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ETAG n° 032
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GUIDELINE FOR EUROPEAN TECHNICAL APPROVAL
of
EXPANSION JOINTS FOR ROAD BRIDGES
PART 7: SUPPORTED EXPANSION JOINTS

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FOREWORD

See Part 1 of this ETAG N° 032.

REFERENCE DOCUMENTS

See Part 1 of this ETAG N° 032.

Additional list of standards referred to in this family Part

Standard	Clause in this family part	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 1097-2	Table 4.2, Table 5.2	Tests for mechanical and physical properties of aggregates – Part 2: Methods for the determination of resistance to fragmentation
EN 1097-8	Table 4.2, Table 5.2	Tests for mechanical and physical properties of aggregates – Part 8: Determination of the polished stone value
EN 1561	Table 4.2, Table 5.2	Founding – Grey cast irons
EN 1562	Table 4.2, Table 5.2	Founding – Malleable cast irons
EN 1563	Table 4.2, Table 5.2	Founding – Spheroidal graphite cast irons
EN 1706	Table 4.2, Table 5.2	Aluminium and aluminium alloys – Castings – Chemical composition and mechanical properties
EN 1990	7.Q.1	Eurocode: Basis of structural design
EN 1991-2	7.R.4, 7.R.6	Eurocode 1: Actions on structures – Part 2: Traffic loads on bridges
EN 1993-1-3 (2007)	Table 4.2, Table 5.2	Eurocode 3: Design of steel structures – Part 1-3: General rules – Supplementary rules for cold-formed members and sheeting
EN 1999	Table 4.2, Table 5.2	Eurocode 9: Design of aluminium structures – Part 1-1: General structural rules Part 1-2: Structural fire design Part 1-3: Structures susceptible to fatigue Part 1-4: Cold-formed structural sheeting Part 1-5: Shell structures
EN 1999-1-3 (2007)	Table 4.2, Table 6.2	Eurocode 9: Design of aluminium structures – Part 1-3: Structures susceptible to fatigue
EN 10025	Table 4.2, Table 5.2	Hot rolled products of structural steels – All parts
EN 10080	Table 4.2, Table 5.2	Steel for the reinforcement of concrete – Weldable reinforcing steel – General
EN 10088	Table 4.2, Table 5.2	Stainless steels – All parts
EN 10204 (2004)	Table 8.1, 8.2.1, Table 8.3	Metallic products – Types of inspection documents
EN 10283	Table 4.2, Table 5.2	Corrosion resistant steel castings
EN ISO 1461	Table 6.2	Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods / Note: To be replaced by ISO/DIS 1461 (2007-11).
EN ISO 11358	Table 4.2, Table 5.2	Plastics – Thermogravimetry (TG) of polymers – General principles.
EN ISO 12944	Table 4.2, 5.1.7.1.1, 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 8.1	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 pieces
ISO 37	Table 4.2, Table 5.2	Rubber, vulcanized or thermoplastic – Determination of tensile stress-strain properties; Technical Corrigendum 1
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	Plastics – Determination of tensile properties – Part 1: General principles
ISO 812 (2006)	Table 4.2, Table 5.2, Table 6.2	Rubber, vulcanized or thermoplastic – Determination of low-temperature brittleness
ISO 815	Table 4.2, Table 5.2	Plastics – Determination of tensile properties
ISO 1183-1	Table 4.2	Plastics – Methods for determining the density of non-cellular plastics – Part 1: Immersion method, liquid pycnometer method and titration method
ISO 1431-1 (2004)	Table 4.2, Table 5.2	Rubber, vulcanized or thermoplastic – Resistance to ozone cracking – Part 1: Static and dynamic strain testing / Note: Corrected and reprinted of French version in 2006-12* To be amended by ISO 1431-1 DAM 1 (2007-12)
ISO 1817	Table 4.2, Table 5.2	Rubber, vulcanized – Determination of the effect of liquids
ISO 2039-1	Table 4.2	Plastics – Determination of hardness – Part 1: Ball indentation method
ISO 2081	Table 6.2	Metallic coatings – Electroplated coatings of zinc on iron or steel / Note: To be replaced by ISO/DIS 2081 (2003-10), ISO/DIS 2081 (2007-06), ISO/FDIS 2081 (2008-09)
ISO 2781 Technical corrections 1 (1996)	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 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	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

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

Section one: INTRODUCTION

1. 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 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 supported 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:

Supported expansion joints can be classified in the following subfamilies:

- Bridging plate expansion joints without fingers
- Bridging plate expansion joints with fingers
- Roller shutter expansion joints

Bridging plate expansion joints without fingers consist of a plate supported by a rotational bearing at one side and sliding element at the other side, supported by a plate (see Figure 1).

Bridging plate expansion joints with fingers (such as comb or saw-tooth or sinusoidal plates) consist of a plate supported by a rotational bearing at one side and sliding fingers at the other side, supported by a plate with intersecting fingers (see Figure 2).

Roller shutter expansion joints consist of one or a succession of sliding plate(s), sliding on a curved support and partially covered by tongue-shaped plate (see Figure 3).

Figures 1, 2 and 3 show examples of supported expansion joints, other details are possible.

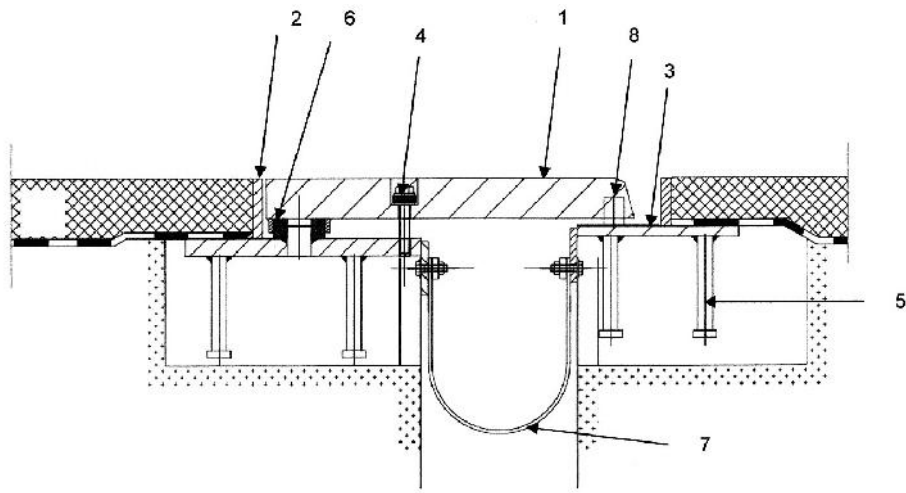
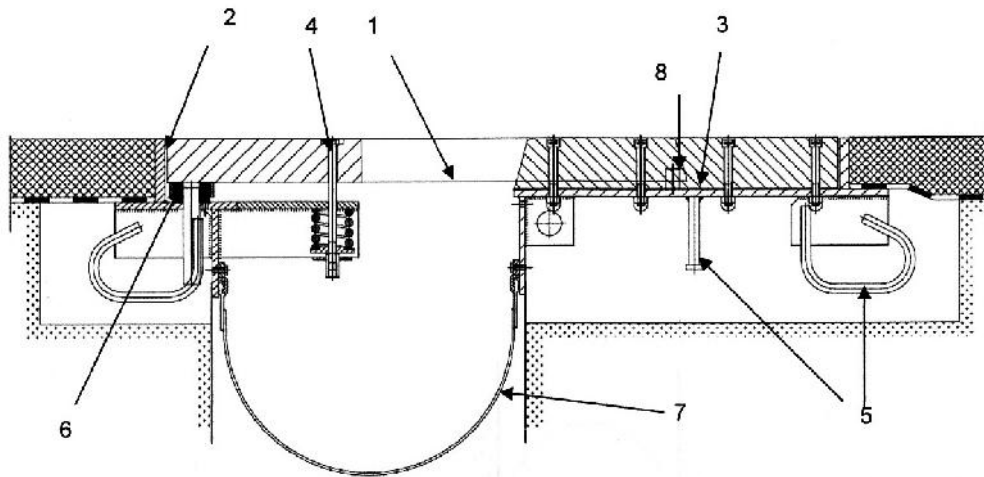


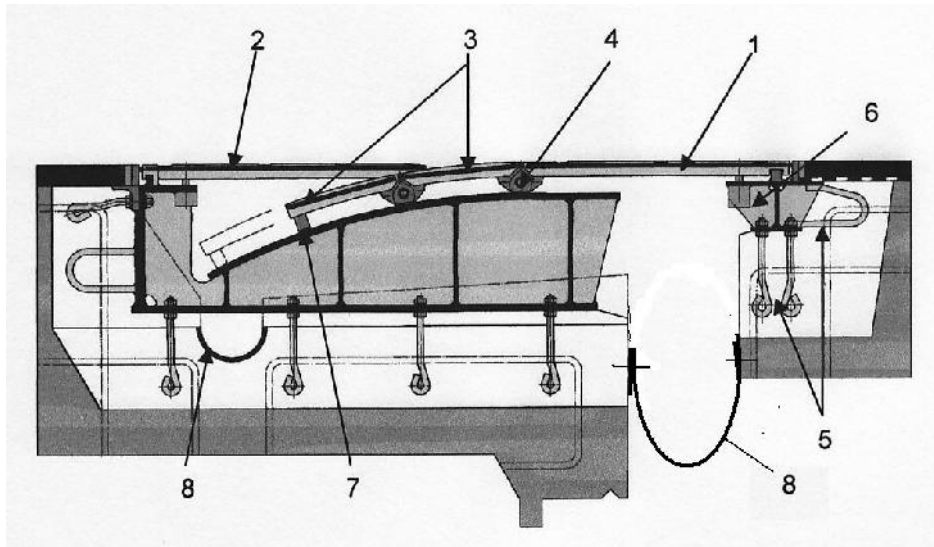
Figure 1: Principle of supported expansion joint without fingers



Key for Figures 1 and 2:

- 1 Sliding plate
- 2 Fixed support base
- 3 Sliding support base
- 4 Holding down device (flexible) of sliding plate
- 5 Anchorage system (Dowels, anchor loops)
- 6 Support
- 7 Gutter
- 8 Sliding support

Figure 2: Principle of supported expansion joint with fingers



Key:

- 1 Bridge plate
- 2 Tongue plate
- 3 Shutter plate
- 4 Hinge – Sliding supports
- 5 Anchorage system
- 6 Holding down devices
- 7 Sliding support base
- 8 Gutter

Figure 3: Principle of roller shutter expansion joint

2.2 USE CATEGORIES AND KITS

2.2.1 Use categories

See Part 1 of this ETAG N° 032.

Note: Some of the surface geometries (gaps and voids) may not be suitable for all user categories (given in 2.2.1 of Part 1) without optional devices.

2.2.2 Kits

See Part 1 of this ETAG N° 032 and 2.1.2 in this ETAG family Part.

Note: An additional top layer (e.g. epoxy layer with quartz or corundum) can be used to achieve a higher level of skid resistance. This is not considered to be part of the kit and any enhanced skid resistance is not declared with the CE marking.

Bridging plate expansion joints without fingers consist at least of the following:

- Bridging plate,
- Anchorage system,
- Holding down devices,
- Rotational support¹⁾,
- Sliding support and cover layer.

(1) **Note:** May be combined with other elements.

In addition, the following precision is given for optional devices, which may be included in the design for the Supported Expansion Joint kit:

- Kerb elements,
- Covers for pedestrian areas and running surfaces,
- Devices for drainage system,
- Supporting substructure (linking the joint to the main structure),
- Adaptations for snow plough impacts (e.g. impact protection strip),
- Connections to the watertight membrane,
- Transition strip,
- Expansion element.

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

Bridging plate expansion joints with fingers consist at least of the following:

- Bridging plate with fingers and counter plate,
- Anchorage system,
- Holding down devices,
- Rotational support²⁾,
- Sliding support and cover layer with fingerplate.

(2) **Note:** May be combined with other elements.

In addition, the following precision is given for optional devices, which may be included in the design for the Supported Expansion Joint kit:

- Kerb elements,
- Covers for pedestrian areas and running surfaces,
- Devices for drainage system,
- Supporting substructure (linking the joint to the main structure),
- Adaptations for snow plough impacts (e.g. impact protection strip),
- Connections to the watertight membrane,
- Transition strip.

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

Roller shutter expansion joints consist at least of the following:

- Surface elements (bridge plate, shutter plates, tongue plate, bearing),
- Supporting structures (including sliding support base),
- Anchorage system,
- Holding down devices,
- Hinge(s), Rockers.

