects of serviceability

See Part 1 of this ETAG N° 032.

4.1.7.3 Aspects of identification

See Part 1 of this ETAG N° 032.

Each mat element shall be clearly identified in order to ensure the traceability, e.g. with a stamp or a vulcanised label in the running surface of the element comprising the following information:

- Manufacturer's name and address,
- Type of product,
- Batch number,
- Date of manufacture.

4.2 COMPONENTS

See Part 1 of this ETAG N° 032.

The manufacturer shall present a list of components with the material characteristics (including tolerances) as given in Table 4.2 in this family Part. Testing shall be carried out to demonstrate that the product meets the declared characteristics.

Components shall be defined and specified in the Technical Manual according to their function and their role in the product. This shall include their characteristics, method of handling and their source of supply.

The tests determine the material characteristics and performance.

The Approval Body shall identify the characteristics of the components of a Mat Expansion Joint which have to be verified during the approval procedure in accordance with this Part of the ETA Guideline.

Table 4.2 below gives requirements which shall be used where they are applicable. Where they do not apply or do not address the correct characteristics for that component/material, alternative criteria, based in preference on European or ISO standards, shall be used by agreement between the ETA applicant and the Approval Body. Details shall be given in the Evaluation Report.

Table 4.2: Material characteristics for components

Parts of the kit	Components of the parts	Material	Requirement/performance characteristic	Standard/specification
Mat	Mat	Elastomer	Density	ISO 2781 Technical corrections 1 (1996)
			Hardness IRHD	ISO 48, ISO 7619-2
			Tensile strength	ISO 37
			Elongation at break	ISO 37
			Tear resistance	ISO 34-1
			Compression set	ISO 815 (type B test piece)
			Resistance to ageing	ISO 188
			Resistance to de-icing agents	ISO 1817
			Resistance to ozone	ISO 1431-1
			Resistance to hot bitumen	ISO 1817
			Low brittleness temperature - Requirements according to ISO 812 (2006), 7.1.1.4	ISO 812
			Thermo gravimetric analysis (TGA)	EN ISO 11358, ISO 9924-1, -2; ASTM D 6370
			Rheometric characteristics	ISO 3417 ISO 6502
Reinforcement	Steel (minimum S235J2)	Stainless steel (grade 1,44xx or 1,45xx)	Geometry	EN 10025 EN 10088-2
			Yield point	
			Tensile strength	
			Chemical composition (C-eq.)	
			Elongation at rupture	
Inserts	Metal	Tensile strength	Relevant specification	
		Elongation at rupture		
Support structure (when part of the kit) (see Figure 1b in 2.1.1) *)	Plates, profiles, steel beam grid	Steel (minimum S235J0)	Geometry	EN 10025, EN 10088
			Yield point	
			Tensile strength	
			Elongation at rupture	
			Chemical composition (C-eq.)	
Reinforcement bars/loops	Steel	Geometry	EN 10080	
		Yield strength		
		Tensile strength		
		Ductility		
		Weldability		
		Bendability		
Dowels	Steel	EN ISO 13918	EN ISO 13918	
Bearing and sliding element	Plastics	Density	ISO 1183-1	
		Hardness IRHD	ISO 2039-1	
		Tensile strength	ISO 527-1	
		Compression set	ISO 815	
		Resistance to low temperatures	ISO 812	
Bearing elements	Stainless steel	Chemical composition	EN 10088	

Table 4.2 (continued)

Parts of the kit	Components of the parts	Material	Requirement/performance characteristic	Standard/specification	
Anchorage devices	Bolts, screws , nuts, washers	Steel	Geometry Grade or quality class (according to the type of component) Tensile strength Yield strength	EN 10080	
	Threaded rod with nuts and washers including resin mortar	Steel (rod) + resin mortar	Relevant load bearing capacity	Relevant specification	
	Bonded anchor	Steel + resin or resin mortar	Relevant load bearing capacity	Relevant specification	
	Stud bolts	Steel	Relevant load bearing capacity	Relevant specification	
Connecting devices*)	Bolts, screws, nuts, washer, profiles	Metal	See "Anchorage devices"		
	Bonding agents/sealants, sockets	Chemicals/Metal	- To be covered by full scale tests (including butt joints) - Bonding agents manufacturers' specifications to be taken into account		
Kerb elements*)	Plate, welded attachments (like covers)	Metal	Remark: See "Covers"		
	Special mat elements	Remark: See "Mat"			
Drainage devices*)	Gutter including their connections and its butt joints	Elastomer (reinforced), (reinforced) plastics (e.g. Polyamide, PVC, Polyethylene), etc.	Depending on the design of the drainage device the following performance characteristics may have to be considered: - Resistance to de-icing agents - Connecting ability to membranes and de-watering systems etc. - Bonding - Tear resistance - Resistance to ozone - Limit temperature of brittleness <i>Note: The list is not considered as exhaustive</i>	Relevant technical specification with respect to the concerned performance characteristics	
		Metal (steel, stainless steel, Grade 1.44xx or 1.45xx)	Resistance to corrosion		EN ISO 12944 EN 10088
			Resistance to de-icing agents		Remark: Covered by resistance to corrosion.
	Fixing elements	Metal	See "Connecting devices"		
Connectors to the watertight membrane*)	According to the relevant specification				

Table 4.2 (continued)

Parts of the kit	Components of the parts	Material	Requirement/performance characteristic	Standard/specification
Covers; sliding plates, bridging plates*)	Plates	Steel minimum S235xx	- Geometry - Yield point - Tensile strength	EN 10025 EN 10088
		Stainless steel, Grade 1.44xx or 1.45xx	- Elongation at rupture - Chemical composition (C-eq.)	
		Aluminium (covers) Plate material: Grade 5xxx Extruded material: Grade 6xxx excluded: grades given in EN 1999-1-3, Clause 3 (2007)	- Geometry - Chemical composition - Tensile strength - Yield point - Stress-strain - Elongation at rupture - Ductility - Charpy-V value <i>Note: Selection depending on chosen materials</i>	Extruded aluminium: EN 755-2
		Cast material: Grade xxx		Cast aluminium: EN 1706

*) Optional devices (see 2.2.2 in this ETAG family Part).

5. METHODS OF VERIFICATION

See Part 1 of this ETAG N° 032.

5.0 GENERAL

Comprehensive table

See Part 1 of this ETAG N° 032 but the clauses in the last column in the table refer to this product family Part.

