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ETAG n° 032

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GUIDELINE FOR EUROPEAN TECHNICAL APPROVAL

of

EXPANSION JOINTS FOR ROAD BRIDGES

PART 6: CANTILEVER EXPANSION JOINTS

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ANNEXES TO THIS ETAG FAMILY PART

Annexes 6-A to 6-L for this family Part correspond to Annexes A – L in Part 1 of this ETAG N° 032, if applicable.

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 part of ETAG	Title
EN 485-2	Table 4.2	Aluminium and aluminium alloys – Sheet, strip and plate – Part 2: Mechanical properties
EN 754-2	Table 4.2	Aluminium and aluminium alloys – Cold drawn rod/bar and tube – Part 2: Mechanical properties
EN 755-2	Table 4.2, Table 5.2	Aluminium and aluminium alloys – Extruded rod/bar, tube and profiles – Part 2: Mechanical properties
EN 1090-3	Table 4.2	Execution of steel structures and aluminium structures – Part 3: Technical requirements for aluminium structures
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 Annex A2	6.Q.1	Eurocode: Basis of structural design
EN 1991-2	6.R.4, 6.R.5, 6.R.6	Eurocode 1: Actions on structures – Part 2: Traffic loads on bridges
EN 1993-1-3 (2007)	Table 5.2	Eurocode 3: Design of steel structures – Part 1-3: General rules – Supplementary rules for cold-formed members and sheeting
EN 1993-1-8 (2005)	Table 4.2	Eurocode 3: Design of steel structures – Part 1-8: Design of joints
EN 1999 (2007)	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 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, Table 8.3	Metallic products – Types of inspection documents
EN 10283	Table 4.2, Table 5.2	Corrosion resistant steel castings

EN 10293	Table 4.2, Table 5.2	Steel castings for general engineering uses
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	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 8.1, 8.2.1	Welding – Studs and ceramic ferrules for arc stud welding
ISO 34-1 (2004)	Table 4.2	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 812 (2006)	Table 4.2, Table 5.2	Rubber, vulcanized or thermoplastic – Determination of low-temperature brittleness
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 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	Rubber, vulcanized – Determination of density. Technical Corrigendum 1
ISO 3417	Table 4.2	Rubber – Measurement of vulcanization characteristics with the oscillating disc curementer
ISO 6502	Table 4.2	Rubber – Guide to the use of curemeters
ISO 7619-2	Table 4.2	Rubber, vulcanized or thermoplastic – Determination of indentation hardness – Part 2: IRHD pocket meter method
ISO 9924	Table 5.2	Rubber and rubber products – Determination of the composition of vulcanizates and uncured compounds by thermogravimetry – Part 1: Butadiene, ethylene-propylene copolymer and terpolymer, isobutene-isoprene, isoprene and styrene-butadiene rubbers Part 2: Acrylonitrile-butadiene and halobutyl rubbers

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 reference will be made to the appropriate clause in Part 1.

2. SCOPE

2.1 SCOPE AND DEFINITION

2.1.1 General

This Part of the ETAG N° 032 specifies the product performance characteristics, methods of verification and assessment procedures for Cantilever 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 032, Part 1:

A Cantilever Expansion Joint consists of cantilever symmetrical and non-symmetrical elements (such as comb or saw-tooth or sinusoidal plates), which are anchored on one side of the deck joint gap and interpenetrate to bridge the deck joint gap. The elements are flush with the running surface.

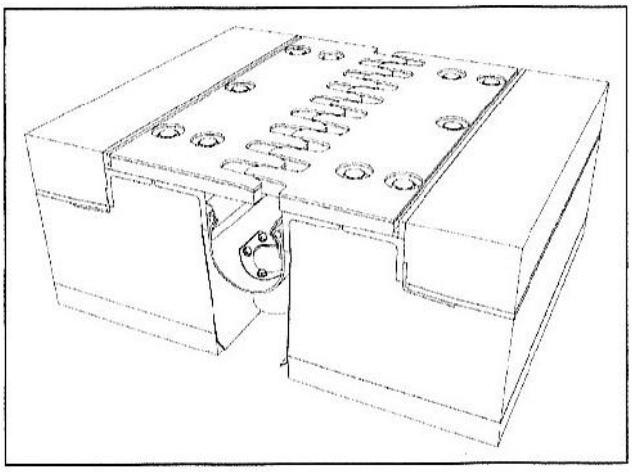


Figure 1: Example of Cantilever Expansion Joints (3D view)

Note: This example shows one design of Cantilever Expansion Joints, other designs are possible.

Examples of finger shapes of Cantilever Expansion Joints are given in Annex 6.M.

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 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.

Cantilever expansion joint kits consist at least of the following:

- Finger plates,
- Anchorage system.