In addition, the following precision is given for optional devices, which may be included in the design for the Supported Expansion Joint kit:

- Seals for surface elements,
- Kerb elements,
- Covers for pedestrian areas and running surfaces,
- Devices for drainage system,
- Adaptations for snow plough impacts (e.g. impact protection strip),
- Connections to the watertight membrane,
- Transition strip.

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, 2.3.2, apply.

To demonstrate that materials are fit for 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.

For replaceable components a working life category, shorter than for the kit, may be chosen. The concerned components and their working life category shall be declared 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 PART

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.

Expansion element: Element providing a running surface in cases where the allowances for gaps and voids would be exceeded without it.

Hinges: Connection between surface elements in order to allow rotation and transmission of forces in the vertical and horizontal direction.

Holding down devices: System preventing the uplift of surface elements.

Void (in case of bridging plate expansion joints with fingers): In application of the definition in ETAG N° 032, Part 1, void is the open space, with infinite depth, between the two opposite cantilever plates.

Rockers: Fixed bearings supporting the surface elements and allowing rotation about one axis.

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° 032 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.

Table 4.1.1 in ETAG N° 032, Part 1, is detailed for the different subfamilies in 4.1.1.2 of this ETAG Part.

The actions, loads and combinations of loads and opening positions are given in Annex G of Part 1 of this ETAG.

The skew angle between the traffic direction and the longitudinal axis of the joint influences the load transfer and shall be considered in the assessment (see 5.1.1.1. in this ETAG family Part).

4.1.1.2 Mechanical resistance

4.1.1.2.1 General

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.

The specific design of a supported expansion joint restricts the movement in the direction perpendicular to and in the same plane as the main sliding direction for dilatation purposes. Maximum relative vertical displacements (+/-) and non-parallelism of supporting lines, as declared by the manufacturer (see also 4.1.1.5 in this family Part) for SLS, shall be considered.

SLS conditions are related to the following two design situations:

SLS_{Annex G of Part 1} is related to the following two design situations:

SLS 1_{Annex G of Part 1}: 100 % load level with 60 % of the maximum opening position,

SLS 2_{Annex G of Part 1}: 70 % load level with 100 % maximum opening position of the joint.

ULS conditions are related to the following two design situations:

ULS_{Annex G} of Part 1 is related to the following two design situations:

ULS 1_{Annex G} of Part 1: 100 % load level with 60 % of the maximum opening position,

ULS 2_{Annex G} of Part 1: 70 % load level with 100 % maximum opening position of the joint.

4.1.1.2.2 Bridging plate expansion joints without fingers

Under SLS conditions the following requirements apply:

- No yielding of any part of the joint.
- Vertical deflections under loaded conditions of the expansion joint itself shall be less than 5 mm.
- No separation of contact surfaces between the bridging plate and its support structure in all service conditions (i.e. all contact surfaces shall be under compression stress).
- In the unloaded situation uplift shall not occur.

Under ULS conditions the following requirements applies:

- Static equilibrium (as stated in table 4.1.1 in ETAG N° 032, Part 1).

4.1.1.2.3 Bridging plate expansion joints with fingers

Under SLS conditions the following requirements applies:

- No yielding of any part of the joint.
- Vertical deflections under loaded conditions of the expansion joint itself shall be less than 5 mm.
- No contact between intersecting cantilevers.
- No separation of contact surfaces between the bridging plate and its support structure in all service conditions (i.e. all contact surfaces shall be under compression stress).
- In the unloaded situation uplift shall not occur.

Under ULS conditions the following requirements applies:

- Static equilibrium (as stated in Table 4.1.1 in ETAG N° 032, Part 1).

4.1.1.2.4 Roller shutter expansion joints

Under SLS conditions the following requirements apply:

- No yielding of any part of the joint.
- Vertical deflections under loaded conditions of the expansion joint itself shall be less than 5 mm.
- No separation of contact surfaces between the bridging plate and its support structure in all service conditions (i.e. all contact surfaces shall be under compression stress). This means: In cases where the bridging plates are supported by two lines in a parallel or rectangular configuration (statically indeterminate), these lines shall be parallel in the vertical plane and this shall be reported in the ETA. This condition need not be fulfilled for designs which allow supporting lines not being parallel. But in no design situations shall the supports of statically indeterminate systems show any uplift.
- In the unloaded situation uplift shall not occur.

Under ULS conditions the following requirements applies:

- Static equilibrium (as stated in Table 4.1.1 in ETAG N° 032, Part 1).

4.1.1.3 Resistance to fatigue

4.1.1.3.1 Bridging plate expansion joints without fingers

The requirements with respect to fatigue resistance according to Table 4.1.1 in ETAG N° 032, Part 1, and including vertical and horizontal loads, apply.

Loads are given in ETAG N° 032, Part 1, Annex G of Part 1.

Stresses due to vertical movement as stated above shall not exceed CAFL.

Note: The number of cycles as indicated in Annex 7.N in this ETAG family Part is related to steel. In case of other materials details should be given for the individual ETA in the Evaluation Report (see also Annex 7.R, 7.R.1).

The interference of loads on the expansion joint and imposed vertical displacement is not to be considered. The sum of the damage of both phenomena shall be used for fatigue assessment.

ULS criteria for the joint under imposed displacements at ULS of the main structure are not of relevance.

For supported expansion joints including flexible expansion elements for consideration of bridge movements under traffic (without consideration of traffic loads on the joint) no debonding in the elastomeric parts or vulcanized connections is allowed.

4.1.1.3.2 Bridging plate expansion joints with fingers

The requirements with respect to fatigue resistance according to Table 4.1.1 in ETAG N° 032, Part 1, and including vertical and horizontal loads, apply.

Loads are given in ETAG N° 032, Part 1, Annex G.

Stresses due to vertical movement as stated above shall not exceed CAFL.

Note: The number of cycles as indicated in Annex 7.N in this ETAG family Part is related to steel. In case of other materials details should be given for the individual ETA in the Evaluation Report (see also Annex 7.R, 7.R.1).

The interference of loads on the expansion joint and imposed vertical displacement is not to be considered. The sum of the damage of both phenomena shall be used for fatigue assessment.

ULS criteria for the joint under imposed displacements at ULS of the main structure are not of relevance.

4.1.1.3.3 Roller shutter expansion joints

The requirements with respect to fatigue resistance according to Table 4.1.1 in ETAG N° 032, Part 1, and including vertical and horizontal loads, apply.

Loads are given in ETAG N° 032, Part 1, Annex G.

Stresses due to vertical movement as stated above shall not exceed CAFL.

Note: The number of cycles as indicated in Annex 7.N in this ETAG family Part is related to steel. In case of other materials details should be given for the individual ETA in the Evaluation Report (see also Annex 7.R, 7.R.1).

The interference of loads on the expansion joint and imposed vertical displacement is not to be considered. The sum of the damage of both phenomena shall be used for fatigue assessment.

ULS criteria for the joint under imposed displacements at ULS of the main structure are not of relevance.

4.1.1.4 Seismic behaviour

4.1.1.4.1 Bridging plate expansion joints without fingers

See Part 1 of this ETAG N° 032. The approaches given in Table 4.1.1.4 of ETAG N° 032, Part 1, apply.

Note: “Gap” according to ETAG N° 032, Part 1, Table 4.1.1.4, is not applicable for this product family due to the fact that there are no gaps but recesses.

The result of the evaluation procedure shall indicate which measures, not necessarily included in the joint itself, shall be taken in order to ensure a proper response to seismic events.

4.1.1.4.2 Bridging plate expansion joints with fingers

See Part 1 of this ETAG N° 032. The approaches given in Table 4.1.1.4 of ETAG N° 032, Part 1 apply.

“Gap” according to ETAG N° 032, Part 1, Table 4.1.1.4, in this context reads “distance between the tooth ends of the opposing supported fingers in opening position”.

The movement capacity of a supported finger expansion joint does not allow movements in all directions, depending on the design of the finger shape. In this case, the result of the evaluation procedure shall indicate which measures, not necessarily included in the joint itself, shall be taken in order to ensure a proper response to seismic events.

The result of the evaluation procedure shall indicate which measures, not necessarily included in the joint itself, shall be taken in order to ensure a proper response to seismic events.

4.1.1.4.3 Roller shutter expansion joints

See Part 1 of this ETAG N° 032. The approaches given in Table 4.1.1.4 of ETAG N° 032, Part 1, apply.

The result of the evaluation procedure shall indicate which measures, not necessarily included in the joint itself, shall be taken in order to ensure a proper response to seismic events.

Note: “Gap” according to ETAG N° 032, Part 1, Table 4.1.1.4, is not applicable for this product family due to the fact that there are no gaps but recesses.

4.1.1.5 Movement capacity

4.1.1.5.1 Bridging plate expansion joints without fingers

For the principles see Part 1 of this ETAG N° 032. The overlapping shall be more than zero.

Horizontal displacements:

The displacement velocity and the temperature may be of relevance and are covered by mechanical resistance (see 4.1.1.1 in this Part) and resistance to wear (see 4.1.1.7 in this Part).

For SLS of the main structure the following additional requirements for displacements apply:

- The remaining opening in the closed position shall be declared for the longitudinal direction,
- The contact area between the bridging plate and the supporting structure shall never be reduced by movement.

Vertical displacements:

Movement capacity is defined as the declared range of the relative vertical displacement and rotation in the vertical plane of the supporting lines, not leading to damage to the product for loaded and unloaded conditions, and shall be declared. The displacement velocity may affect the response of the expansion joint. This shall be analysed. The temperature does not affect the response of the supported expansion joints.

4.1.1.5.2 Bridging plate expansion joints with fingers

For the principles see Part 1 of this ETAG N° 032. The overlapping shall be more than zero.

Horizontal displacements:

The displacement velocity and the temperature may be of relevance and are covered by mechanical resistance (see 4.1.1.1 in this Part) and resistance to wear (see 4.1.1.7 in this Part).

For SLS of the main structure the following additional requirements for displacements apply:

- The remaining opening in the closed position shall be declared for the longitudinal direction,
- The contact area between the finger and the supporting structure shall never be reduced by movement.

Vertical displacements:

Movement capacity is defined as the declared range of the relative vertical displacement and rotation in the vertical plane of the supporting lines, not leading to damage to the product for loaded and unloaded conditions, and shall be declared. The displacement velocity may affect the response of the expansion joint. This shall be analysed. The temperature does not affect the response of the supported expansion joints.

4.1.1.5.3 Roller shutter expansion joints

For the principles see Part 1 of this ETAG N° 032. The overlapping shall be more than zero.

Horizontal displacements:

The displacement velocity and the temperature may be of relevance and are covered by mechanical resistance (see 4.1.1.1 in this Part) and resistance to wear (see 4.1.1.7 in this Part).

For SLS of the main structure the following additional requirements for displacements apply:

- The contact area between the lowest bearing and the sliding area shall never be reduced by movement,
- The remaining opening in the closed position shall be declared for the longitudinal direction.

Vertical displacements:

Movement capacity is defined as the declared range of the relative vertical displacement and rotation in the vertical plane of the supporting lines, not leading to damage to the product for loaded and unloaded conditions, and shall be declared. The displacement velocity may affect the response of the expansion joint. This shall be analysed. The temperature does not affect the response of the supported expansion joints.

4.1.1.6 Cleanability

See Part 1 of this ETAG N° 032.

4.1.1.6.1 Bridging plate expansion joints without fingers

The recess in which the bridging plate is sliding may accumulate debris. The requirement on cleanability shall be met by means of good accessibility and cleanability of the recess or by proper design.

In case of expansion joints equipped with a drainage system for ensuring watertightness, the requirement is also related to this system.

4.1.1.6.2 Bridging plate expansion joints with fingers

The recesses in which the fingers are sliding may accumulate debris. The expansion joint shall be designed such that any accumulation of debris does not affect the performance of the joint in any movement direction. This shall be achieved by a proper design of the fingers (self cleaning geometry of the finger ends) for self-cleaning.

In case of expansion joints equipped with a drainage system for ensuring watertightness, the requirement on cleanability is also related to this system.

4.1.1.6.3 Roller shutter expansion joints

The surface of roller shutter expansion joints is considered not to be susceptible to accumulation of debris.

In case of expansion joints equipped with a drainage system for ensuring watertightness, the requirement on cleanability is also related to this system.

4.1.1.7 Resistance to wear

4.1.1.7.1 General

In general, see Part 1 of this ETAG N° 032, with the addition that components subject to wear shall be inspectable. The indications for the wear limit, considering the movement capacity in the concerned directions, shall be given by the manufacturer and stated in the ETA.

The working life with respect to wear of a component shall be determined assuming that on average each day results in a horizontal movement of the expansion joint equal to 33 % of the maximum movement capacity.

Vertical and rotational movement capacity are considered by arrangement (positions of the components) in the test rig.