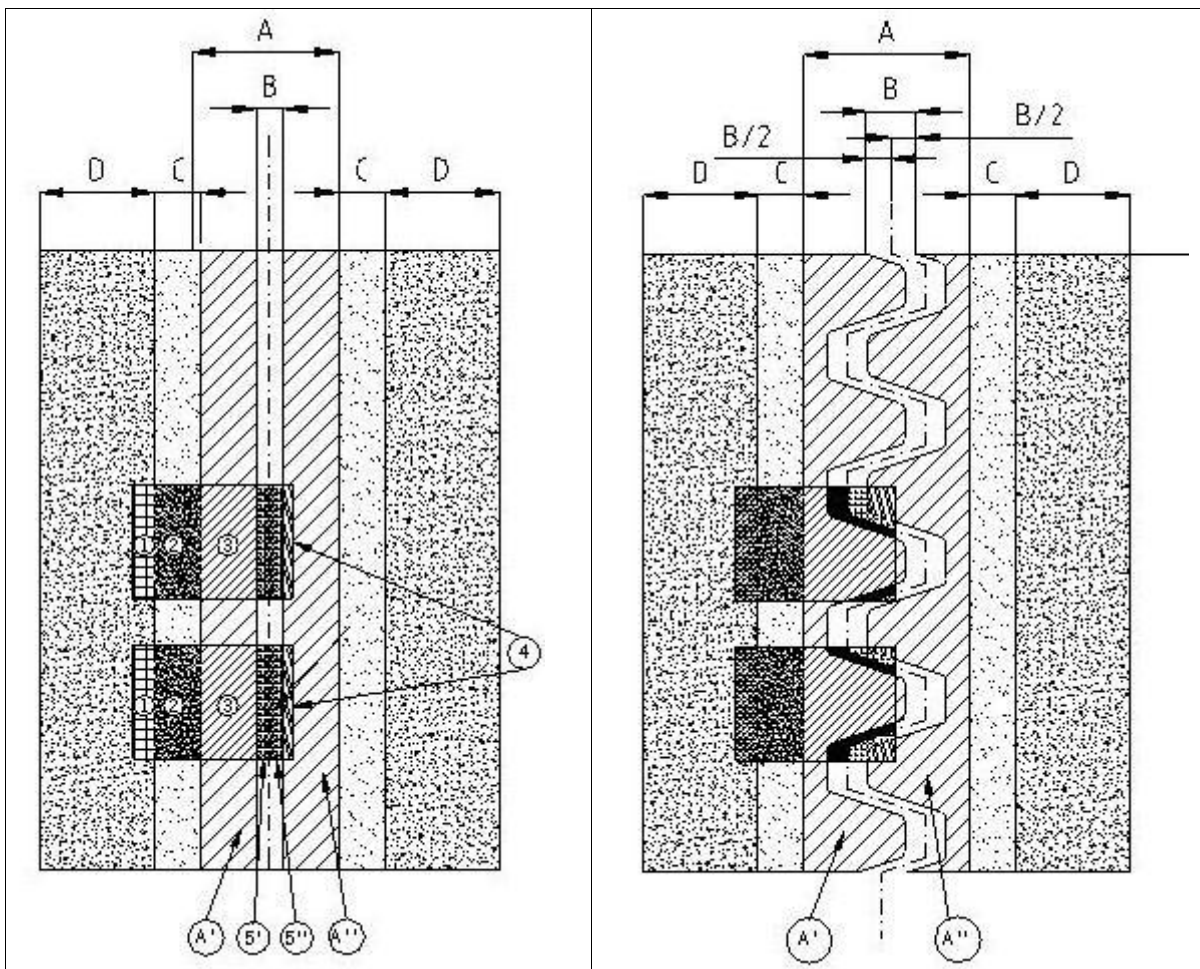
5.1 KITS

5.1.1 Mechanical resistance and stability

5.1.1.1 General

See Part 1 of this ETAG N° 032.

For mat expansion joints the following load distribution applies: In case the voids are designed straight-oriented, the load distribution as given in right-hand sketch in Figure 5.1.1.1 applies. In case of non-straight-oriented voids, the load distribution as given in the left-hand sketch in Figure 5.1.1.1 applies. The conditions for load distribution, detailed for other product families, are to be considered.



For Key, see Figure G1 in Part 1.

Figure 5.1.1.1: Load distribution for mat expansion joints

5.1.1.2 Mechanical resistance

See Part 1 of this ETAG N° 032.

For Mat Expansion Joints with intermediate supports (see 2.1.1, Figure 3), verification of these supports shall be done according to ETAG N° 032, Part 8. The relevant load combination on the support system shall be derived according to Annex G.

For Mat Expansion Joints, mechanical resistance shall be verified by calculation or testing. Calculation shall be carried out based on relevant standards and/or criteria derived from standards. If calculation, based on standards, is not possible, verification shall be done by means of full scale test.

5.1.1.2.1 Calculation

See Part 1 of this ETAG N° 032.

The calculation shall include the geometrical and physical non-linear behaviour, if any, together with the spring characteristics (for the displacement directions given in 4.1.1.5 of ETAG N° 032, Part 1, of the Mat Expansion Joints. The material characteristics shall be based on standards, where available, or testing.

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

5.1.1.2.2 Testing

Annex 5.M of this ETAG Part gives the test method for mechanical resistance for SLS and ULS.

5.1.1.3 Resistance to fatigue

5.1.1.3.1 General

Fatigue resistance of Mat Expansion Joints shall be verified by testing. However, for metallic parts, such as anchors and inserts, the fatigue resistance can be verified by calculation, provided that all boundary conditions and loads are known in detail.

Upswing effects shall be taken into account and consideration shall be stated in the Evaluation Report. Verification of upswing effects shall be done (e.g. by tests; for test loading conditions see ETAG N° 032 Part 8, Annex 8.O, 8.O.7.2) in order to verify the concerned deflection and to determine the related forces to be taken into account.

The aspects dynamic amplification and number of cycles, as mentioned in 5.1.1.3 in ETAG N° 032, Part 1, are covered in the loads and cycles, given in Annex 5.O.

5.1.1.3.2 Calculations

In addition to ETAG N° 032, Part 1:

Calculation is applicable for bonded steel parts. The calculation shall include the geometrical and physical non-linear behaviour, if any, together with the spring characteristics (for the displacement directions given in 4.1.1.5 of ETAG N° 032, Part 1, of the Mat Expansion Joints. The material characteristics shall be based on standards, where available, or testing.

5.1.1.3.3 Testing

Verification of resistance to fatigue due to loads on the joint according to 4.1.1.3.1.2 is carried out by means of full scale testing according to Annex 5.O.

Depending on the type of mat expansion joint and its mechanical properties, the testing method given in 5.1 or 5.2 of Annex 5.O shall be selected by the testing body in agreement with the Approval Body, based on justifiable reasons.

Verification of resistance to fatigue caused by bridge movements due to traffic on the bridge but without loads on the joint itself according to 4.1.1.3.1.1 is given in Annex 5.N.

5.1.1.4 Seismic behaviour

See Part 1 of this ETAG N° 032.

Note: For verification the following aspects may be of relevance:

- Description of the behaviour of the different approaches according to ETAG N° 032, Part 1, 4.1.1.4 (Excessive deformations),
- Changing of stiffness of reaction forces due to the velocity of imposed deformations (sensitivity of compounds to dynamic loads).

5.1.1.5 Movement capacity

For the nominal movement capacity under unloaded conditions see ETAG N° 032, Part 1.

For demonstration of the movement capacity for SLS and ULS conditions according to 5.1.1.5 in Part 1, for Mat Expansion Joints the verification method Annex 5.M applies.

5.1.1.6 Cleanability

See Part 1 of this ETAG N° 032.

5.1.1.7 Resistance to wear

For verification due to traffic loads on the expansion joint, Annex 5.O shall be used.

For verification due to bridge movement without traffic loads on the expansion joints, Annex 5.N shall be used.

In case of elastomer, for further identification purposes the abrasion shall be determined according to ISO 4649 (method B) with the precisions stated below. For other materials for identification purposes concerned standardized verification methods (preference is given to European standards) shall be used.

Precisions to ISO 4649:

Amendment to Clause 6.1 Type and preparation

The test pieces shall be prepared at the same time as the manufacture of the product in specific devices in the same mould used for the manufacture of the element of the expansion joint.

If possible test pieces may be taken from the product. Where the required thickness for the test is not reached, use the possibility proposed at the end of the 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 $23\text{ °C} \pm 3\text{ °C}$.

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 follow:

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”.

5.1.1.8 Watertightness

See Part 1 of this ETAG N° 032.

For the test method according to L 5.3 of Annex L in Part 1 in ETAG N° 032, the worst condition of opening is defined by the minimum contact pressure, in relation to this requirement, between the mat joint and the adjacent part and the conditions of any butt joint if part of the kit.

If a gutter forms part of the kit in order to ensure watertightness, Annex L of ETAG N° 032 does not apply. In this case, the durability of the gutter and its discharge capacity are considered to be the crucial aspects and have to be verified. For durability aspects, the concerned requirements and verification methods, given in 4.2 and 5.2 apply.

With reference to Annex H in ETAG N° 032, Part 1, for Mat Expansion Joints only one (1) test is necessary to cover the concerned range of products.

Mat expansion joints (including butt joint, if part of the design) shall be tested using a specimen already submitted to a fatigue test.

Note: For inclusion of verification of watertightness of the connection between the expansion joint and waterproofing of the main structure see ETAG N° 032, Part 1.

5.1.2 Safety in case of fire

According to Part 1 of this ETAG N° 032: not relevant.

5.1.3 Hygiene, health and environment

See Part 1 of this ETAG N° 032.

5.1.4 Safety in use

5.1.4.1 Ability to bridge gaps and levels in the running surface

5.1.4.1.1 Allowable surface gaps and voids

See Part 1 of this ETAG N° 032.