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

- Kerb elements,
- Covers for pedestrian areas,
- Devices for running surfaces (cyclist areas),
- Substructure (linking the joint to the main structure),
- Adaptations for snow plough impacts (e.g. impact protection strip),
- Devices for watertightness or sub-surface drainage system,
- Connections to the watertight membrane,
- Transition strip.

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

Note 2: Additional top layers (e.g. epoxy layer with quartz or corundum) can be used to achieve a higher level of skid resistance. These are not considered to be part of the kit and any enhanced skid resistance is not declared with the CE marking.

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, but not less than 10 years, may be chosen. The concerned component and its 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.

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

Figure 2 shows typical shapes of Cantilever Expansion Joints in plan.

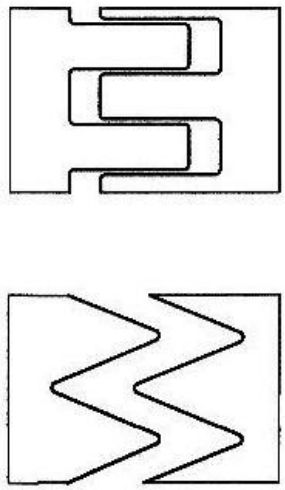


Figure 2: Examples of typical shapes of Cantilever Expansion Joints

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.

The actions, loads and combinations of loads and opening positions are given in Annex G of Part 1 of this ETAG N° 032.

The allowed skew angle between the traffic direction and the longitudinal axis of the joint influences the load transfer and shall be considered in the assessment.

4.1.1.2 Mechanical resistance

The general requirements for the external load and imposed deformation conditions related to the fundamental combination ULS and the characteristic combination SLS are given in ETAG N° 032, Part 1, 4.1.1.2.

SLS conditions are related to the two design situations: according to Annex G, G.4, in ETAG N° 032, Part 1.

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 contact between intersecting cantilevers (see also 4.1.1.5 in this ETAG family Part),
- No separation of contact surfaces (i.e. all contact surfaces shall be under compression stress).

ULS conditions are related to the two design situations: according to Annex G, G.4, in ETAG N° 032, Part 1.

For ULS the requirements, given in Table 4.1.1 in ETAG N° 032, Part 1, apply.

Under imposed displacements at ULS of the main structure no contact between intersecting cantilevers shall occur.

Loads are given in Part 1, Annex G.

4.1.1.3 Resistance to fatigue

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.

Resistance against repeated movements of the main structure due to temperature and traffic is not relevant because they do not generate internal forces.

4.1.1.4 Seismic behaviour

See Part 1 of this ETAG N° 032.

“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 cantilever plates in opening position”.

The movement capacity of a cantilever 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.

4.1.1.5 Movement capacity

See Part 1 of this ETAG N° 032.

The displacement velocity and the temperature do not affect the response of the Cantilever Expansion Joints.

No requirement for an additional allowance for displacements and corresponding rotation is of relevance.

For Cantilever Expansion Joints with overlapping fingerplates it shall be assessed which bridge deck uplift is feasible. The related value, to be declared in relation to the opening position, shall be stated in the ETA.

A minimum of overlapping as illustrated in Figure 4.1.1.5 is required.

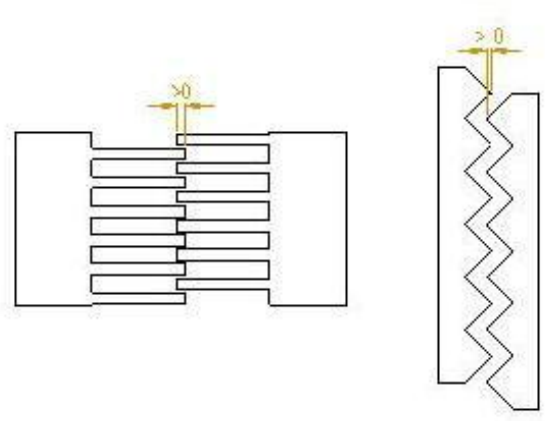


Figure 4.1.1.5: Rectangular and triangular cantilever minimum allowable intersecting

4.1.1.6 Cleanability

See Part 1 of this ETAG N° 032.

In principle, Cantilever Expansion Joints without drainage devices (gutter/seal, etc.) are considered as self-cleaning by nature of their design. For such expansion joints this requirement is not of relevance.

In case of Cantilever Expansion Joints equipped with, or for which the manufacturer specifies, features (gutter/seal) for watertightness, the requirement is related to these features. The gutter/seal shall have a good accessibility for cleaning devices in order to reduce the obstruction of the traffic to a minimum.

4.1.1.7 Resistance to wear

Not relevant for this product family.

4.1.1.8 Watertightness

See Part 1 of this ETAG N° 032.