This means that, in relation to temperature effects in the bridge, the total slide path for the test procedure according to 5.1.1.7 of this ETAG Part, in relation to a working life of "a" years of a component is derived from $[a] \times 365 \times 0,33 \times \text{maximum movement capacity of the expansion joint} = 120 \times [a]$ cycles with maximum movement capacity of the joint (a = a number of years).

4.1.1.7.2 Bridging plate expansion joints without fingers

The sliding element(s) and/or surface of the supports are considered to be subject to wear. The accumulation of wear during the declared working life shall not result in:

- change in kinematic conditions (e.g. loss of original contact pressure in the sliding surface; or increase of friction coefficient, resulting in overload of components of the expansion joint),
- complete disappearance of the original cover layer leading to insufficient protection against corrosion,

as far as relevant.

4.1.1.7.3 Bridging plate expansion joints with fingers

The sliding element(s) and/or surface of the supports are subject to wear. The accumulation of wear during the declared working life shall not result in:

- change in kinematic conditions (e.g. loss of original contact pressure in the sliding surface; or increase of friction coefficient, resulting in overload of components of the expansion joint),
- complete disappearance of the original cover layer leading to insufficient protection against corrosion.

as far as relevant.

4.1.1.7.4 Roller shutter expansion joints

The surface of curvi-linear support beams, the sliding bearing(s) and the hinges are considered to be subject to wear. The accumulation of wear 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; or increase of friction coefficient, resulting in overload of components of the expansion joint),
- change in support conditions (e.g. three supports out of four transferring the load),
- complete disappearance of the original cover layer leading to insufficient protection against corrosion,

as far as relevant.

4.1.1.8 Watertightness

4.1.1.8.1 Bridging plate expansion joints without fingers

See Part 1 of this ETAG N° 032.

Watertightness is achieved by a sub-surface drainage system (e.g. gutter).

The drainage devices and the clamping devices shall be durable (see also 4.2).

Where additional seals are used (e.g. between bridging plates and transition strips) they shall be durable (see also 4.2).

4.1.1.8.2 Bridging plate expansion joints with fingers

See Part 1 of this ETAG N° 032.

Watertightness is achieved by a sub-surface drainage system (e.g. gutter).

The drainage devices and the clamping devices shall be durable (see also 4.2).

Where additional seals are used (e.g. between bridging plates and transition strips) they shall be durable (see also 4.2).

4.1.1.8.3 Roller shutter expansion joints

See Part 1 of this ETAG N° 032.

Watertightness is achieved by a combination of seals (between the roller shutter plates) and a sub-surface drainage system (e.g. gutter). The seals, drainage devices and the clamping devices shall be durable (see also 4.2).

4.1.2 Safety in case of fire

According to Part 1 of this ETAG N° 032: 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.

4.1.4.1.1.1 Bridging plate expansion joints without fingers

See Part 1 of this ETAG N° 032.

4.1.4.1.1.2 Bridging plate expansion joints with fingers

See Part 1 of this ETAG N° 032.

4.1.4.1.1.3 Roller shutter expansion joints

See Part 1 of this ETAG N° 032.

4.1.4.1.2 Level differences in the running surface

4.1.4.1.2.1 Bridging plate expansion joints without fingers

a) Unloaded conditions:

See Part 1 of this ETAG N° 032.

b) Loaded conditions (loading of the joint itself):

The requirement for vertical deflection, given in 4.1.1.2.1 of this family Part, applies.

4.1.4.1.2.2 Bridging plate expansion joints with fingers

a) Unloaded conditions:

See Part 1 of this ETAG N° 032.

b) Loaded conditions (loading of the joint itself):

The requirement for vertical deflection, given in 4.1.1.2.1 of this family Part, applies.

4.1.4.1.2.3 Roller shutter expansion joints

a) Unloaded conditions:

See Part 1 of this ETAG N° 032.

b) Loaded conditions (loading of the joint itself):

The requirement for vertical deflection, given in 4.1.1.2.1 of this family Part, applies.

4.1.4.2 Skid resistance

4.1.4.2.1 Bridging plate expansion joints without fingers

See Part 1 of this ETAG N° 032.

4.1.4.2.2 Bridging plate expansion joints with fingers

See Part 1 of this ETAG N° 032.

4.1.4.2.3 Roller shutter expansion joints

See Part 1 of this ETAG N° 032.

4.1.4.3 Drainage capacity

4.1.4.3.1 Bridging plate expansion joints without fingers

ETAG N° 032, Part 1, applies. The drainage is achieved by a sub-surface drainage system. The drainage system shall be durable and shall have a sufficient*) discharge capacity.

*) Sufficient means that at least the area of the expansion joint itself is to be considered for the discharge capacity.

4.1.4.3.2 Bridging plate expansion joints with fingers

ETAG N° 032, Part 1, applies. The drainage is achieved by a sub-surface drainage system. The drainage system shall be durable and shall have a sufficient*) discharge capacity.

*) Sufficient means that at least the area of the expansion joint itself is to be considered for the discharge capacity.

4.1.4.3.3 Roller shutter expansion joints

ETAG N° 032, Part 1, applies. The drainage is achieved by a sub-surface drainage system. The drainage system shall be durable and shall have a sufficient*) discharge capacity.

*) Sufficient means that at least the area of the expansion joint itself is to be considered for the discharge capacity.

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 conjunction with Table 4.2 of this ETAG Part.

In addition, specific consideration may be needed of the influence of electrochemical corrosion (e.g. interaction of different materials or galvanic effects).

4.1.7.1.2 Chemicals

See Part 1 of this ETAG N° 032 in conjunction with Table 4.2 of this ETAG Part.

For supported expansion joints for the components made of elastomer (e.g. gutter/seal) resistance to de-icing agents is considered (See cl. 4.2). Elastomeric parts made of materials based on Polychloroprene rubber (CR), Ethylene-Propylene-Diene Material (EPDM), Styrol-Butadiene-Rubber (SBR) do not need to be assessed against attack of oil, petrol or fuel oil. For other materials 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

See Part 1 of this ETAG N° 032 in conjunction with Table 4.2 of this ETAG Part.

For supported expansion joints for the components made of elastomer (e.g. gutter/seal) resistance against ageing (e.g. due to chemical attacks) shall be considered (see 4.2). For low temperatures brittleness temperature is considered, depending on the range of temperature (see 2.3.2 and 4.2).

4.1.7.1.4 Resistance against freeze-thaw

For gutter/seal of supported expansion joints, resistance against freeze-thaw shall be considered.

See Part 1 of this ETAG N° 032 in conjunction with Table 4.2 of this ETAG Part.

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 expansion joint shall be clearly identified with a type plate, 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 component 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 Supported 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	Required characteristics	Standard/ specification
Surface element (Fingerplate for supported expansion joints with and without fingers and plates for roller shutter expansion joints bridging plate, shutter plates and tongue plate, expansion element)		Structural steel, Cast steel, Cast iron, Stainless steel	Yield point Tensile strength Elongation at rupture Energy absorption Ductility Charpy-V value Chemical composition (including CEV)	Structural steel: EN 10025 Cast steel: Relevant standards, i.e. EN 10283, EN 1562 Stainless steel: EN 10088 Cast iron: EN 1561, EN 1563
		Aluminium: - Plate material: Grade 5xxx - Extruded material: Grade 6xxx, excluded: grades given in EN 1999-1-3, cl. 3 (2007) - Cast material: Grade equivalent level as given for plate material and extruded material	Chemical composition Tensile strength Yield point Stress-strain Elongation at rupture Ductility Charpy-V value	Aluminium EN 1999 Extruded aluminium: EN 755-2 Cast aluminium: EN 1706
		Elastomer	<i>Note: selection depending on chosen materials</i> Hardness IRHD Tear resistance Elongation at break Compression set Resistance to low temperatures Resistance to ageing Resistance to ozone Resistance to de-icing agents Thermo gravimetric analysis Rheometric characteristics	ISO 48, ISO 7619-2 ISO 34-1 (2004) Method A ISO 37 ISO 815 (type B test piece) ISO 812 ISO 48, ISO 37, ISO 188 ISO 1431-1 ISO 1817 EN ISO 11358, ISO 9924-1-2 ISO 3417, ISO 6502
Supporting substructure	Plates, profiles, steel beam grid, etc.	Steel Stainless steel	Yield point Tensile strength Elongation at rupture Chemical composition (C-eq.) Energy absorption (in case welded connection with transition strip)	EN 10025, EN 10088
	Bearings (in case of roller shutter expansion joints)	Steel, Elastomer, Plastics	Steel: See relevant clauses for elements made of steel	
			Elastomer: Hardness IRHD Tear resistance Elongation at break Compression set Resistance to low temperatures Resistance to ageing Resistance to de-icing agents Thermo gravimetric analysis Rheometric characteristics	ISO 48, ISO 7619-2 ISO 34-1 (2004) Method A ISO 37 ISO 815 (type B test piece) ISO 812 ISO 48, ISO 37, ISO 188 ISO 1817 EN ISO 11358, ISO 9924-1,-2 ISO 3417, ISO 6502
			Plastics: Density Hardness IRHD Tensile strength Compression set Resistance to low temperatures Resistance to de-icing agents	ISO 1183-1 ISO 2039-1 ISO 527-1 ISO 815 (type B test piece) ISO 812 ISO 1817 (or equivalent)
Rotational supports (e.g. line rocker, point rocker, bearing)	Steel, elastomer, plastics	Due to the variety of elements to be defined case by case. For general guidance see also ETAG N° 032, Part 8, Annex 8.M. Results to be stated in the Evaluation Report.		
Hinges, rockers (in case of roller shutter expansion joints)	Steel	Yield point Tensile strength Elongation at rupture Chemical composition (C-eq.) Energy absorption (in case welded connection with transition strip)	EN 10025	

Table 4.2 (continued)

Parts of the kit	Components of the parts	Material	Required characteristics	Standard/ specification
Supporting substructure	Transition strip	Steel Stainless steel	Yield point Tensile strength Elongation at rupture Energy absorption Chemical composition (C-eq.)	EN 10025, EN 10088
	Reinforcement bars/loops	Steel	Yield strength Tensile strength Ductility Weldability Bendability Bond property	EN 10080
	Welded dowels for dynamically loaded components	Steel	EN ISO 13918	EN ISO 13918
	Snow plough impact protection strip *)	Steel: See "Plates, profiles"		
Anchorage/holding down devices	Bolts, screws, nuts, washers	Steel	Grade or quality class (according to the type of component) Tensile strength Yield strength	According to the relevant standard in the list given in EN 1993-1-8 (2005), 2.8 group 4
	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
	Spring	Steel	Relevant technical specification	Relevant specification
		Elastomer	Hardness IRHD Tear resistance Elongation at break, Compression set Resistance to low temperatures Resistance to ageing	ISO 48, ISO 7619-2 ISO 34-1 (2004) Method A ISO 37 ISO 815 (type B test piece) ISO 812 ISO 48, ISO 37, ISO 188
Stud bolts	Steel	Relevant load bearing capacity	Relevant specification	
Sliding support and cover layers	Sheets, surface layer	Sheets: Steel Elastomer/ Plastics	See "Supporting substructure"	
		Layers: Metal, paint	For surface layers (e.g. hard chromium coating, metal application by welding, paint etc.): According to the relevant technical specifications	
Connecting devices	Bolts, screws, nuts, washer, profiles	Metal	See "Anchorage devices"	
	Bonding agents/sealants, sockets	Chemicals/ Metal	- To be covered by full scale tests - Bonding agents manufacturers' specifications to be taken into account	
Kerb elements	Plate, welded attachments (like covers)	Metal	<i>Remark: See "Covers"</i>	

Table 4.2 (continued)

Parts of the kit	Components of the parts	Material	Required characteristics	Standard/ specification
Drainage devices *)	Gutter/seal including their connections and butt joints	Elastomer (optionally reinforced), plastics (reinforced) (e.g. Polyamide, PVC, Polyethylene), etc.	Depending on the design of the drainage device the following performance characteristics may have to be considered:	Relevant specification with respect to the concerned performance characteristics, e.g.:
			Resistance to de-icing agents	ISO 1817
			Resistance to ozone	ISO 1431-1
			Limit temperature of brittleness (Requirements according to ISO 812 (2006), 7.1.1.4)	ISO 812
			Hardness IRHD	
			Tensile strength	ISO 37
			Elongation at break	ISO 34-1 Method A
			Tear resistance	ISO 48, ISO 7619-2
			Density	ISO 2781 Technical corrections 1 (1996)
			Thermogravimetric analysis (TGA)	
			Rheometric characteristics	EN ISO 11358 for TGA; ISO 3417, ISO 6502
			Resistance to ageing	ISO 188
	<i>Note: The list is not considered as exhaustive.</i>			
	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"	
Connections to the watertight membrane *)	According to the relevant specification			
Transition strip, snow plough impact protection strip (not included in the supporting structure *)	Transition strip	Resin mortar and cement mortar	According to the manufacturer's specification, define e.g.: Resin - Elongation at break - Compressive strength - Modulus of elasticity Aggregate and fillers: - Type - Grading - Resistance to fragmentation - Polished Stone Value (PSV) Mortar: - Compressive strength	Relevant specification EN 1097-2 EN 1097-8
	Snow plough impact protection strip	Resin mortar		
Covers *)	Plates	Steel minimum: S235xx	Yield point Tensile strength	EN 10025
		Stainless steel, Grade 1.44xx or 1.45xx	Elongation at rupture Chemical composition (C-eq.)	EN 10088
Covers *)	Plates	Aluminium: Plate material: Grade 5xxx Extruded material: Grade 6xxx Excluded grades given in EN 1999-1-3, cl. 3 (2007) Cast material: Grade xxx	Chemical composition Tensile strength Yield point Stress-strain elongation at rupture Ductility Charpy-V value <i>Note: selection depending on chosen materials</i>	EN 1999 Extruded aluminium: EN 755-2 Cast aluminium: EN 1706

*) Optional devices (see also 2.2.2 in this ETAG 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.