5.1.4.1.2 Level differences in the running surface

Verification under unloaded conditions: see ETAG N° 032, Part 1.

Verification under deformed conditions (maximum contraction and/or maximum elongation) shall be carried out by measuring during the execution of movement test according to Annex K of Part 1. In addition to the expression of test results according to K.8 of Annex K in Part 1 of this ETAG N° 032 the following results have to be recorded:

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

Verification for the loaded conditions shall be carried out using Annex 5.M. The vertical displacement of a twin axle wheel may be considered as the vertical deflection of the running surface according to 4.1.4.1.2.

5.1.4.2 Skid resistance

See Part 1 of this ETAG N° 032.

5.1.4.3 Drainage capacity

See Part 1 of this ETAG N° 032.

Where relevant due to the design of the mat expansion joint, verification is covered by the verification method according to 5.1.1.8.

5.1.5 Protection against noise

According to Part 1 of this ETAG N° 032: not relevant.

5.1.6 Energy economy and heat retention

According to Part 1 of this ETAG N° 032: not relevant.

5.1.7 Aspects of durability, serviceability and identification of the products

See Part 1 of this ETAG N° 032.

5.1.7.1 Aspects of durability

See Part 1 of this ETAG N° 032.

5.1.7.1.1 Corrosion

For resistance to corrosion, see Part 1 of this ETAG N° 032.

For metallic surfaces of components made out of steel and protected by painting, the climatic classification in accordance with EN ISO 12944-2 with respect to the intended use of the product shall be taken into account.

5.1.7.1.2 Chemicals

Verifications shall be carried out according to 5.2 of this ETAG Part.

For the verification of the resistance to oil, petrol or fuel oil for materials, not listed in the related chapter in 4.1.7.1.2 of this ETAG Part, verification shall be carried out according to ETAG N° 032, Part 1, 5.1.7.1.2.

5.1.7.1.3 Ageing resulting from UV radiation, temperature and ozone

Verifications shall be carried out according to 5.2 of this ETAG Part, taking into account the precisions in this clause for this product family.

5.1.7.1.4 Resistance against freeze-thaw

Not relevant.

5.1.7.2 Aspects of serviceability

See Part 1 of this ETAG N° 032.

With respect to the operating temperature conditions according to 2.3.2 for execution of the brittleness test (ISO 812), the temperatures according to 4.2 apply.

5.1.7.3 Aspects of identification

See Part 1 of this ETAG N° 032.

5.2 COMPONENTS

See Part 1 of this ETAG N° 032.

The manufacturer shall present a list of components with test methods and/or standards.

Table 5.2 below gives assessment methods which shall be used where they are applicable. Where the methods do not apply or do not assess the correct characteristics for that component/material, alternative assessment methods, based in preference on European or ISO standards, shall be used by agreement between the ETA applicant and the Approval Body. Details shall be given in the Evaluation Report.

Table 5.2: Assessment methods for components

Parts of the kit	Components of the parts	Material	Requirement/performance characteristic	Verification method/conditions	
Mat			Density	ISO 2781 Technical corrections 1 (1996)	
			Hardness IRHD	ISO 48, ISO 7619-2	
			Tensile strength	ISO 37	
			Elongation at break	ISO 37	
			Tear resistance	ISO 34-1 (2004) Method A	
			Compression set	ISO 815 (type B test piece) 24 hours 70 °C Constant deflection 25 %	
			Resistance to ageing	ISO 48, ISO 37, ISO 188 (7 days in hot air 70 °C)	
			Resistance to de-icing agents	ISO 1817, 14 days 23°C, 4% sodium-chloride solution or equivalent	
	Mat	Elastomer	Resistance to ozone	ISO 1431-1, Test procedure A (static strain testing), strip specimens with an elongation of 20 %, 72 h, test temperature 40 °C (± 2 °C) Ozone concentration: 50 (+ 5) ppm	
			Resistance to hot bitumen (for contact surface to the adjacent pavement)	In analogy to ISO 1817 30 min 220 °C in bitumen 85/25	
			Low brittleness temperature	ISO 812 (2006)/Method B a) at brittleness temperature of -25 °C for operating temperature down to -20 °C according to ETAG N° 032, Part 1, 2.3.2 b) at brittleness temperature of -40 °C for operating temperature down to -30 °C according to ETAG N° 032, Part 1, 2.3.2 c) at brittleness temperature of -55 °C for operating temperature down to -40 °C according to ETAG N° 032, Part 1, 2.3.2	
				Thermo gravimetric analysis (TGA)	ISO 9924-1,-2; ASTM D 6370, EN ISO 11358
				Rheometric characteristics	ISO 3417 ISO 6502
		Reinforcement	Steel Stainless steel	- Geometry - Yield point - Tensile strength resistance	EN 10025 EN 10088
		Inserts	Metal	- Tensile strength - Elongation at rupture - Chemical composition (C-eq.)	Relevant specification

Table 5.2 (continued)

Parts of the kit	Components of the parts	Material	Requirement/performance characteristic	Verification method/conditions
Support structure (when part of the kit)	Plates, profiles, steel beam grid	Steel	- Geometry - Yield point - Tensile strength - Elongation at rupture - Chemical composition (C-eq.)	EN 10025, EN 10088
	Reinforcement bars/loops	Steel	- Geometry - Yield strength - Tensile strength - Ductility - Weldability - Bendability - Bond property	EN 10080
	Dowels	Steel	EN ISO 13918	EN ISO 13918
	Bearing and sliding element	Plastics	- Density	ISO 1183-1
			- Hardness IRHD	ISO 2039-1
			- Tensile strength	ISO 527-1
			- Compression set	ISO 815
- Resistance to low temperatures	ISO 812			
Bearing elements	Stainless steel	Chemical composition	EN 10088	
Anchorage devices	Bolts, screws, nuts, washers (for dynamically loaded connections)	Steel + resin mortar	Geometry Grade or quality class (according to the type of component) Tensile strength Yield strength	According to the relevant standard in the list given EN 1993-1-8 (2005), 1.2.4 group 4
	Threaded rod with nuts and washers including resin	Steel (rod) + resin mortar	Relevant load bearing capacity	Relevant specification
	Bonded anchor	Steel (anchor) + resin mortar	Relevant load bearing capacity	Relevant specification
	Stud bolts	Steel	Relevant load bearing capacity	Relevant specification
Connecting devices	Bolts, screws, nuts, washer, profiles	Metal	Energy absorption	Charpy test
	Bonding agents/sealants, sockets	Chemicals /Metal	Resistance to low temperatures (chemicals) Tensile strength resistance (metal)	
Kerb elements	Plate, welded attachments (like covers)	Metal	See "Covers"	
	Special mat elements	Remark: see "Mat"		

Table 5.2 (continued)

Parts of the kit	Components of the parts	Material	Requirement/performance characteristic	Verification method/conditions
Drainage devices	Gutter including their connections and its butt joints	Elastomer (reinforced), (reinforced) plastics (e.g. Polyamide, PVC, Polyethylene), etc.	Depending on the concept of the drainage device the following performance characteristics may have to be considered: <ul style="list-style-type: none"> - Resistance to de-icing agents - Connecting ability to membranes and de-watering systems etc. - Bonding - Tear resistance - Resistance to ozone - Limit temperature of brittleness Note: The list is not considered as exhaustive.	Relevant technical specification with respect to the concerned performance characteristics
		Metal (steel, stainless steel)	Resistance to corrosion	EN ISO 12944 EN 10088 (stainless steel)
			Resistance to de-icing agents	Remark: Covered by verification of resistance to corrosion
	Fixing elements	Metal	See "Connecting devices"	
Connectors to the watertight membrane	According to the relevant specification			
Covers; Sliding plates, Bridging plates	Plates	Steel	- Geometry	EN 10025 EN 10088
		Stainless steel	- Yield point - Tensile strength - Elongation at rupture - Chemical composition (C-eq.)	
	Aluminium (covers): Plate material: Grade 5xxx Extruded material: Grade 6xxx excluded: grades given in EN 1999-1-3, Cl .3 (2007)	- Geometry - Chemical composition - Tensile strength - Yield point - Stress-strain - Elongation at rupture - Ductility - Charpy-V value	Extruded aluminium: EN 755-2	
Cast material: Grade xxx	Note: selection depending on chosen materials	Cast aluminium: EN 1706		

6 ASSESSING AND JUDGING THE FITNESS OF PRODUCTS FOR AN INTENDED USE

This chapter details the performance requirements to be met (Chapter 4) in precise and measurable (as far as possible and proportional to the importance of the risk) or qualitative terms, related to the product and its intended use, using the outcome of the verification methods (Chapter 5).