The actions, loads and combinations of loads and opening positions to be used for verification are given in Annex G of Part 1 of this ETAG.

The allowed skew angle between the traffic direction and the longitudinal axis of the joint shall be addressed as separate parameter of the verification. This aspect can be analyzed with calculations.

Note: Whether, due to the design of the expansion joint, the application of horizontal loads (perpendicular and/or longitudinal) may be neglected for specific components, needs analysis by the Approval Body in order to evaluate this.

5.1.1.2 Mechanical resistance

5.1.1.2.1 General

See Part 1 of this ETAG N° 032.

For supported expansion joints mechanical resistance shall be verified by calculation or calculation assisted by testing of components. The principles, given in 5.1.1.1 of ETAG N° 032, Part 1, apply.

Clamping effects at the supports and effects of the holding-down system shall be considered.

ULS verification

For the verification under ULS the load shall be applied on the most adverse position of the supported expansion joint kit, related to the concerned ULS design situations according to 4.1.1.2.

SLS verification

For the verification under SLS the load shall be applied on the most adverse position of the supported expansion joint kit, related to the concerned SLS design situations according to 4.1.1.2.

The verification shall include the absence of uplift for the maximum declared relative vertical displacement of the fixed and sliding support in combination with the effect of elastic unloading and/or suction effects. Relaxation and creep, if any, of clamping elements or holding-down systems, shall be considered.

Note: Background for derivation of loads for SLS_{Annex G of Part 1} verification: See Annex 7Q.

5.1.1.2.2 Calculations

See Part 1 of this ETAG N° 032.

Supported expansion joints shall be calculated based on relevant standards, literature etc.

5.1.1.2.3 Calculation assisted by testing

Calculation assisted by testing shall be carried out if:

- parts of the kit cannot be verified by calculation, or
- components consists of materials not covered by standards, or
- components cannot be verified as a whole by means of standards or approvals for this intended use.

The specimen shall include the relevant part of the kit.

The test loads and assessment criteria for the components to be tested shall be derived from a static calculation for the relevant design situations.

The test method is given in Annex 7.M.

5.1.1.2.3.1 Bridging plate expansion joints without fingers

The verification method is given in Annex 7.M.

5.1.1.2.3.2 Bridging plate expansion joints with fingers

The verification method is given in Annex 7.M.

5.1.1.3.3 Roller shutter expansion joints

The verification method is given in Annex 7.M.

5.1.1.3 Resistance to fatigue

5.1.1.3.1 General

For supported expansion joints resistance to fatigue shall be verified by calculation or calculation assisted by testing. Verification shall be carried out with 60 % of the movement capacity.

For metallic parts, the unlimited fatigue life (CAFL according to Table 4.1.1 in ETAG N° 032, Part 1) is characterized by 5×10^6 cycles at the maximum stress/strain interval in relation to FLM 1EJ.

CAFL for other materials shall be based on fatigue classifications derived from the relevant standards or testing.

For metallic parts, the limited fatigue life is characterized as a number of cycles (lorries according to ETAG N° 032 Part 1, clause 2.3.4) in relation to FLM 2EJ.

For other materials fatigue classifications shall be derived from the relevant standards or testing. Testing can also be used to achieve more accurate classifications for common fatigue details.

The amplification factor $\Delta\phi_{fat} = 1,3$ as mentioned in ETAG N° 032, Part 1, 5.1.1.3, and included in Annex G of Part 1, G.3.2 and G.3.3, may be reduced, considering unevenness effects (in the meaning of level differences of adjacent parts or structural elements) by more than 4 mm, based on dynamic testing (rollover test).

Remark: 4 mm are considered in general as allowable tolerance of unevenness in case of installed road surfaces

Upswing effects shall be taken into account and consideration shall be stated in the Evaluation Report. The verification of upswing effects shall be done (e.g. by calculation or testing; for test the loading conditions given in Annex 8.O in family Part 8, 8.O.7.2 shall be used in an appropriate way, details to be stated in the Evaluation Report) in order to verify the concerned deflection and to determine the related forces to be taken into account. In case of absence of field test or calculation results, the fatigue verification shall be done with a fatigue load amplitude of +100 % and -30 % (this means a fatigue load interval of 1,3 times the fatigue load in Annex G of ETAG N° 032) of the load defined in Annex G of Part 1 of ETAG N° 032.

5.1.1.3.2 Calculation

See also Part 1 of this ETAG N° 032.

Calculation shall be carried out based on relevant standards. This applies when the load transfer and load introduction into the main structure can be modelled with common engineering principles.

Regarding resistance to fatigue, caused by upward and downward movements according to 4.1.1.3 in this ETAG family part, verification shall be carried out by calculation, taking into account infinite fatigue life, depending on the working life category declared according to this ETAG N° 032, Part 1.

5.1.1.3.3 Calculations assisted by testing

Calculation shall be carried out based on relevant standards.

Component testing can be used for verification of components, depending on the design of the joint. If the conditions according to 5.1.1.3.1 with respect to the load introduction into the main structure are not fulfilled, the load transfer between the expansion joint and the main structure shall be tested for the most adverse conditions.

The test loads and assessment criteria for the components to be tested shall be derived from a static calculation for the relevant design situations (traffic loads and displacements). The concerned contact pressure, the wheel print and the number of cycles, given in Table 7.N.1, in conjunction with an opening position of 60 % of the maximum opening position, and the kinematic conditions and concerned stiffnesses, shall be taken into account.

5.1.1.3.3.1 Bridging plate expansion joints without fingers

The verification method is given in Annex 7.N.

Verification of resistance to fatigue caused by bridge movements due to traffic on the bridge but without loads on the joint itself is given in Annex 7.O.

5.1.1.3.3.2 Bridging plate expansion joints with fingers

The verification method is given in Annex 7.N.

5.1.1.3.3.3 Roller shutter expansion joints

The verification method is given in Annex 7.N.

5.1.1.4 Seismic behaviour

5.1.1.4.1 Bridging plate expansion joints without fingers

See Part 1 of this ETAG N° 032.

5.1.1.4.2 Bridging plate expansion joints with fingers

See Part 1 of this ETAG N° 032.

The intrinsic movement capacities of a Supported Expansion Joint may not allow movements in all directions. In this case, the result of the evaluation procedure that indicate that measures (e.g. guided bearings), not necessarily included in the joint itself, shall be taken in order to ensure a proper response to seismic events.

5.1.1.4.3 Roller shutter expansion joints

See Part 1 of this ETAG N° 032.

The movement capacities of a Roller Shutter Expansion Joint may not allow movements in all directions. In this case, the result of the evaluation procedure shall indicate which measures, not necessarily included in the joint itself, shall be taken in order to ensure a proper response to seismic events.

5.1.1.5 Movement capacity

See Part 1 of this ETAG N° 032.

The verification of the nominal movement capacity in horizontal, vertical and rotational directions for unloaded conditions can be done by analysis of the technical file (e.g. CAD). In this case verification by testing according to ETAG N° 032, Part 1 is not compulsory.

5.1.1.5.1 Bridging plate expansion joints without fingers

For the verification of the movement capacity at SLS and ULS, conditions according to ETAG N° 032, Part 1, apply. The criteria are given in 4.1.1.5.1 of this family Part.

In addition, the effect of the displacement velocity in case of vertical movement on the response of the expansion joint shall be considered.

5.1.1.5.2 Bridging plate expansion joints with fingers

For the verification of the movement capacity at SLS and ULS, conditions according to ETAG N° 032, Part 1, apply.

In addition, the effect of the displacement velocity in case of vertical movement on the response of the expansion joint shall be considered.

The influence of longitudinal slopes shall be also verified.

5.1.1.5.3 Roller shutter expansion joints

For the verification of the movement capacity at SLS and ULS, conditions according to ETAG N° 032, Part 1, apply. The criteria are given in 4.1.1.5.3 of this family Part.

In addition, the effect of the displacement velocity in case of vertical and horizontal movement on the response of the expansion joint shall be considered.

The influence of longitudinal slopes shall be also verified.

5.1.1.6 Cleanability

5.1.1.6.1 Bridging plate expansion joints without fingers

For the verification of the expansion joint itself, see Part 1 of this ETAG N° 032.

Cleanability can be achieved either by a proper design of the front edge of the sliding plate (self cleaning geometry) or good accessibility for cleaning. Both possibilities are to be checked by using the technical file. Verification of good accessibility of the drainage system, if any, shall also be done by check of the technical file.

5.1.1.6.2 Bridging plate expansion joints with fingers

For the verification of the expansion joint itself, see Part 1 of this ETAG N° 032.

Verification of proper design of the fingers (self cleaning geometry of the finger ends) shall be checked by using the technical file. Verification of good accessibility of the drainage system, if any, shall also be done by check of the technical file.

5.1.1.6.3 Roller shutter expansion joints

Verification of features for watertightness shall be done by analysis of the design.

Verification of good accessibility of the drainage system, if any, shall also be done by check of the technical file.

5.1.1.7 Resistance to wear

5.1.1.7.1 General

Resistance to wear of supported expansion joints shall be done by full scale model testing of the concerned sliding part(s) of the joint.

Verification shall include geometrical affects from the wear limits, given by the manufacturer, at the most unfavourable position (e.g. prestress), by means of proper analysis.

The number of tests for the concerned range of products referred to a movement capacity of 240 mm according to ETAG N° 032, Part 1, Annex H, is applicable also for component testing in general.

5.1.1.7.2 Bridging plate expansion joints without fingers

The verification method is given in Annex 7.P.

5.1.1.7.3 Bridging plate expansion joints with fingers

The verification method is given in Annex 7.P.

5.1.1.7.4 Roller shutter expansion joints

The verification method is given in Annex 7.P.

5.1.1.8 Watertightness

See Part 1 of this ETAG N° 032.

For verification of watertightness by a subsurface drainage system (e.g. gutter), Annex L of Part 1 of this ETAG N° 032 may apply in principle. Where not possible to verify the watertightness by means of Annex L, at least, verification of the performance of the subsurface drainage system in terms of durability and discharge capacity, as stated below, is relevant.

5.1.1.8.1 Bridging plate expansion joints without fingers

The durability of the sub-surface drainage system (e.g. gutter) and its discharge capacity are considered to be the crucial aspects and have to be verified. For durability aspects of the drainage devices, including clamping devices, and the seal, if any, the concerned verification methods, given in 5.2 of this family Part, apply. For the verification of the discharge capacity, 5.1.4.3 of this ETAG Part applies.

5.1.1.8.2 Bridging plate expansion joints with fingers

The durability of the sub-surface drainage system (e.g. gutter) and its discharge capacity are considered to be the crucial aspects and have to be verified. For durability aspects of the drainage devices, including clamping devices, and seals, if any, the concerned verification methods, given in 5.2 of this family Part, apply. For the verification of the discharge capacity, 5.1.4.3 of this ETAG Part applies.

5.1.1.8.3 Roller shutter expansion joints

The durability of the sub-surface drainage system (e.g. gutter) and its discharge capacity are considered to be the crucial aspects and have to be verified. For durability aspects of the drainage devices, including clamping devices and seals, the concerned verification methods, given in 5.2 of this family Part, apply. For the verification of the discharge capacity, 5.1.4.3 of this ETAG Part applies.

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

5.1.4.1.1.1 Bridging plate expansion joints without fingers

See Part 1 of this ETAG N° 032.

5.1.4.1.1.2 Bridging plate expansion joints with fingers

See Part 1 of this ETAG N° 032.