6.0 TABLE LINKING THE ESSENTIAL REQUIREMENTS TO PRODUCT REQUIREMENTS

ER	Characteristics specified in the mandate	ETAG paragraph on product performance to be assessed	Class, use category, criterion		No performance determined option
1	Mechanical resistance	6.1.1.2	Carriageway	Pass/fail	No
			and/or Footpath	Pass/fail	No
			and/or options: - Accidental load on footway - Collision on kerb	Pass/fail	No
				Pass/fail	No
	Resistance to fatigue	6.1.1.3	Caused by traffic loads on the expansion joint	Pass/fail	No
			Caused by bridge movements under traffic (without consideration of traffic loads on the joint)	Pass/fail	Yes
	Seismic behaviour	6.1.1.4	Declaration of selected approach and relevant information (aspects, etc.)		Yes
	Movement capacity	6.1.1.5	Declared value		No
	Cleanability	6.1.1.6	Pass/fail		Yes
Resistance to wear	6.1.1.7	Pass/fail	Declaration of value of abrasion	No	
Watertightness	6.1.1.8	Pass/fail		Yes	
2	Not relevant				
3	Release of dangerous substances	6.1.3	Indication of dangerous substances incl. concentration, etc. Or : "No dangerous substances"		Yes
4	Allowable surface gaps and voids	6.1.4.1.1	Gap		
			For vehicle	Pass/fail	Yes
			Gap for use in longitudinal axis	Pass/fail	Yes
			Gap/recess		
			- For cyclist - For pedestrian	Pass/fail Pass/fail	Yes Yes
	Level differences in the running surface	6.1.4.1.2	Level differences and steps in unloaded conditions	Pass/fail	Yes
			Level differences and steps under deformed conditions	Pass/fail	Yes
Level differences and steps under loaded conditions					

ER	Characteristics specified in the mandate	ETAG paragraph on product performance to be assessed	Class, use category, criterion		No performance determined option
4	Skid resistance	6.1.4.2	On carriageway	Declared value if relevant	Yes
			On footpath	Declared value if relevant	Yes
	Drainage capacity	6.1.4.3	Declared capacity if drainage system is present		Yes
5	Not relevant				
6	Not relevant				
7	Durability of the characteristics against: Corrosion, ageing, chemicals, temperature, UV-radiation, freeze-thaw, ozone	6.1.7.1	Corrosion	Pass/fail (considering the working life category)	No
			Chemicals	See 6.2	No
			Ageing resulting from:		No
			- temperature		No
			- UV radiation		No
			- ozone		No
Other aspects	See 6.2.	No			

6.1 KITS

6.1.1 Mechanical resistance and stability

6.1.1.1 General

6.1.1.2 Mechanical resistance

The product will be judged as fit for purpose, for the designated use categories given in 2.2.1, provided that it satisfies the performance requirements in 4.1.1.2 by the verification procedure as described in 5.1.1.2.

6.1.1.3 Resistance to fatigue

Resistance to fatigue caused by traffic loads: The product will be judged as fit for purpose provided that it satisfies the performance requirements in 4.1.1.3.1.2 by means of passing the verification procedure as described in 5.1.1.3.2 in relationship with Annex 5.O.

Resistance to fatigue caused by bridge movements under traffic (without consideration of traffic loads on the joint): The product will be judged as fit for purpose provided that it satisfies the performance requirements in 4.1.1.3.1.1 by means of passing the verification procedure as described in 5.1.1.3.2 in relationship with Annex 5.N.

6.1.1.4 Seismic behaviour

The selected approach in accordance with 4.1.1.4, and the relevant indications as in Table 4.1.1.4 of Part 1, shall be declared and stated in the ETA. The verification shall be in accordance with 5.1.1.4.

6.1.1.5 Movement capacity

The results of the verification according to the verification method given in 5.1.1.5 shall be stated in the ETA for the concerned directions by means of declared values. The reaction forces shall be stated in the ETA. The minimum opening shall be stated in the ETA.

6.1.1.6 Cleanability

Assessment shall be undertaken only on the basis of analysis of the design. The product will be judged as fit for use provided that the geometry of the expansion joint demonstrates ability to extrude debris by movement, using the verification procedure as described in 5.1.1.6, or good accessibility for maintenance is provided.

6.1.1.7 Resistance to wear

The product will be judged as fit for purpose provided that it satisfies the mechanical resistance requirement according to 4.1.1.7.

In addition, the value for abrasion, expressed in mm³ (according to ISO 4649, including precisions given in 5.1.1.7 of this ETAG Part) shall be declared in the ETA. The verification method used (method B) shall be reported in the ETA. For TGA according to 5.2 in conjunction with 5.1.1.7 the results, expressed by means of a graph, shall be stated in the ETA.

6.1.1.8 Watertightness

The assessment of whether the assembled kit remains watertight, shall be undertaken according to the verification method given in 5.1.1.8.

If watertightness is achieved by a sub-surface drainage system this shall be addressed, including assessment of passage of water and durability of the material of the drainage system.

For the subsurface drainage system, see 6.1.4.3.

If the Expansion Joint includes a connection between the joint and the waterproofing of the main structure, this connection shall be assessed with a pass/fail criterion.

6.1.2 Safety in case of fire

According to Part 1 of this ETAG N° 032: Not relevant.

6.1.3 Hygiene, health and environment (ER 3)

6.1.3.1 Release of dangerous substances

The expansion joint shall comply with all relevant European and national provisions applicable for the uses for which it is brought to the market. The attention of the applicant shall be drawn on the fact that for other uses or other Member States of destination there may be other requirements which would have to be respected. For dangerous substances contained in the expansion joint, the NPD option (no performance determined) is applicable.

The expansion joint and/or constituents of the expansion joint listed in the EOTA TR 034: "General Checklist for ETAGs/CUAPs/ETAs -Content and/or release of dangerous substances in products/kits", which have to be considered will be verified by the given methods taking into account the installation conditions of the construction product and the release scenarios resulting from there. Regulations related to placing the product on the market may also need to be taken into account.

Regarding the release scenarios referred to in the EOTA TR 034, the use category S/W2 (Product with no direct contact to but possible impact on soil, ground and surface water have to be considered).

6.1.4 Safety in use

6.1.4.1 Ability to bridge gaps and levels in the running surface

6.1.4.1.1 Allowable surface gaps and voids

The expansion joint will be judged as fit for purpose provided that it satisfies the performance requirements in 4.1.4.1.1 by means of passing the verification procedure as described in 5.1.4.1.1.

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

6.1.4.1.2 Level differences in the running surface

Assessment for the unloaded condition and without any imposed horizontal deformation 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.

For deformed condition by maximum contraction and/or maximum elongation the maximum dimension of steps and the difference of the running surface levels according to the verification, given in 5.1.4.1.2, shall be stated in the ETA.

For the un-deformed condition (no contraction and/or elongation), loaded by traffic loads, the maximum dimension of steps and the difference of the running surface levels according to the verification, given in 5.1.4.1.2, shall be stated in the ETA. The dimensions of the steps and differences in the running surfaces shall be derived for 70 % of the SLS-level, considering the difference between static and dynamic stiffness of the materials, if any.

6.1.4.2 Skid resistance

Assessment shall be undertaken on the basis of analysis of the design. If required, the PTV according to the verification method given in 5.1.4.2 shall be stated in the ETA.

6.1.4.3 Drainage capacity

If relevant, assessment shall be undertaken on the basis of analysis of the design according to 5.1.4.3.

6.1.5 Protection against noise

According to Part 1 of this ETAG: not relevant.

6.1.6 Energy economy and heat retention

According to Part 1 of this ETAG: not relevant.