5.1.4.1.1.3 Roller shutter expansion joints

See Part 1 of this ETAG N° 032.

5.1.4.1.2 Level differences in the running surface

5.1.4.1.2.1 Bridging plate expansion joints without fingers

For unloaded conditions see Part 1 of this ETAG N° 032.

For loaded conditions (loading of the joint itself) verification shall be done according to 5.1.1.2.

5.1.4.1.2.2 Bridging plate expansion joints with fingers

For unloaded conditions see Part 1 of this ETAG N° 032.

For loaded conditions (loading of the joint itself) verification shall be done according to 5.1.1.2.

5.1.4.1.2.3 Roller shutter expansion joints

For unloaded conditions see Part 1 of this ETAG N° 032.

For loaded conditions (loading of the joint itself) verification shall be done according to 5.1.1.2.

5.1.4.2 Skid resistance

5.1.4.2.1 Bridging plate expansion joints without fingers

See Part 1 of this ETAG N° 032.

5.1.4.2.2 Bridging plate expansion joints with fingers

See Part 1 of this ETAG N° 032.

5.1.4.2.3 Roller shutter expansion joints

See Part 1 of this ETAG N° 032.

5.1.4.3 Drainage capacity

See Part 1 of this ETAG N° 032.

5.1.4.3.1 Bridging plate expansion joints without fingers

The discharge capacity of the drainage device for bridging plate expansion joints without fingers shall be demonstrated either by calculation or by testing.

For durability aspects of the drainage system (e.g. gutter), the concerned requirements and verification methods, given in 4.2 and 5.2, apply.

5.1.4.3.2 Bridging plate expansion joints with fingers

The discharge capacity of the drainage device for bridging plate expansion joints without fingers shall be demonstrated either by calculation or by testing.

For durability aspects of the drainage system (e.g. gutter), the concerned requirements and verification methods, given in 4.2 and 5.2, apply.

5.1.4.1.2.3 Roller shutter expansion joints

The discharge capacity of the drainage device for bridging roller shutter expansion joints shall be demonstrated either by calculation or by testing.

For durability aspects of the drainage system (e.g. gutter), the concerned requirements and verification methods, given in 4.2 and 5.2, apply.

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

See Part 1 of this ETAG N° 032 in conjunction with Table 5.2 of this ETAG Part.

In the verification the influence of electrochemical corrosion, indicated in 4.1.7.1, has to be taken into account in a proper way of design.

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

See Part 1 of this ETAG N° 032 in conjunction with Table 4.2 of this ETAG Part.

For the resistance to oil, petrol or fuel oil for materials, not considered in the related chapter in 4.1.7.2 of this ETAG part as being not relevant, 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 temperature, UV radiation and ozone

See Part 1 of this ETAG N° 032 in conjunction with Table 5.2 of this ETAG Part.

5.1.7.1.4 Resistance against freeze-thaw

Where relevant see ETAG N° 032, Part 1.

5.1.7.2 Aspects of serviceability

See Part 1 of this ETAG N° 032.

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	Required characteristics	Standard/specification
Surface element (Fingerplate for supported expansion joints with and without fingers and plates for roller shutter expansion joints bridging plate, shutter plates and tongue plate, expansion element)		Structural steel, Cast steel, Cast iron, Stainless steel	Yield point Tensile strength Elongation at rupture Energy absorption Ductility Charpy-V value Chemical composition (including CEV)	Structural steel: EN 10025 Cast steel: Relevant standards, i.e. EN 10283, EN 1562. Stainless steel: EN 10088 Cast iron: EN 1561, EN 1563
		Aluminium: Plate material: Grade 5xxx Extruded material: Grade 6xxx, excluded: grades given in EN 1999-1-3, cl. 3 (2007) Cast material: Grade equivalent level as given for plate material and extruded material	Chemical composition Tensile strength Yield point Stress-strain elongation at rupture Ductility Charpy-V value	Aluminium EN 1999 Extruded aluminium: EN 755-2 Cast aluminium: EN 1706

Table 5.2 (continued)

Parts of the kit	Components of the parts	Material	Required characteristics	Standard/specification
Surface element (Fingerplate for supported expansion joints with and without fingers and plates for roller shutter expansion joints bridging plate, shutter plates and tongue plate, expansion element).		Elastomer	<p><i>Note: Selection depending on chosen materials</i></p> <p>Hardness IRHD Tear resistance Elongation at break Compression set</p> <p>Resistance to low temperatures</p> <p>Resistance to ageing agents Resistance to ozone</p> <p>Resistance to de-icing agents</p> <p>Thermo gravimetric analysis Rheometric characteristics</p>	<p>Standards: See Table 4.2. Testing conditions for specific items: ISO 34-1 (2004) Method A ISO 815 (type B test piece) 24 hours 70 °C Constant Deflection 25 % 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. ISO 48, ISO 37, ISO 188 (7 days in hot air 70 °C). ISO 1431-1 (2004) (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). ISO 1817 (14 days 23 °C, 4% sodium-chloride solution or equivalent).</p>
	Plates, profiles, steel beam grid, etc.	Steel Stainless steel	<p>Yield point Tensile strength Elongation at rupture Chemical composition (C-eq.) Energy absorption (in case welded connection with transition strip)</p>	EN 10025, EN 10088
Supporting substructure	Bearings (in case of roller shutter expansion joints)	Steel, Elastomer, Plastics	<p>Steel: See relevant clauses for elements made of steel</p> <p>Elastomer: Hardness IRHD Tear resistance Elongation at break Compression set Resistance to low temperatures Resistance to ageing agents Resistance to de-icing agents Thermo gravimetric analysis Rheometric characteristics</p>	Standards: See Table 4.2- Testing conditions for specific items: See above "Surface elements"
			<p>Plastics: Density Hardness IRHD Tensile strength Compression set Resistance to low temperatures Resistance to de-icing agents</p>	

Table 5.2 (continued)

Parts of the kit	Components of the parts	Material	Required characteristics	Standard/specification
Supporting substructure	Rotational supports (e.g. line rocker, point rocker, bearing)	Steel, elastomer, plastics	Due to the variety of elements to be defined case by case. For general guidance see also ETAG N° 032, Part 8, Annex 8.M. Results to be stated in the Evaluation Report.	
	Hinges, rockers (in case of roller shutter expansion joints)	Steel	Yield point Tensile strength Elongation at rupture Chemical composition (C-eq.) Energy absorption (in case welded connection with transition strip)	EN 10025
	Transition strip	Steel Stainless steel	Yield point Tensile strength Elongation at rupture Energy absorption Chemical composition (C-eq.)	EN 10025, EN 10088
	Reinforcement bars/loops	Steel	Yield strength Tensile strength Ductility Weldability Bendability Bond property	EN 10080
	Welded dowels for dynamically loaded components	Steel	EN ISO 13918	EN ISO 13918
	Snow plough impact protection strip *)	Steel: See "Plates, profiles"		
Anchorage/ Holding down devices	Bolts, screws, nuts, washers	Steel	Grade or quality class (according to the type of component) Tensile strength Yield strength	According to the relevant standard in the list given in EN 1993-1-8 (2005), 2.8 group 4
	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
	Springs	Steel	Relevant technical specification	Standards: See Table 4.2
		Elastomer	Hardness IRHD Tear resistance Elongation at break, Compression set Resistance to low temperatures Resistance to ageing	Standards: See Table 4.2. Testing conditions for specific items: See above "Surface elements"
Stud bolts	Steel	Relevant load bearing capacity	Relevant specification in Table 4.2	
Sliding support and cover layers	Sheets, surface layer	Sheets: Steel Elastomer/ Plastics	See "Supporting substructure"	
		Layers: Metal, paint	For surface layers (e.g. hard chromium coating, metal application by welding, paint etc.): According to the relevant technical specifications	For surface layers: According to the relevant technical specifications
Connecting devices	Bolts, screws, nuts, washer, profiles	Metal	See "Anchorage devices"	
	Bonding agents/ sealants, sockets	Chemicals/Metal	- Tensile strength resistance (Metals) - Resistance to low temperatures (Chemicals)	Relevant manufacturer's specifications
Kerb elements	Plate, welded attachments (like covers)	Metal	Remark: See "Covers"	

Table 5.2 (continued)

Parts of the kit	Components of the parts	Material	Required characteristics	Standard/specification
Drainage devices *)	Gutter/seal including their connections and butt joints	Elastomer (optionally reinforced), plastics (reinforced) (e.g. Polyamide, PVC, Polyethylene), etc.	Depending on the design of the drainage device the following performance characteristics may have to be considered: Characteristics according to Table 4.2	Relevant technical specification with respect to the concerned performance characteristics E.g.:
			Resistance to de-icing agents	ISO 1817
			Resistance to ozone	ISO 1431-1
			Limit temperature of brittleness (Requirements according to ISO 812 (2006), 7.1.1.4)	ISO 812
			Hardness IRHD	ISO 48, ISO 7619-2
			Tensile strength	ISO 37
			Elongation at break	
			Tear resistance	ISO 34-1 Method A
			Density	ISO 2781 Technical corrections 1 (1996)
			Thermogravimetric analysis (TGA)	EN ISO 11358
			Rheometric characteristics	ISO 3417, ISO 6502
			Resistance to ageing	ISO 188
	<i>Note: The list is not considered as exhaustive.</i>			
		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"	
Connections to the watertight membrane *)	According to the relevant specification			
Transition strip, snow plough impact protection strip (not included in the supporting structure) *)	Transition strip	Resin mortar and cement mortar	According to the manufacturer's specification, e.g.: Resin - Elongation at break - Compressive strength - Modulus of elasticity Aggregate and fillers: - Type - Grading - Resistance to fragmentation - Polished Stone Value (PSV) Mortar: - Compressive strength	Relevant technical specification EN 1097-2 EN 1097-8
	Snow plough impact protection strip	Resin mortar		
Covers *)	Plates	Steel minimum: S235xx	Yield point Tensile strength Elongation at rupture Chemical composition (C-eq.)	EN 10025
		Stainless steel, Grade 1.44xx or 1.45xx		EN 10088
Covers *)	Plates	Aluminium: Plate material: Grade 5xxx Extruded material: Grade 6xxx excluded: grades given in EN 1999-1-3, cl. 3 (2007) Cast material: Grade xxx	Chemical composition Tensile strength Yield point Stress-strain Elongation at rupture Ductility Charpy-V value <i>Note: Selection depending on chosen materials</i>	EN 1999 Extruded aluminium: EN 755-2 Cast aluminium: EN 1706

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

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:	Pass/fail	No
			- Accidental load on footway - Collision on kerb	Pass/fail	No
	Resistance to fatigue	6.1.1.3	Pass/fail		No
	Seismic behaviour	6.1.1.4	Declaration of selected approach and relevant information (aspects, etc.)		Yes
	Movement capacity	6.1.1.5	Declared		No
	Cleanability	6.1.1.6	Pass/fail		Yes
Resistance to wear	6.1.1.7	Pass/fail		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	(See ETAG 032, Part 1.)		
			For vehicle	Pass/fail	Yes
			Gap for use in longitudinal axis	Pass/fail	Yes
			Gap/voids/recess		
			- For cyclist	Pass/fail	Yes
			- For pedestrian	Pass/fail	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 loaded conditions	Pass/fail	Yes
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	If relevant	Declared capacity (in case of drainage system)	Yes	
5	Not relevant				
6	Not relevant				

ER	Characteristics specified in the mandate	ETAG paragraph on product performance to be assessed	Class, use category, criterion		No performance determined option
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		No
			Ageing resulting from		
			- temperature,	See 6.2 in this Part	No
			- UV radiation,		No
			- ozone.		No
Resistance against freeze-thaw	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

The product will be judged as fit for purpose provided that it satisfies the performance requirements in 4.1.1.3 by means of passing the verification procedure as described in 5.1.1.3.

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 by means of passing the verification procedure as described in 5.1.1.3.3.1 in relationship with Annex 7.O.

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.

The evaluation shall report which movement capacities/directions of a type of supported expansion joint do not allow movements in all directions and which additional measures may be used.

6.1.1.5 Movement capacity

The results of the verification according to the verification method given in 5.1.1.5, including movement in relation to the skew and guide angle for related combinations, shall be stated in the ETA for the concerned directions by means of declared values. The minimum opening shall be stated in the ETA.

6.1.1.6 Cleanability

Assessment is related to additional devices (gutter/seal), if part of the kit, and shall be undertaken on the basis of analysis of them. The product will be judged as fit for use, provided that the geometry of the additional devices demonstrates good accessibility for cleaning devices.

6.1.1.7 Resistance to wear

The product will be judged as fit for purpose provided that it satisfies the performance requirements in 4.1.1.7 by means of passing the verification procedure as described in 5.1.1.7.

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 sub-surface drainage system this shall be addressed, including assessment of passage of water and durability of the material of the drainage system.

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.

For the subsurface drainage system, see 6.1.4.3.

6.1.2 Safety in case of fire

According to Part 1 of this ETAG: Not relevant.

6.1.3 Hygiene, health and environment

The product/kit 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 product but not covered by the ETA, 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 shall be undertaken on the basis of analysis of the technical file and drawings. The maximum dimension of steps and difference of the running surface levels shall be stated in the ETA.

In addition, the maximum dimension of steps and difference of the running surface levels under loaded conditions and verified according to 5.1.4.1.2 shall be stated in the ETA.

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

Assessment shall be undertaken on the basis of analysis of the design according 5.1.4.3.

6.1.5 Protection against noise

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

6.1.6 Energy economy and heat retention

According to Part 1 of this ETAG N° 032: 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 5.1.7.1.3 in conjunction with 6.2.

6.1.7.1.4 Resistance against freeze-thaw

Where relevant, assessment shall be undertaken on the basis of 5.1.7.1.4.

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 verification method given in 5.1.7.2.

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.

The table below presents assessment criteria for materials according to 4.2 and 5.2 of this ETAG family Part. For component materials not covered in Table 6.2 below, appropriate assessment criteria shall be used. The Approval Body shall assess the fitness for purpose of the components based on the manufacturers 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	Required characteristics	Assessment criteria
Surface element (Fingerplate for supported expansion joints with and without fingers and plates for roller shutter expansion joints bridging plate, shutter plates and tongue plate, expansion element).		Structural steel, Cast steel, Cast iron, Stainless steel	Yield point Tensile strength Elongation at rupture Energy absorption Ductility Charpy-V value Chemical composition (including CEV)	MDV
		Aluminium: Plate material: Grade 5xxx Extruded material: Grade 6xxx, excluded: grades given in EN 1999-1-3, cl. 3 (2007) Cast material: Grade equivalent level as given for plate material and extruded material	Chemical composition Tensile strength Yield point Stress-strain Elongation at rupture Ductility Charpy-V value	MDV
		Elastomer	Hardness IRHD Tear resistance Elongation at break Compression set Resistance to low temperatures Resistance to ageing agents Resistance to ozone Resistance to de-icing agents Thermo gravimetric analysis Rheometric characteristics	MDV MDV MDV Pass/fail: 25 % Pass/fail: Requirements according to ISO 812 (2006) 7.1.1.4 Pass/fail: Maximum change from unaged value: IRHD: - 0 to 7 tensile strength: - 0 to 15 % elongation at break: 0 to 25 % Pass/fail: No visible cracks Pass/fail: - Decrease of hardness ≤ 5 - Increase of volume ≤ 10 % MDV MDV
Supporting substructure	Plates, profiles, steel beam grid, etc.	Steel Stainless steel	Yield point Tensile strength Elongation at rupture Chemical composition (C-eq.) Energy absorption (in case welded connection with transition strip)	MDV
	Bearings (in case of roller shutter expansion joints)	Steel, Elastomer, Plastics	Steel: See relevant clauses for elements made of steel	MDV
			Elastomer: Hardness IRHD Tear resistance Elongation at break Compression set Resistance to low temperatures Resistance to ageing Resistance to de-icing agents Thermo gravimetric analysis Rheometric characteristics	MDV and pass/fail: See "surface elements".
		Plastics: Density Hardness IRHD Tensile strength Compression set Resistance to low temperatures Resistance to de-icing agents	MDV and pass/fail: See "surface elements"	

Table 6.2 (continued)

Parts of the kit	Components of the parts	Material	Required characteristics	Assessment criteria
Supporting substructure	Rotational supports (e.g. line rocker, point rocker, bearing)	Steel, elastomer, plastics	Due to the variety of elements to be defined case by case. For general guidance see also ETAG N° 032, Part 8, Annex 8.M.	
	Hinges, rockers (in case of roller shutter expansion joints)	Steel	Yield point Tensile strength Elongation at rupture Chemical composition (C-eq.) Energy absorption (in case welded connection with transition strip)	MDV
	Transition strip	Steel Stainless steel	Yield point Tensile strength Elongation at rupture Energy absorption Chemical composition (C-eq.)	MDV
	Reinforcement bars/loops	Steel	Yield strength Tensile strength Ductility Weldability Bendability Bond property	MDV
	Welded dowels for dynamically loaded components	Steel	EN ISO 13918	MDV
	Snow plough impact protection strip *)	Steel: See "Plates, profiles"		
Anchorage/ Holding down devices	Bolts, screws, nuts, washers	Steel	Grade or quality class (according to the type of component) Tensile strength Yield strength Note: The fitness for use is also related to proper behaviour with respect to hydrogen effects in accordance with ISO 2081 and EN ISO 1461 respectively	MDV
	Threaded rod with nuts and washers including resin mortar	Steel (rod) + resin mortar	Relevant load bearing capacity	MDV
	Bonded anchor	Steel + resin or resin mortar	Relevant load bearing capacity	MDV
	Springs	Steel	Relevant technical specification	MDV and pass/fail: See "surface elements"
		Elastomer	Hardness IRHD Tear resistance Elongation at break, Compression set Resistance to low temperatures Resistance to ageing	MDV and pass/fail: See "surface elements"
Stud bolts	Steel	Relevant load bearing capacity	MDV	
Sliding support and cover layers	Sheets, surface layer	Sheets: Steel Elastomer/Plastics		See "Supporting substructure"
		Layers: Metal, paint		MDV
Connecting devices	Bolts, screws, nuts, washer, profiles	Metal	See "Anchorage devices"	
	Bonding agents/sealants, sockets	Chemicals/Metal	- To be covered by full scale tests - Bonding agents manufacturers' specifications to be taken into account	MDV
Kerb elements	Plate, welded attachments (like covers)	Metal	<i>Remark: See "Covers"</i>	

Table 6.2 (continued)

Parts of the kit	Components of the parts	Material	Required characteristics	Assessment criteria
Drainage devices *)	Gutter/seal including their connections and butt joints	Elastomer (optionally reinforced), plastics (reinforced) (e.g. Polyamide, PVC, Polyethylene), etc.	Depending on the design of the drainage device the following performance characteristics may have to be considered: Characteristics according to Table 4.2	In general declaration or pass/fail for the related parameter according to the relevant standard:
			Resistance to de-icing agents	Resistance to de-icing agents: Pass/fail (decrease of hardness ≤ 5; Increase of volume ≤ 10 %)
			Resistance to ozone	Resistance to ozone: Pass/fail (no visible cracks)
			Limit temperature of brittleness (Requirements according to ISO 812 (2006), 7.1.1.4)	
			Hardness IRHD	
			Tensile strength	
			Elongation at break	
			Tear resistance	
			Density	
			Thermogravimetric analysis (TGA)	
	Rheometric characteristics			
			Resistance to ageing	Resistance to ageing: Pass/fail (Maximum change from un-aged value: IRHD: 0 to 7; tensile strength: 0 to 15 %; elongation)
		Metal (steel, stainless steel, Grade 1.44xx or 1.45xx)	Resistance to corrosion	MDV or Pass/fail criterion, where this applies
			Resistance to de-icing agents	
	Fixing elements	Metal	See "Connecting devices"	
Connections to the watertight membrane *)	According to the relevant specification			
Transition strip, snow plough impact protection strip (not included in the supporting structure) *)	Transition strip	Resin mortar and cement mortar	According to the manufacturer specification, define e.g.: Resin - Elongation at break - Compressive strength - Modulus of elasticity Aggregate and fillers: - Type - Grading - Resistance to fragmentation - Polished Stone Value (PSV) Mortar: - Compressive strength	MDV or pass/fail according to the relevant standard
	Snow plough impact protection strip	Resin mortar		
Covers *)	Plates	Steel minimum: S235xx	Yield point	MDV
		Stainless steel, Grade 1.44xx or 1.45xx	Tensile strength Elongation at rupture Chemical composition (C-eq.)	MDV
Covers *)	Plates	Aluminium: Plate material: Grade 5xxx Extruded material: Grade 6xxx excluded: grades given in EN 1999-1-3, cl. 3 (2007) Cast material: Grade xxx	Chemical composition Tensile strength Yield point Stress-strain Elongation at rupture Ductility Charpy-V value	MDV
			Note: Selection depending on chosen materials	

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.

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.

Guidance for accessibility for inspection of the kit, including information on how to measure the parts of the joint subject to wear, shall be given in the installation manual.

In the ETA information shall be given about which parts of the supported expansion joint may not be self cleaning (see 4.1.1.6 in this family Part and in Part 1 of ETAG N° 032).

Section three: ATTESTATION OF CONFORMITY (AoC)

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: Factory Production Control – Control for incoming materials/products

Material/products	Characteristics (1)	FPC	Frequency
Elastomer (for the surface element)	Density Hardness IRHD Tear resistance Tensile strength Elongation at break Rheometric characteristics In addition: Resistance to ageing	Y Y Y Y Y Y Y	Each batch (1) or certificate according to EN 10204 (2004), type 3.1
Elastomer, plastics for bearing	Density Hardness IRHD Tear resistance Tensile strength Elongation at break Resistance to de-icing Rheometric characteristics	Y Y Y Y Y Y Y	Each batch (1) 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, elastomer, plastics for rotational supports	Relevant performance characteristics according to the individual concept	Y	Certificate according to EN 10204 (2004), type 3.1 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
Structural steel, cast steel, cast iron, stainless Steel (fingerplate)	Yield point Tensile strength Elongation at rupture Energy absorption Ductility Charpy-V value Chemical composition	Y Y Y Y Y Y Y	Certificate according to EN 10204 (2004), type 3.1, at each delivery
Aluminium (surface elements)	Yield point Tensile strength Elongation at rupture Chemical composition Stress-strain Ductility Charpy-V value Note: Selection depending on chosen materials	Y Y Y Y Y Y Y	Certificate according to EN 10204 (2004), type 3.1, at each delivery

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

Material/products	Characteristics (1)	FPC	Frequency
(Stainless) Steel (kerbs, cover plates)	Yield point Tensile strength Elongation at rupture Chemical composition	Y Y Y Y	Certificate according to EN 10204 (2004), type 3.1, at each delivery
Aluminium (kerbs, cover plates)	Yield point Tensile strength Elongation at rupture Chemical composition Stress-strain Ductility Charpy-V value	Y Y Y Y Y Y Y	Certificate according to EN 10204 (2004), type 3.1, at each delivery
Hinges, rockers (in case of roller shutter expansion joints)	Yield point Tensile strength Elongation at rupture Chemical composition (C-eq.) Energy absorption (in case welded connection with transition strip)	Y Y Y Y Y	Certificate according to EN 10204 (2004), type 3.1, at each delivery
(Stainless) Steel (Components for supporting structure and anchorage)	Yield point Tensile strength Elongation at rupture Chemical composition Energy absorption (in case welded connection with transition strip)	Y Y Y Y Y	Certificate according to EN 10204 (2004), type 3.1, at each delivery
Steel (Reinforcement bars/loops for support structure)	Yield strength Tensile strength Ductility Weldability Bendability Bond property	Y Y Y Y Y Y	Certificate according to EN 10204 (2004), type 3.1, at each delivery
Welded dowels for dynamically loaded components	EN ISO 13918	Y	Delivery note with indication of material grade and standard at each delivery
Steel (Bolts nuts, washers)	Grade or quality class (according to the type of component) Tensile strength Yield strength	Y	Delivery note with indication of material grade and standard at each delivery
Bonded anchor (Steel + resin mortar/grout)	Equivalent to those for bolts	Y	Delivery note with indication of material grade and standard at each delivery
Steel, elastomer (springs)	Relevant performance characteristics according to the individual concept	Y	Certificate according to EN 10204 (2004), type 3.1 at each batch
	Parameters according Table 4.2	Y	
Elastomer/Plastics Sliding supports Cover layers Metal	Sheets made of steel: See "Supporting substructure" Layer: Relevant performance characteristics according to the individual concept	Y	Certificate according to EN 10204 (2004), type 3.1 at each batch
Steel + resin mortar/grout (anchor)	Equivalent to those for bolts	Y	
Resin mortar for transition strip/snow plough impact protection strip and cement mortar for transition strip	According to the manufacturer's specification, define e.g.: Resin: - Elongation at break - Compressive strength - Modulus of elasticity	Y	Frequencies shall be defined in the approval procedure in function of the quantity used and in order to guarantee a correct level of quality
	Aggregate and fillers: - Type - Grading - Resistance to fragmentation - Polished Stone Value (PSV)	Y	
	Mortar: Compressive strength	Y	

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

For components not transferring main loads, certificates type 2.1 according to EN 10204 (2004) instead of type 3.1 may be acceptable.