6.1.7 Aspects of durability, serviceability and identification of the products

6.1.7.1 Aspects of durability

6.1.7.1.1 Corrosion

Assessment shall be undertaken on the basis of analysis of the Technical File according to 5.1.7.1.1.

6.1.7.1.2 Chemicals

Assessment shall be undertaken on the basis of 5.1.7.1.2 in conjunction with 6.2.

6.1.7.1.3 Ageing resulting from temperature, UV radiation and ozone

Assessment shall be undertaken on the basis of 5.1.7.1.2 in conjunction with 6.2.

6.1.7.1.4 Resistance against freeze-thaw

Not relevant for this family product.

6.1.7.2 Aspects of serviceability

The assessment shall be undertaken according to the verification method given in 5.1.7.2.

6.1.7.3 Aspects of identification of the product

The assessment shall be undertaken according to the 5.1.7.3.

6.2 COMPONENTS

The Approval Body shall assess the possible effects on the performance of the expansion joint due to the variability of the elements and materials characteristics and, where applicable, declared tolerances.

Table 6.2 below presents assessment criteria for materials for the components, defined in 4.2. For component materials not covered in the table below, appropriate assessment criteria shall be used. The Approval Body shall assess the fitness for purpose of the components based on the manufacturer's stated values.

Related tolerances shall be declared by the manufacturer and shall be assessed by the Approval Body in respect to possible effects on the performance of the product/kit.

Table 6.2: Assessment criteria for materials in components

Parts of the kit	Components of the parts	Material	Requirement/performance characteristic	Assessment criteria
Mat	Mat	Elastomer	Density	MDV
			Hardness IRHD	MDV
			Tensile strength	MDV
			Elongation at break	MDV
			Tear resistance	MDV
			Compression set	Pass/fail: 30 %
			Resistance to ageing	Pass/fail : Maximum change from un-aged value - IRHD : 0 to 7 - tensile strength : 0 to 15 % - elongation at break : 0 to 25 %
			Resistance to de-icing agents	Pass/fail : - Decrease of hardness ≤ 5 - Increase of volume ≤ 10 %
			Resistance to ozone	Pass/fail: No visible cracks
			Resistance to hot bitumen	Pass/fail: - Decrease of tear resistance ≤ 20 % - Decrease of elongation at tear ≤ 20 %
	Low brittleness temperature	Pass/fail: Requirements according to ISO 812 (2006), 7.1.1.4		
	Thermo gravimetric analysis (TGA)	MDV		
	Rheometric characteristics	MDV		
Reinforcement	Steel Stainless steel Metal	Geometry	MDV	
		Yield point		
		Tensile strength		
		Elongation at rupture		
Inserts	Metal	Chemical composition (C-eq.)	MDV	
		Tensile strength		
Support structure (when part of the kit)	Plates, profiles, steel beam grid	Steel	- Geometry - Yield point - Tensile strength - Elongation at rupture - Chemical composition (C-eq.)	EN 10025, EN 10088
	Reinforcement bars/loops	Steel	- Geometry - Yield strength - Tensile strength - Ductility - Weldability - Bendability - Bond property	EN 10080
	Dowels	Steel	EN ISO 13918	MDV
	Bearing and sliding element	Plastics	- Density - Hardness IRHD - Tensile strength - Compression set - Resistance to low temperatures	MDV
	Bearing elements	Stainless steel	Chemical composition	EN 10088
	Anchorage devices	Bolts, screws, nuts, washers	Steel	Geometry Grade or quality class (according to the type of component) Tensile strength Yield strength
Threaded rod with nuts and washers including resin mortar		Steel (rod) + resin mortar	Relevant load bearing capacity	
Bonded anchors			Relevant load bearing capacity	
Stud bolts		Steel	Relevant load bearing capacity	MDV

Table 6.2 (continued)

Connecting devices	Bolts, screws, nuts, washer, profiles	Metal	See "Anchorage devices"	
	Bonding agents/sealants, sockets	Chemicals/ Metal	- To be covered by full scale tests (including butt joints), - Bonding agents manufacturers' specifications to be taken into account	MDV
Kerb elements	Plate, welded attachments (like covers)	Metal	Remark: See "Covers"	
	Special mat elements	Remark: See "Mat"		
Drainage devices	Gutter including its connections and its butt joints	Elastomer (reinforced) (reinforced) plastics (e.g. Polyamide, PVC, Polyethylene), etc.	Depending on the concept of the drainage device the following performance characteristics may have to be considered: - Resistance to de-icing agents - Connecting ability to membranes and de-watering systems etc. - Bonding - Tear resistance - Resistance to ozone - Limit temperature of brittleness	MDV or pass/fail according to the relevant standard
		Metal (steel, stainless steel)	- Resistance to corrosion - Resistance to de-icing agents (Remark: Covered by resistance to corrosion)	
	Fixing elements	Metal	See "Connecting devices"	
Connectors to the watertight membrane	According to the relevant specification			
Covers; Sliding plates, Bridging plates	Plates	Steel	- Geometry - Yield point - Tensile strength - Elongation at rupture - Chemical composition (C-eq.)	MDV
		Stainless steel		
		Aluminium (covers)	- Geometry - Chemical composition - Tensile strength - Yield point - Stress-strain	
		Cast aluminium: according to EN 1706	- Elongation at rupture - Ductility - Charpy-V value	
		<i>Note: Selection depending on chosen materials</i>		

MDV = Manufacturer's declared value.

In general for all metal components susceptible to corrosion, the corrosion protection shall be assessed using MDV or pass/fail criterion, where applicable.

7. ASSUMPTIONS AND RECOMMENDATIONS UNDER WHICH THE FITNESS FOR USE OF THE PRODUCTS IS ASSESSED

See Part 1 of this ETAG N° 032.

7.0 GENERAL

See Part 1 of this ETAG N° 032.

7.1 DESIGN OF WORKS

See Part 1 of this ETAG N° 032.

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 defined in the installation manual.

7.2 PACKAGING, TRANSPORT AND STORAGE

See Part 1 of this ETAG N° 032.

7.3 EXECUTION OF WORKS

See Part 1 of this ETAG N° 032.

7.4 MAINTENANCE AND REPAIR

See Part 1 of this ETAG N° 032.

Section three: ATTESTATION OF CONFORMITY (AC)

8. ATTESTATION AND EVALUATION OF CONFORMITY

8.1 EC DECISION

See Part 1 of this ETAG N° 032.

8.2 RESPONSIBILITIES

See Part 1 of this ETAG N° 032.

8.2.1 Tasks for the manufacturer

See Part 1 of this ETAG N° 032.

8.2.1.1.2 Control of incoming products and materials

Characteristics and suitable tests for incoming materials/products are given in Table 8.1.

Table 8.1 below presents procedures for commonly used materials for the components (see also 4.2, 5.2 and 6.2 in this family Part). For component materials not covered in the table below, equivalent procedures shall apply.

Table 8.1: Factory Production Control – Control for incoming materials/products

Material	Characteristics (1)	FPC	Frequency
Elastomer (for the component mat)	- Density - Hardness IRHD - Tensile strength - Elongation at break - Rheometric characteristics	Y	Each batch (1) or certificate according to EN 10204 (2004), type 3.1
	- Hardness IRHD - Tensile strength - Elongation at break - Resistance to ageing - Abrasion	Y	Each lot (sequence of batches with identical composition) or certificate according to EN 10204 (2004), type 3.1
Elastomer, plastics (for the component drainage devices)	Relevant performance characteristics according to the individual concept	Y	Certificate according to EN 10204 (2004), type 2.1 at each batch
Steel, stainless steel (for the component drainage devices)	- Resistance to corrosion - Resistance to de-icing agents (Remark: Covered by resistance to corrosion)	Y, where relevant (see also Table 8.2)	Certificate according to EN 10204 (2004), Type 3.1, at each delivery
(Stainless) Steel (reinforcement for mats, cover plates; components for support structure)	- Geometry - Yield point - Tensile strength - Elongation at rupture - Chemical composition (C-eq.)	Y	Certificate according to EN 10204 (2004), Type 3.1, at each delivery
Metal (inserts)	- Tensile strength - Elongation at rupture	Y	Certificate according to EN 10204 (2004), Type 3.1, at each delivery
Steel (reinforcement bars/loops for support structure)	- Geometry - Yield strength - Tensile strength - Ductility - Weldability - Bendability - Bond property	Y	Certificate according to EN 10204 (2004), Type 3.1, at each delivery