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
Surface elements				
Manufacturing of surface elements	Dimensions, thickness, Corrosion protection including layer thickness measurement	Internal procedure	Each element	Conformity to the design drawings
Support structure, anchorage devices and kerb elements				
Plates, profiles, etc.	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/seal				
Assembly of gutter/seal and fixings	Dimensional check		Each delivery	Conformity to the design drawings
General assembly				
Assembly of kit	Dimensional check Recheck of corrosion protection		Each unit	Conformity to the design drawings

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

See Part 1 of this ETAG N° 032.

Factory Production Control – Testing of samples taken at the factory

Testing of samples of completed expansion joint sections, taken at the factory, is not relevant for supported finger joints.

8.2.2 Tasks for the approved body

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 the table 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 supplier's certificate (for type of certificate see remark in Table 8.3 below) or by individual testing.

Table 8.3: Type testing for materials and related components

Material	Characteristics (1)	Initial Type Testing	Remark
Elastomer, plastics (for the component drainage devices, e.g. gutter/seal)	Selection of relevant performance characteristics in accordance with Table 4.2., depending on the individual concept	Y	Certificate according to EN 10204 (2004), type 3.1 or 2.1
Elastomer (for the surface element, bearing, spring)	Selection of relevant performance characteristics in accordance with Table 4.2., depending on the individual concept	Y	Certificate according to EN 10204 (2004), type 3.1
Structural steel, cast steel, cast iron, stainless steel for surface elements	Performance characteristics in accordance with Table 4.2	Y	Certificate according to EN 10204 (2004), type 3.1
Aluminium for surface elements, kerbs, cover plates	Performance characteristics in accordance with Table 4.2	Y	Certificate according to EN 10204 (2004), type 3.1
(Stainless) Steel (for supporting structure: plates, profiles, steel beam grid, transition strip)	Performance characteristics in accordance with Table 4.2	Y	Certificate according to EN 10204 (2004), type 3.1
Hinges, rockers (in case of roller shutter expansion joints)	Performance characteristics in accordance with Table 4.2	Y	Certificate according to EN 10204 (2004), type 3.1
Steel, elastomer, plastics for rotational support	Performance characteristics in accordance with Table 4.2	Y	Certificate according to EN 10204 (2004), type 3.1
Steel, elastomer (Springs)	Performance characteristics in accordance with Table 4.2	Y	Certificate according to EN 10204 (2004), type 3.1
(Stainless) Steel (components for drainage devices)	Performance characteristics in accordance with Table 4.2	Y	Certificate according to EN 10204 (2004), type 2.1
(Stainless) steel (kerbs, cover plates)	Performance characteristics in accordance with Table 4.2	Y	Certificate according to EN 10204 (2004), type 3.1
Steel (reinforcement bars/loops for support structure)	Performance characteristics in accordance with Table 4.2	Y	Certificate according to EN 10204 (2004), type 3.1
Steel (welded dowels)	Performance characteristics in accordance with Table 4.2	Y	Certificate according to EN 10204 (2004), type 3.1
Steel (bolts, nuts, washers)	Performance characteristics in accordance with Table 4.2	Y	Certificate according to EN 10204 (2004), type 3.1
Steel + resin mortar/grout (Threaded rod)	Performance characteristics in accordance with Table 4.2	Y	
Steel + resin mortar/grout (Bonded anchor)	Performance characteristics in accordance with Table 4.2	Y	
Resin mortar, cement mortar (for transition strip/snow plough impact protection strip)	Performance characteristics in accordance with Table 4.2	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 and 8.2.

(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 ACCOMPANYING 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.

9.1 THE ETA-CONTENT

9.1.1 Model ETA

See Part 1 of this ETAG N° 032.

9.1.2 Checklist for the Approval Body

See Part 1 of this ETAG N° 032.

9.2 ADDITIONAL INFORMATION

See Part 1 of this ETAG N° 032.

Additional information for supported expansion joints with fingers:

In case of using aluminium for the finger plate, the following items shall be stated in a proper way:

- declaration about protection of aluminium parts when in contact with concrete under humid circumstances,
- information about insulation measures taken to avoid galvanic elements (electrolytic corrosion).

The manufacturer shall give sufficient instruction about the proper cleaning procedure of the gutter.

Information about possible additional measures with respect to seismic behaviour shall be given.

Regarding the declared movement capacity in the transverse direction it shall be accompanied by information that its suitability is influenced by the following:

- relative shift of the two elements of the expansion joint in transverse direction due to temperature differences between the structure and the abutment,
- bearing play,
- rotation due to horizontal curvatures of the main structure caused by temperature gradients.

Information about combinations when the longitudinal slope exceeds 4 % (see 4.1.1.1) and/or verified skew angle shall be given.

9.3 CONFIDENTIAL INFORMATION

See Part 1 of this ETAG N° 032.

9.4 INSTALLATION REQUIREMENTS

See Part 1 of this ETAG N° 032.

ANNEXES TO THIS ETAG FAMILY PART

Annexes 7-A to 7-L: for this family Part correspond to Annexes A – L in Part 1 of this ETAG N° 032, if applicable.

Annex 7.M: Mechanical resistance test method for supported expansion joints (Full scale component test)

7.M.1. SCOPE

This annex describes the method for verifying the mechanical resistance both for SLS and ULS load combinations of components of supported expansion joints in one testing procedure.

7.M.2. PRINCIPLES

The principle of this test is to apply a load, derived from calculations, representing the design situations and to investigate the behaviour at SLS and ULS. The test results will be used to verify the requirements according to 4.1.1.2.

In the case of calculation assisted by testing the samples to be tested shall cover the relevant part of the kit according to 5.1.1.2.3 in this ETAG Part. For each part at least three specimens shall be tested.

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

The test specimens shall correspond to the relevant part of design including all features of the components.

7.M.4. LOAD ARRANGEMENTS

7.M.4.1 TEST LOADS

The concerned test loads for SLS and ULS shall be derived from the relevant design situations in accordance with 5.1.1.2.

7.M.4.2 APPLICATION OF TEST LOAD

The application of loads shall take into account the representative introduction of the loads into the component and into the substructure.

7.M.5. TESTING ARRANGEMENT

The test conditions shall represent an appropriate modelling of the built in conditions, taking into account the declared maximum vertical displacements derived from the boundary conditions.

7.M.6. EXECUTION OF THE TEST

The execution shall cover the SLS and ULS design situation derived according to 7.M.4.1 of this annex.

7.M.6.1 TEST CONDITIONS

The test shall be run at ambient temperature. 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.

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

7.M.6.2 TEST PROCEDURES

7.M.6.2.1 Test procedures for SLS design situation

The load shall be applied until the relevant SLS load level.

At that SLS-load level the following verifications shall be carried out:

- visual inspection during applying the load,
- measurement and continuous recording of deformations,
- observations with respect to uplift.

Total removal of the load:

- after removal of the test load remaining deformations shall be recorded,
- visual inspection.

7.M.6.2.2 Procedure for ULS design situation

The load shall be applied until ULS load level and at 100 % ULS level it shall be maintained for a period of three minutes.

At 100 % of ULS-load level the following verifications shall be carried out: Visual inspection for identifying the failure modes, if any.

Note: After passing the ULS test loading may be further increased until collapse as far as the equipment allows and to identify the post critical behaviour.

7.M.7. EXPRESSION OF TEST RESULTS

The following phenomena shall be monitored and recorded (using figures and/or graph(s) as applicable) for all test procedures:

- Applied loads (kN) and loading rate,
- Values of the deflections (e.g. photographs),
- Exceptional behaviour, e.g. excessive deformations (e.g. photographs and description),
- Failure mode (characteristic of failure, failure progress at ULS, location, uplift) shall be described.

7.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 arrangement,
- Date of the preparation of specimens, the date of test and the mean test temperature,
- Dimensions of test specimens,
- Material characteristics (e.g. concrete quality of the support structure, prefabricated parts),
- Expression of monitored phenomena according to 7.M.7.

Annex 7.N: Supported expansion joints – Verification of resistance to fatigue by full scale component testing

7.N.1. SCOPE

This annex describes the method for verifying by testing the resistance to fatigue of component of supported expansion joints caused by traffic loads and vertical bridge displacements.

7.N.2. PRINCIPLES

The two following situations shall be considered:

- traffic load on the expansion joint and,
- vertical displacements caused by bridge movements.

The principle of this test procedure is to investigate the different fatigue life categories in relation to the working life categories. The test results will be used to verify the requirements according to 4.1.1.3 in this ETAG Part.

In case of calculation assisted by testing at least three specimens covering the relevant type according to 5.1.1.3.2 in this ETAG Part shall be tested.

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

The test specimens shall correspond to the relevant part of design including all features.

7.N.4. TESTING ARRANGEMENT (TEST LOADS, DISPLACEMENTS AND NUMBER OF CYCLES)

The application of loads shall take into account the representative introduction of the loads into the component and into the substructure.

The test conditions shall represent an appropriate modelling of the built in conditions.

Table 7.N.1: Load cycles for verification of different fatigue lives in relation to the working life categories

Supported 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	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 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

Note 1: For simplification it is possible to replace n_v by n_{v+h} .

Note 2: For idealisation of axle load histogram to maximum axle loads with equivalent numbers of cycles $m = 3$ is used. Use of $m = 3$ is related to the situation that the load transferring components are made of steel.

Note 3: If horizontal loads can be neglected (see also 5.1.1 in this ETAG Part), the total numbers of vertical load cycles become: $2,8 \times 10^6$ (10 years category), $4,2 \times 10^6$ (15 years category) and 7,1 million (25 years category) for contact pressure = $0,8 \text{ N/mm}^2$. For the 50 years category the total number of cycles related to FLM 1 applies.

For contact pressure = $1,0 \text{ N/mm}^2$ a similar simplification applies.

7.N.5. EXECUTION OF THE TEST

Depending on the design situation of the component(s) considered, the test shall be carried out either displacement controlled or load controlled. The procedure shall be stated in the test report and in the Evaluation Report. The test shall be run at ambient temperature. 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. If relevant, load reversals (tension/compression) shall be considered.

7.N.6. EXPRESSION OF THE RESULTS

The following shall be monitored and recorded:

- Applied loads (kN), displacements and cycles, corresponding deformations,
- Cracks (supported by photographs),
- Loosening, breaking,
- Specific elongations/stresses.

7.N.7. TEST REPORT

The test report shall refer to the present 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 7.N.6.

Annex 7.O: Verification of resistance by full scale testing caused by cyclic movements without traffic loads

7.O.1. SCOPE

This annex describes the method for verifying of the resistance to cyclic movement of supported expansion joints in case of bridge movement with no traffic loads on the expansion joint.

7.O.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.

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

The test specimens shall correspond to the relevant part of the design, including all features of the concerned component(s) (e.g. fixing).

The length of the test specimen shall be at least 400 mm, representative for the transfer of the reaction forces.

7.O.4. LOAD AND MOVEMENT ARRANGEMENTS

This test phase describes the imposed bridge movements, leading to cyclic movement.

7.O.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.

7.O.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 the related movement capacity.

Phase 1b: Expansion joint at maximum opening position; 2 500 cycles of 1/3 of the related 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 the nominal opening position; 2 500 cycles of vertical translation Δh ($\Delta h = 3$ mm up, 8 mm down).
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.

7.0.7. 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.

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

7.0.8. 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 7.0.7.

Annex 7.P: Verification of wear of sliding surfaces

7.P.1. SCOPE

This annex describes the method for verifying the resistance to wear of supported expansion joints by full scale model testing of the concerned sliding part(s) of the joint.

7.P.2. PRINCIPLES

The principle of this test procedure is to apply a simulation of the bridge movements in the most unfavourable position of the supported expansion joint in respect to wear. One test shall be carried out.

7.P.3. SAMPLES AND PREPARATION OF TEST SPECIMENS

The dimensions of the test specimen shall be representative for the concerned entire contact surface. The minimum length of the moving part sample (representing the part of the sliding plate or finger respectively) should be the length of the concerned contact area of the sliding element and may be reduced to a length of 50 mm.

7.P.4. LOAD AND MOVEMENT ARRANGEMENTS

The total slide path for the test procedure in relation to a working life of “a” years of a component is derived from $a \times 365 \times 0,33 \times \text{maximum movement capacity} = 120 \times a$ cycles with maximum movement capacity of the joint.

For “a” see working life categories in Table in 2.3.4 of this Part of ETAG N° 032.

Contact force (including the effects from declared vertical displacement) in sliding surface(s):

Note: Contact force is related to 50 % of opening position of the expansion joint.

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

7.P.5. TESTING ARRANGEMENT

The test arrangement shall consider the most unfavourable position, considering declared permanent rotation capacity. Possible accumulation of debris shall be considered.