Table 8.1 (continued)

Material	Characteristics (1)	FPC	Frequency
Steel (dowels)	EN ISO 13918	Y	Certificate according to EN 10204 (2004), type 3.1 at each delivery
Plastics (bearing and sliding element)	Density Hardness IRHD Tensile strength	Y	Each delivery or certificate according to EN 10204 (2004), type 3.1
Stainless steel (bearing elements for support structure)	Chemical composition	Y	Certificate according to EN 10204 (2004), Type 3.1, at each delivery
Steel (bolts nuts, washers for dynamically loaded connections of the anchorage system)	Relevant load bearing capacity	Y	Delivery note with indication of material grade and standard at each delivery
Steel (bolts, nuts, washers for general purposes of the anchorage system)	Relevant load bearing capacity	Y	Delivery note with indication of material grade and standard at each delivery
Steel + resin mortar/grout (threaded rod)	Equivalent to those for bolts	Y	Delivery note with indication of material grade and standard at each delivery
Steel + resin mortar/grout (anchor)	Equivalent to those for bolts	Y	Delivery note with indication of material grade and specification at each delivery

(1) "Each batch respectively certificate ..." means: Either tested for each batch or verified by certificate according to EN 10204 (2004), type 3.1.

8.2.1.1.3 Inspection and testing during production

See Part 1 of this ETAG N° 032.

Table 8.2: Factory Production Control during and at the end of the production process

Part	Aspect	Procedure	Frequency	Remarks
Mat elements				
Reinforcement, inserts	Surface characteristics	Internal procedure	Random sampling	
Elastomer materials	-	-	-	See Table 8.1
Vulcanizing	Pressure time; temperature	Internal procedure	Each element	
Manufacturing of each mat element	Dimensions, cover thickness	Internal procedure	Each element	Conformity to the design drawings
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 certifications	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 design drawings

Components with certificates according to EN 10204 (2004), types 3.1 and 2.1 respectively, do not need separate consideration.

8.2.1.2 Testing of samples taken at the factory – Prescribed test plan

See Part 1 of this ETAG N° 032.

Table 8.3: Factory Production Control – Testing of samples taken at the factory

Part	Aspect	Procedure	Frequency	Remarks
Mat elements				
Manufacturing of mat element	Bonding quality	Internal procedure	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	

8.2.2 Tasks of the Approved Body

See Part 1 of this ETAG N° 032.

8.2.2.1 General

See Part 1 of this ETAG N° 032.

Tasks and test frequency to be covered in the agreed test plan are given in Tables 8.1, 8.2 and 8.3.

8.2.2.2 Initial Type Testing

See Part 1 of this ETAG N° 032.

Type testing according to Table 8.4 below includes all kind of verifications (e.g. testing, calculation or deemed to satisfy provisions).

Prior to approval testing of the expansion joint kit the manufacturer shall assess the suitability of the materials for the components listed below. Once suitability has been assessed, components can be checked either using a suppliers certificate (for type of certificate see remark in Table 8.4) or by individual testing.

Table 8.4: Type testing for materials and related components

Material	Characteristics (1)	Initial Type Testing	Remark
Elastomer (for the component mat)	<ul style="list-style-type: none"> - Density - Hardness IRHD - Tensile strength - Elongation at break - Tear resistance - Compression set - Resistance to ageing - Abrasion - Resistance to de-icing agents - Resistance to ozone - Resistance to hot bitumen - Brittleness temperature - Thermo gravimetric analysis (TGA) Rheometric characteristics 	Y	Certificate according to EN 10204 (2004), type 3.1
Elastomer, plastics (for the component drainage devices)	Selection of relevant performance characteristics in accordance with Table 4.2	Y	Certificate according to EN 10204 (2004), type 2.1
(Stainless) Steel (Reinforcement for mats, cover plates)	<ul style="list-style-type: none"> - Geometry - Yield point - Tensile strength - Elongation at rupture - Chemical composition (C-eq.) 	Y	Certificate according to EN 10204 (2004), Type 3.1
Metal (inserts)	<ul style="list-style-type: none"> - Tensile strength - Elongation at rupture 	Y Y	Certificate according to EN 10204 (2004), Type 3.1
(stainless) Steel (components for support structure)	<ul style="list-style-type: none"> - Geometry - Yield point - Tensile strength - Elongation at rupture - Chemical composition (C-eq.) 	Y	Certificate according to EN 10204 (2004), Type 3.1
Steel (reinforcement bars/loops for support structure)	<ul style="list-style-type: none"> - Geometry - Yield strength - Tensile strength - Ductility - Weldability - Bendability - Bond property 	Y	Certificate according to EN 10204 (2004), Type 3.1
Steel (dowels)	EN ISO 13918	Y	Certificate according to EN 10204 (2004), type 3.1
Plastics (bearing and sliding element)	<ul style="list-style-type: none"> - Density - Hardness IRHD - Tensile strength - Compression set - Resistance to low temperatures 	Y	Certificate according to EN 10204 (2004), type 3.1
Stainless steel (bearing elements for support structure)	Chemical composition		Certificate according to EN 10204 (2004), Type 3.1
Steel (bolts nuts, washers)	Relevant load bearing capacity	Y	Certificate according to EN 10204 (2004), type 3.1 (for dynamically loaded purposes) and type 2.1 (for other purposes)
Steel + resin mortar/ grout (threaded rod)	Equivalent to those for bolts	Y	
Steel + resin mortar/ grout (anchor)	Equivalent to those for bolts	Y	

8.3 DOCUMENTATION

See Part 1 of this ETAG N° 032.

(4) Test plan (as part of FPC)

See Part 1 of this ETAG N° 032.

Frequencies of routine tests are given in Tables 8.1, 8.2 and 8.3.

(5) Prescribed test plan

The cornerstones for the test plan are given in Tables 8.1, 8.2 and 8.3.

8.4 CE MARKING AND INFORMATION

See Part 1 of this ETAG N° 032.

Section four: ETA CONTENT

9. THE ETA CONTENT

See Part 1 of this ETAG N° 032.

ANNEXES TO THIS ETAG FAMILY PART

Annexes 5-A to 5-L: for this family Part correspond to Annexes A – L in Part 1 of this ETAG N° 032, if applicable

Annex 5.M: MECHANICAL RESISTANCE TEST METHOD FOR MAT EXPANSION JOINTS

5.M.1. SCOPE

This annex describes the method for verifying the mechanical resistance of Mat Expansion Joints in one testing procedure.

5.M.2. PRINCIPLES

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 shall include the anchorage. Samples covering the most relevant types (type according to this ETAG N° 032, Annex H) of the range of products shall be tested for verification. In principle, one sample has to be tested. In case of unknown designs, more than one sample may be needed. This has to be agreed between the manufacturer, the Approval Body and the testing body based on the principles given in EN 1990.

5.M.3. SAMPLES AND PREPARATION OF TEST SPECIMENS

The test specimen pieces 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 design.

Without further analysis, 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.

If the load transfer of the joint is affected by wear in the sliding surfaces, caused by direct traffic loads, and ageing, the mechanical resistance test shall be carried out on an artificially aged specimen with worn out sliding surfaces. The manufacturer shall state what he considers to be a worn out piece.

5.M.4. LOAD ARRANGEMENTS

5.M.4.1 Arrangement of the loads

The load arrangement shall be derived from Annex G, Table G2 of ETAG N° 032, Part 1.

5.M.4.2 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 Annex G, G 4.2 and G 4.3 of ETAG N° 032, Part 1.

5.M.4.3 Test load

The vertical test load for verification 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 Annex G in Part 1: 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 Annex G, G.2.2.1) and the horizontal load perpendicular to the traffic direction (transverse direction) is 0,2 (according to Annex G, G.2.2.2) 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 Annex G, Table G.5, 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 Annex G: 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 Annex G, Table G.5, apply.

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

Explanation: *The joint shall at least fulfil the mechanical strength at the design load level (= 1,35 – according to EN 1990 (2002/A1), Annex A2 of EN 1990, Table A2.4 (B) Design values of actions – times the characteristic loads given in Table 1 of Annex G).*

5.M.5. 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.

5.M.6. EXECUTION OF THE TEST

According to Annex 5.M.4.2, the test shall be run at two opening positions:

For the verification 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 5.M.4.3. In another test procedure 70 % load level shall be combined with 100 % of the maximum opening position.

For the verification 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 5.M.4.3. 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 verification of characteristic combinations. The same applies for verification of fundamental combinations.

Note: For general information about alternative simplified testing procedure see Annex 5.Q.4.

5.M.6.1 Test conditions

In principle the testing temperature shall be within the range of +5 °C to +30 °C. If the materials show changes of mechanical properties in the range of temperature according to 2.3.2 in Part 1 of this ETAG N° 032, these effects shall be considered (see 5.M.7).

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.

5.M.6.2 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 verifications 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 verification 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 verification of fundamental combinations and shall be kept at this level for 30 minutes.

The following verifications 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.

5.M.7. EXPRESSION OF TEST RESULTS

At every dwell period the following phenomena shall be monitored and recorded (using figures of 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.

5.M.8. TEST REPORT

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

- Name of the manufacturer and production centre;
- Name and signature of testing body;
- Model identification (type, theoretical movement capacity, N° of batch);
- Any deviation from this annex;
- 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;
- Expression of monitored phenomena according to 5.M.7.

Annex 5.N

VERIFICATION OF WEAR OF SLIDING SURFACES AND RESISTANCE TO FATIGUE BY FULL SCALE TESTING CAUSED BY BRIDGE MOVEMENTS WITHOUT TRAFFIC LOADS

5.N.1. SCOPE

This annex describes the method for verifying the resistance to fatigue of Mat Expansion Joints in case of bridge movement with no traffic loads on the expansion joint. The test method includes the effects of the accumulation of wear of sliding surfaces.

5.N.2. PRINCIPLES

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 test shall be carried out.

5.N.3. SAMPLES AND PREPARATION OF TEST SPECIMENS

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

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.

5.N.4. LOAD AND MOVEMENT ARRANGEMENTS

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

5.N.5. TESTING 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 $\pm 5\%$ 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.

5.N.6. EXECUTION OF THE TEST

The test shall be run at ambient temperature¹⁾.

Horizontal translations:

Phase 1a: Expansion joint at closed 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.

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 at 125 % of nominal opening position; 2 500 cycles of vertical translation Δh ($\Delta h = 5$ mm).

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

1) Low and high operating temperatures according to 2.3.2 in ETAG N° 032, Part 1, are covered by the concerned material test of the elastomer. If the materials show changes of mechanical properties in the range of temperature according to 2.3.2 in ETAG N° 032, Part 1, these effects shall be considered in the evaluation of the test results.

5.N.7. 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.

5.N.8. TEST REPORT

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

- Name of the manufacturer and production centre;
- Name and signature of testing body;
- Model identification (type, theoretical movement capacity, N° of batch);
- Any deviation from this annex;
- Description of the test equipment;
- Date of the preparation of specimens, the date of test and the mean test temperature;
- Dimensions of test specimens;
- Expression of monitored phenomena according to 5.N.7.

Annex 5.O

VERIFICATION OF RESISTANCE TO FATIGUE BY FULL SCALE TESTING AND VERIFICATION OF WEAR OF SLIDING SURFACES

5.O.1. SCOPE

This annex describes the method for verifying the resistance to fatigue of Mat Expansion Joints by full scale testing. The test method includes the effects of the accumulation of wear of sliding surfaces.

5.O.2. PRINCIPLES

The principle of this test procedure is to apply a simulation of the traffic loads. These conditions are considered to represent the design situations. In principle, one sample has to be tested. In case of unknown designs more than one sample may be needed. This has to be agreed between the manufacturer, the Approval Body and the testing body based on the principles given in EN 1990.

5.O.3. SAMPLES AND PREPARATION OF TEST SPECIMENS

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

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.

5.O.4. LOAD AND MOVEMENT ARRANGEMENTS

5.O.4.1 Traffic loads and number of cycles

The test loads are to be derived from FLM1EJ and/or FML2EJ for a contact pressure of 0,8 N/mm² and 1,0 N/mm² respectively, in accordance with Annex G, G3 of ETAG N° 032, Part 1. According to this, the conditions in Table 5.O.1 apply:

Table 5.O 1: Load cycles for verification of different fatigue lives in relation to the working life categories

Mat expansion joint		Number of cycles				
		FLM 2 EJ				FLM 1 EJ
Test description		10 years	15 years	25 years	50 years	Unlimited
Contact pressure: 0,8 N/mm ²	1 st stage: vertical and horizontal loads simultaneously applied	1,7 x 10 ⁶	2,5 x 10 ⁶	4,2 x 10 ⁶	7,4 x 10 ⁶ (FLM 1 EJ applies)	7,4 x 10 ⁶
	2 nd 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 (FLM 1 EJ applies)	7,4 x 10 ⁶
Contact pressure: 1,0 N/mm ² (alternatively to 0,8 N/mm ²)	1 st 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 (FLM 1 EJ applies)	3,8 x 10 ⁶
	2 nd 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 (FLM 1 EJ applies)	3,8 x 10 ⁶

Minimum vertical test load per wheel = $A_{\min} \times 0,8 = 300 \times 250 \times 0,8 = 60 \times 10^3 \text{ N} = 60 \text{ kN}$ (for contact pressure and contact area see Annex 5.P).

Corresponding horizontal test load per wheel = $(0,2/1,3) \times 60 = 9,2 \text{ KN}$.

The partial factor $F_{f} = 1,0$.

5.O.4.2 Position of load to be applied

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

5.O.5. TESTING CONDITIONS

The test load shall be derived from 5.O.4 and distributed according to G1 and formula G1 in Part 1 of this ETAG N° 032. It shall be applied with an angle according to the vertical and horizontal load ratio given in Annex G of Part 1 in the direction of the expansion joint gap (see note in G3.3 in Part 1 of this ETAG N° 032).

The test is carried out under the following conditions:

- Test temperature:

The ambient temperature during the test shall be between +5 °C and +30 °C. These conditions cover all operating temperatures, taking in account the conditions given in 2.3.2 of this ETAG family Part.¹⁾

- Number of load cycles:

The number of load cycles is determined according to the specified categories of working life (see 2.3.4 and 5.O.4 of this family Part).

- Positioning of the sample:

The test shall be run 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 agreed.

- Frequency:

The frequency shall be equal to or greater than 0,5 Hz.

1): Low and high operating temperatures according to 2.3.2 in ETAG N° 032, Part 1, are covered by the concerned material test of the elastomer. If the materials show changes of mechanical properties in the range of temperature according to 2.3.2 in ETAG N° 032, Part 1, and not covered by the addressed tests, these effects shall be considered in the evaluation of the test results.

5.O.6. 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 $\pm 5 \%$ 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 $\pm 1 \text{ kN}$.

5.O.7. EXECUTION OF THE TEST

The test shall be run at 60 % of the maximum opening position at ambient temperature (see 5.O.5) with the number of cycles according to 5.O.4.1. 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).

5.O.8. 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.

5.O.9. TEST REPORT

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

- Name of the manufacturer and production centre;
- Name and signature of testing body;
- Model identification (type, theoretical movement capacity, N° of batch);
- Any deviation from this annex;
- 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;
- Expression of monitored phenomena according to 5.O.8.

Annex 5.P

EXAMINATION OF REQUESTED LOAD CYCLES AND REQUESTED LOADS FOR VERIFICATION OF FATIGUE RESISTANCE FOR AN ASSUMED FATIGUE LIFE OF 10, 15, 25 AND 50 YEARS¹ AND UNLIMITED FATIGUE LIFE (informative)

5.P.1, FOREWORD

The objective of this annex is to give sufficient background information on the loads and load cycles used in Annex 5.O of this Part of the ETAG in conjunction with Annex G of ETAG N° 032, Part 1, and Eurocode EN 1991-2 (2003).