The testing arrangement shall allow the application of the forces within a tolerance of ± 2 % 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.

7.P.6. EXECUTION OF THE TEST

The test shall be run at ambient temperature. In case of sensitivity of materials against low or high temperatures (see range of temperatures according to ETAG N° 032, Part 1, 2.3.2), this has to be taken into account when choosing the testing temperature in order to obtain results for the most adverse temperature conditions.

Attention shall be paid to the question of whether materials might be susceptible to the influence of ageing and debris, if so, this shall be considered in the verification.

Apply the movements with a minimum mean velocity of 4 mm/s on the test specimen. One stroke shall be at least three times of the length of the contact surface of the test specimen (see 7.P.3). In case of movement capacity less than three times of that contact surface, the stroke is defined by movement capacity value itself.

For required number of cycles and minimum accumulated wear path see ETAG Part 7, 4.1.1.7.

The increase of temperature during test is limited to the declared range of operating temperature (see 2.3.2 in this ETAG family Part).

7.P.7. EXPRESSION OF THE RESULTS

Depending on the design concept, the following shall be monitored and recorded in steps of 20 % of the total wear path:

- abrasion of sliding material expressed in loss of thickness (mm),
- horizontal reaction forces,
- debonding of sliding material, resulting in loss of corrosion protection,
- accumulation of debris, influencing wear aspects, shall be reported and evaluated.

And for roller shutter expansion joints at the end of the test special attention shall be paid to:

- hinges (rotation without limitations),
- sliding bearings (remaining load bearing capacity),
- state of support conditions.

7.P.8. TEST REPORT

The test report shall refer to the present 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, including amount and types of debris used,
- 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 7.P.7.

Annex 7.Q: Explanations for the design situations for SLS and ULS, used in the supported expansion joints – Mechanical resistance test method (Informative)

The objective of this annex is to give sufficient background information on the selected design situations in Annex 7.N of this Part of the ETAG in conjunction with Annex G of ETAG N° 032, Part 1.

7.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 $\alpha_{od} = 0,6$ for $C_{ULS} = 1$ according to Annex G of Part 1, G.4.2.1 and G.4.3.1.

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 $\alpha_{OT} = 1,0$ for $C_{ULS} = 1$ according to Annex G of Part 1, G.4.2.1 and G.4.3.1.

Note: The design situation for C_{SLS} is considered to be analogous to C_{ULS} (see also G.4.2.2 in Annex G of ETAG N° 032, Part 1).

Background for derivation of loads for $ULS_{Annex\ G\ of\ Part\ 1}$ verification (see 5.1.1.2 of this ETAG family Part):

The vertical load is $1,35 \times 150$ kN acting on a wheel print of 300 mm x 250 mm (contact pressure of 1,35 N/mm²). Where necessary, the load and the wheel print may be reduced, keeping the concerned contact pressure. The horizontal load in 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 this ETAG N° 032, Part 1, Annex G, Table G.5, apply.

Explanation: *The joint shall at least fulfil the mechanical strength at the design load level (= 1,35 – according to EN 1990, Annex A2, Table A2.4 (B) Design values of actions – times the characteristic loads given in Table 1 of Annex G of Part 1). However there is an uncertainty in the quality of the specimen.*

Note: Background for derivation of loads for $SLS_{Annex\ G\ of\ Part\ 1}$ verification: (see 5.1.1.2 of this ETAG family Part):

The load shall be derived from a vertical test load being 150 kN acting on a wheel print of 300 mm x 250 mm (contact pressure of 1,00 N/mm²). Where necessary, the considered load and the considered wheel print may be reduced, keeping the theoretical contact pressure. The considered theoretical horizontal load in traffic direction (longitudinal) is 0,4 (according to Annex G of Part 1, G.2.2.1) of the vertical load and the horizontal load perpendicular to the traffic direction (transverse direction) is 0,2 (according to Annex G of Part 1, G.2.2.2) of the vertical load. If the test specimen is subjected to a combination effect of vertical and horizontal loads, the combination factors ψ as given in this ETAG N° 032, Part 1, Annex G, Table G.5, apply.

7.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 $\sigma_d = 1,0$ for $C_{ULS} = 2$ according to Annex G of Part 1, G.4.2.1 and G.4.3.1.

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

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

7.Q.3. SITUATION ACCORDING TO ANNEX G OF PART 1, G.4.3.2 (FREQUENT COMBINATION)

Not of relevance for current supported expansion joints.

7.Q.4. ALTERNATIVE SIMPLIFIED VERIFICATION PROCEDURE

(instead of procedure 1 + procedure 2): Opening position: 100 % in combination with 100 % SLS load level (σ_d and $\sigma_T = 1,0$)

According to Annex G of Part 1, G.4.2.1, SLS1 and SLS2 can be covered by an envelope approach with the condition σ_d and $\sigma_T = 1,0$.

For ULS due to the specific situation of level differences at intersecting cantilevers no distinction between ULS 1 and ULS 2 has to be made. For ULS 100 % load level applies.

Annex 7.R: Examination of requested load cycles and requested loads for verification of fatigue resistance for supported expansion joints for an assumed fatigue life of 10, 15, 25 and 50 years¹ and unlimited fatigue life (Informative)

7.R.1. FOREWORD

The objective of this annex is to give sufficient background information on the used loads and load cycles used in Annex 7.N of this Part of the ETAG in conjunction with Annex G of ETAG N° 032, Part 1 and Eurocode 1991-2.

Sources: Annex G of ETAG N° 032, Part 1, G.3.3 FLM 2, Table G4 + N_{obs} according to EC 1991-2, Table 4.5.

Precondition: If for supported expansion joints for the kit (according to 5.1.1.3.3) or parts of them (anchorage according to 5.1.13.2) unlimited fatigue life is of relevance FLM1 to Annex G of ETAG N° 032, Part 1 applies. If limited fatigue life is of relevance, FLM2 according to Annex G of ETAG N° 032, Part 1 applies.

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

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

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

7.R.2. EQUIVALENT NUMBER OF AXLE RATES FOR SUPPORTED EXPANSION JOINTS AND ANCHORAGE SYSTEMS

Table 7.R.1: Idealisation of axle load histogram to maximum axle loads with equivalent numbers of cycles

	Axle number rate	Equivalent number of axle rates for vertical loads	
	1,1	0,16	
	1,25	0,31	
	0,20	0,10	
	0,45	0,32	
	0,45	0,45	
	n _{equ}	1,34	

Background:

- Horizontal loads are related to traction forces only,
- $0,16 = 1,1 \times (100/190)^3$,
- $0,07 = 0,20 \times (20/28)^3$,
- Exp3 – see Palmgren-Miner hypothesis about damage accumulation (Fictitious: $m = 3$; related to the situation that most of relevant components are made of steel).

For other materials the appropriate fatigue classifications and S-N-lines shall be derived from standards or testing.

¹ Years according to WL categories in Part 1 of the ETAG 032 (draft edition September 2011)

$Q_{1k,fat}$ according to Annex G of Part 1, Table G.4, including $\gamma_{fat} = 1,3$
 $Q_{1k,fat}$, including $\gamma_{fat} = 1,0$
 Axle number rate according to Annex G of Part 1, Table G.4.

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

- 10 = 10 years assumed working life according to category 1 in Part 1 (10 years),
- 15 = 15 years assumed working life according to category 2 in Part 1 (15 years),
- 25 = 25 years assumed working life according to category 3 in Part 1 (25 years),
- 50 = 50 years assumed working life according to category 4 in Part 1 (50 years).

7.R.3. CONCLUSION FOR REQUESTED LOAD CYCLES FOR AXLE LOADS ON SUPPORTED EXPANSION JOINTS

Fatigue behaviour is tested as a summation of two load categories:

- vertical loads,
- vertical loads combined with horizontal loads in the traffic direction.

1. Load cycle derived from vertical axle load 190 kN (see Table 6.R. 1, line 5):

$$n = (1,34 - 0,80) \times 500\,000 \times 10 = 0,54 \times 500\,000 \times 10 = \mathbf{2,7 \times 10^6}$$

2. Load cycle derived from vertical axle load (190 kN) in combination with horizontal axle load 28 kN (see Table 6.R.1, line 5):

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

Note 1: Resulting load: $(190^2 + 28^2)^{0.5} = 192$ kN. Inclination of load application: 8,4°.

Note 2: Table 1 shows that only the 100 kN up to 150 kN vertical axle loads represent a very small volume of the total axle load cycles. Therefore the n for combination of vertical and horizontal loads in 2.2 has a relative high value, compared to n in 2.1 for F_v (see also F_{v+h} and F_v in Tables 6.R. 2 and 6.R. 3).

7.R.4. TEST LOAD (F) FOR SUPPORTED EXPANSION JOINTS, BASED ON FLMEJ 2

1. According to Annex G.3.3 of 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 this ETAG N° 032, Part 1, Annex G, Table G.4, 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).

Consequence for the test load to be used:

Due to the geometry and the load path of supported expansion joints and the need to consider realistic strain intervals in these structures, for supported 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. This contact pressure is considered to act on a fictitious wheel print of at least 300 mm x 250 mm. The effect of the voids is disregarded.

Consequently, the requested vertical test load F_{TV} has to be calculated, using an average contact pressure (0,8 N/mm²) and a fictitious 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 $p_{\text{requested}} = 1,0$: $(0,8/1,0)^3 = 0,5$ x load cycles.

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

7.R.5. TEST LOAD (F) FOR SUPPORTED EXPANSION JOINTS, BASED ON FLMEJ 1

1. According to Annex G of ETAG N° 032, Part 1, G.3.2, 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 of ETAG N° 032, Part 1, G.3.2, 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 ETAG N° 032, 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.
3. The related theoretical contact pressure = $68300/(300 \times 250) = 0,91$ N/mm². In principle, this covers the contact pressure in practice. If for FLM 1 EJ the contact pressure is reduced from 0,91 N/mm², the associated number of cycles is

$$(0,91/0,8)^3 \times 5\,000\,000 = 7,4 \times 10^6$$

4. 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: $((0,91/p_{\text{requested}})^3) \times$ load cycles.

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

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

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

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

7.R.6. SUMMARIZING TABLE OF CALCULATED LOAD CYCLES FOR DIFFERENT FATIGUE LIVES

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

For unlimited fatigue life the contact pressure and number of cycles is stated in relation to Annex G of ETAG N° 032, Part 1 and EN 1991-2.

Table 7.R.2: Calculated load cycles

Item		FLM 2 EJ				FLM 1 EJ
		10 years	15 years	25 years	50 years	Unlimited
Supported Expansion Joints, including anchorage system (Contact pressure: 0,8 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	$1,1 \times 10^6$	$1,7 \times 10^6$	$2,9 \times 10^6$	$5,8 \times 10^6$	
Supported Expansion Joints, including anchorage system (Contact pressure: 0,91 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.	

Background:

- 0,8 see 3.3,
- 0,8 see 3.4,
- exp³ from SN-line with constant slope.

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), included in the loads according to Annex G of Part 1,
4. $n = 5 \times 10^6$ according to EN 1991 for constant amplitude fatigue limit σ_D ,
5. $V =$ Vertical axle load, $H =$ Horizontal axle load.

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

Comment on comparison between limited fatigue life of 50 years and unlimited fatigue life according to EN 1991: 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 supported expansion joints.

7.R.7. NUMBER OF LOAD CYCLES FOR DIFFERENT FATIGUE LIVES

Table 7.R.3: Load cycles for verification of different fatigue lives in relation to the working life categories

Supported 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	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	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	(FLM 1 EJ applies)	3,8 x 10 ⁶

Note 1: For idealisation of the axle load histogram to maximum axle loads with equivalent numbers of cycle $m = 3$ is used. The use of $m = 3$ is related to the situation that the load transferring components are made of steel.

Note 2: If horizontal loads can be neglected (see also 5.1.1 in this ETAG Part), the total numbers of vertical load cycles become: $2,8 \times 10^6$ (10 years category), $4,2 \times 10^6$ (15 years category) and $7,1 \times 10^6$ (25 years category) for contact pressure = 0,8 N/mm². For 50 years category the total number of cycles related to FLM 1 applies.

For contact pressure = 1,0 N/mm² a similar simplification applies.

Derivation of test loads from contact pressure:

The load application shall be executed by means of a contact area which simulates the geometry and stiffness of the wheel.

(In case of pulsating test: elastomeric pad: $\geq 300 \text{ mm} \times 250 \text{ mm}$):

Minimum vertical test load per wheel = $A_{\text{min}} \times 0,8 = 300 \times 250 \times 0,8 = 60 \times 10^3 \text{ N} = 60 \text{ kN}$,

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

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