Sources: Annex G of ETAG N° 032, Part 1: G.3.3 FLM 2, Table G3 + N_{obs} according to EN 1991-2 (2003), Table 4.5.

Precondition: If for Mat Expansion Joints or parts of them (e.g. reinforcements, anchorage) unlimited fatigue life is of relevance, FLM1 according to Annex G of Part 1 applies. If limited fatigue life is of relevance, FLM2 according to Annex G of Part 1 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.

5.P.2. EQUIVALENT NUMBER OF AXLE RATES FOR MAT EXPANSION JOINTS AND ANCHORAGE SYSTEMS, IF ANY

Table 5.P.1: Idealisation of axle load histogram to maximum axle loads with equivalent numbers of cycles

$Q_{1k,fat}$ Vertical axle load kN	$Q_{11k,fat}$ 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	n_{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 Annex G, Table G.4 of Part 1, including $\gamma_{fat} = 1,3$

$Q_{11k,fat}$, including $\gamma_{fat} = 1,0$

Axle number rate according to Annex G, Table G.4 of Part 1

¹ Years according to WL categories in Part 1 of the ETAG N°032.

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

10 = 10 years assumed working life acc. to category 1 in Part 1 of this ETAG N° 032 (10 years)
15 = 15 years assumed working life acc. to category 2 in Part 1 of this ETAG N° 032 (15 years)
25 = 25 years assumed working life acc. to category 3 in Part 1 of this ETAG N° 032 (25 years)
50 = 50 years assumed working life acc. to category 4 in Part 1 of this ETAG N° 032 (50 years)

Conclusion for requested load cycles for Mat Expansion Joints

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

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

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

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

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

Test load (F) for Mat Expansion Joints, based on FLMEJ 2

1. According to Annex G.3.3 in Part 1 the maximum vertical axle load (190 kN) for FLM 2 EJ is related to an axle with two dual tyres.

2. The wheel print area of 300 mm x 250 mm according to Annex G, Table G.4, in Part 1, substitutes a dual tyre print with a related load of $190/4 = 47,5$ kN.

3. The related theoretical contact pressure = $47\,500/(300 \times 250) = 0,63$ 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 verify 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: $((0,8/p_{requested})^3) \times$ load cycles.

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

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

5.P.3. TEST LOAD (F) FOR MAT EXPANSION JOINTS, BASED ON FLMEJ 1

1. According to Annex G, G.3.2 of Part 1, the maximum vertical axle load is 273 kN for FLM 1 EJ. This is related to a theoretical wheel print of 300 mm x 250 mm.

2. According to Annex G, G.3.2 of Part 1, the maximum horizontal axle load is 42 kN for FLM 1 EJ.

3. The wheel print area of 300 mm x 250 mm according to Annex G of Part 1 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 = $68\,300 / (300 \times 250) = 0,91 \text{ N/mm}^2$. In principle, this covers the contact pressure in practice. If for FLM 1 EJ the contact pressure is reduced from $0,91 \text{ N/mm}^2$, 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 to a maximum of $1,0 \text{ N/mm}^2$. In such cases, a reduction of load cycles can be calculated as follows: $((0,91/p_{\text{requested}})^3) \times \text{load cycles}$.

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

Consequence for the test load to be used: The requested vertical test load F_{TV} has to be calculated, using the internal tyre pressure ($0,91 \text{ N/mm}^2$) and a contact area not smaller than $300 \text{ mm} \times 250 \text{ mm}$.

The horizontal test load F_{Th} is calculated according to Annex G, G.3.2, of Part 1, as follows:

$$F_{Th} = (0,2/1,3) \times F_{TV}$$

5.P.4. SUMMARIZING TABLE OF CALCULATED LOAD CYCLES FOR DIFFERENT FATIGUE LIVES

For limited fatigue life the accumulated number of cycles is stated in relation to an assumed working life in years according to Part 1 of this ETAG N° 032.

For unlimited fatigue life the contact pressure and number of cycles is stated in relation to Annex G, Part 1, and EN 1991-2 (2003).

Table 5.P.2: Calculated load cycles

Item		FLM 2 EJ				FLM 1 EJ
		10 years	15 years	25 years	50 years	Unlimited
Mat expansion joints including anchorage system (Contact pressure: $0,8 \text{ N/mm}^2$)	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: $0,91 \text{ N/mm}^2$)	n_{v+h}			-	-	5×10^6
Remarks					Number of cycles exceeds those for FLM 1 EJ (unlimited fatigue life) >> FLM 1 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 (daf),
4. $n = 5 \times 10^6$ according to EN 1991-2 (2003) for constant amplitude fatigue limit σ ,
5. $V = \text{Vertical axle load}$, $H = \text{Horizontal axle load}$.

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 (2003): 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.

5.P.5. NUMBER OF LOAD CYCLES FOR DIFFERENT FATIGUE LIVES

Table 5.P.3: Load cycles for verification of different fatigue lives in relation to the working life categories

Mat expansion joints (including anchorage system)		Number of cycles				
		FLM 2 EJ				FLM 1 EJ
Test description		10 years	15 years	25 years	50 years	Unlimited
Contact pressure: 0.8 N/mm ²	1 st stage: vertical and horizontal loads simultaneously applied	1,7 x 10 ⁶	2,5 x 10 ⁶	4,2 x 10 ⁶	FLM 1 EJ applies	7,4 x 10 ⁶
	2 nd stage: vertical loads only applied	1,1 x 10 ⁶	1,7 x 10 ⁶	2,9 x 10 ⁶	--	--
	Envelope approach: 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 (FLM 1 EJ applies)	7,4 x 10 ⁶
Contact pressure: 1.0 N/mm ² (alternatively to 0,8 N/mm ²)	1 st 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 (FLM 1 EJ applies)	3,8 x 10 ⁶
	2 nd stage: vertical loads only applied	0,57 x 10 ⁶	0,87 x 10 ⁶	1,5 x 10 ⁶	--	--
	Envelope approach: 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 (FLM 1 EJ applies)	3,8 x 10 ⁶

Annex 5.Q

EXPLANATIONS FOR THE DESIGN SITUATIONS FOR SLS AND ULS, USED IN THE MAT EJ MECHANICAL RESISTANCE TEST METHOD

(informative)

The objective of this annex is to give sufficient background information on the selected design situations in Annex 5.M in conjunction with Annex G of ETAG N° 032, Part 1.

5.Q.1. 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 $\sigma_{od} = 0,6$ for $C_{ULS} = 1$ according to Annex G, G.4.2.1 and G.4.3.1, in Part 1.

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

The 100 % SLS load level is related to the conditions, described with $\sigma_{OT} = 1,0$ for $C_{ULS} = 1$ according to Annex G, G.4.2.1 and G.4.3.1, in Part 1.

Note: The design situation for C_{SLS} is considered to be analogous to C_{ULS} (see also G. 4.2.2 in Annex G in Part 1).

5.Q.2. 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 $\sigma_{od} = 1,0$ for $C_{ULS} = 2$ according to Annex G, G.4.2.1 and G.4.3.1, in Part 1.

The 70 % SLS load level is related to the conditions, described with $\sigma_{OT} = 0,7$ for $C_{ULS} = 2$ according to Annex G, G.4.2.1 and G.4.3.1, in Part 1.

Note: The situation for C_{SLS} is considered to be analogous to C_{ULS} (see also G. 4.2.2 in Annex G in Part 1).

5.Q.3. SITUATION ACCORDING TO ANNEX G, G.4.3.2 (FREQUENT COMBINATION)

This situation is covered by SLS 1 and 2 with an increased deformation criterion of 12 mm for differences in the running surface and 8 mm for steps respectively, given in ETAG N° 032, Part 1, 4.1.4.1.2.

5.Q.4. ALTERNATIVE SIMPLIFIED TESTING PROCEDURE

(instead of procedure according to 5.Q.2 and 5.Q.3): Opening position: 100 % in combination with 100 % SLS/ULS load level (σ_{od} and $\sigma_{OT} = 1,0$)

According to Annex G, G.4.2.1 in Part 1, SLS/ULS 1 and 2 can be covered by an envelope approach with the condition σ_{od} and $\sigma_{OT} = 1,0$.