Watertightness of Cantilever Expansion Joints is achieved either by a seal or by a sub-surface drainage system (e.g. gutter).

The requirements for the gutter/seal and the clamping devices are covered by 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.

4.1.4.1.2 Level differences in the running surface

a) Unloaded conditions:

For unloaded conditions the principles are given in ETAG N° 032, Part 1.

In particular, the design of Cantilever Expansion Joints shall be such that intersecting teeth with sloping surfaces do not cause effective level differences in the traffic direction exceeding the values given in ETAG N° 032, Part 1.

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

For user category “Vehicles“ according to ETAG N° 032, Part 1, 2.2.1, the intersecting teeth with sloping surfaces (e.g. chamfering at the tips of the fingers) shall not cause effective level differences in the traffic direction greater than 12 mm at SLS level.

For non sloping surfaces the effective steps in the traffic direction shall not exceed 5 mm.

4.1.4.2 Skid resistance

See Part 1 of this ETAG N° 032.

4.1.4.3 Drainage capacity

See Part 1 of this ETAG N° 032.

In the case of a gutter or similar devices, they 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, 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 Cantilever Expansion Joints for the components made of elastomer (e.g. gutter/seal) resistance to de-icing agents is considered (see 4.2). Elastomeric parts made of materials based on Polychloroprenerubber (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 Cantilever 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 shall be considered, depending on the range of temperature (see 2.3.2 and 4.2).

4.1.7.1.4 Resistance against freeze-thaw

For gutters/seals of Cantilever Expansion Joints resistance against freeze-thaw shall be considered (see also verification of resistance against low temperature brittleness according to 4.2 of this family Part.)

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 kit 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 product meets the declared characteristics.

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

The tests determine the material characteristics and performance.

The Approval Body shall identify the characteristics of the components of a Cantilever Expansion Joint which have to be verified during the approval procedure in accordance with this Part of 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: Requirements on components

Parts of the kit	Components of the parts	Material	Required characteristics	Standard/specification
		Structural steel Cast steel Cast iron Stainless steel	Yield point Tensile strength Elongation at rupture Ductility Charpy-V value (Energy absorption) Chemical composition	Structural steel: EN 10025 Cast steel: Relevant standards, i.e. EN 10283, EN 10293, EN 1562 Stainless steel: EN 10088 Cast iron: EN 1561, EN 1563
Surface element (Fingerplate)		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 Elongation at rupture Ductility Charpy-V value **Note**: Selection depending on chosen materials	Relevant standard, e.g. EN 755-2 EN 1706 EN 1090-3 EN 485-2 EN 754-2

Table 4.2 (continued)

Parts of the kit	Components of the parts	Material	Required characteristics	Standard/specification
Supporting substructure *)	Plates, profiles, steel beam grid	Steel Stainless steel	Yield point Tensile strength Elongation at rupture Chemical composition (C-eq.) Weldability	EN 10025, EN 10088
	Transition strip	Steel Stainless steel	Yield point Tensile strength Elongation at rupture Weldability Chemical composition (C-eq.)	EN 10025, EN 10088
	Reinforcement bars/loops	Steel	Yield strength Tensile strength Ductility Weldability Bendability	EN 10080
	Welded dowels for dynamically loaded components	Steel	EN ISO 13918	
	Snow plough – impact protection strip	See "Plates, profiles"		
Anchorage 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
	Stud bolts	Steel	Relevant load bearing capacity	Relevant specification
Connecting devices	Bolts, screws, nuts, washer, profiles	Metal	See "Anchorage devices"	
	Bonding agents/ sealants, sockets	Chemicals/ Metal	- To be covered by full scale tests - Bonding agents manufacturers' specifications to be taken into account	
Kerb elements *)	Plate, welded attachments (like covers)	Metal	*Remark: See "Covers"*	
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: - Resistance to de-icing agents - Resistance to ozone - 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 ***Note**: The list is not considered as exhaustive*	
		Metal (steel, stainless steel, Grade 1.44xx or 1.45xx)	Resistance to corrosion Resistance to de-icing agents	EN ISO 12944 EN 10088 *Remark: Covered by resistance to corrosion.*
	Fixing elements	Metal	See "Connecting devices"	

Table 4.2 (continued)

Parts of the kit	Components of the parts	Material	Required characteristics	Standard/specification
Connectors to the watertight membrane *)	According to the relevant specification			
Transition 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 technical specification EN 1097-2 EN 1097-8
Covers *)	Plates	Steel minimum: S235xx Stainless steel, Grade 1.44xx or 1.45xx	Yield point Tensile strength Elongation at rupture Chemical composition (C-eq.)	EN 10025 EN 10088
	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 **Note**: Selection depending on chosen materials	Relevant standard, e.g. EN 755-2 EN 1706 EN 1090-3 EN 485-2 EN 754-2

*) 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.

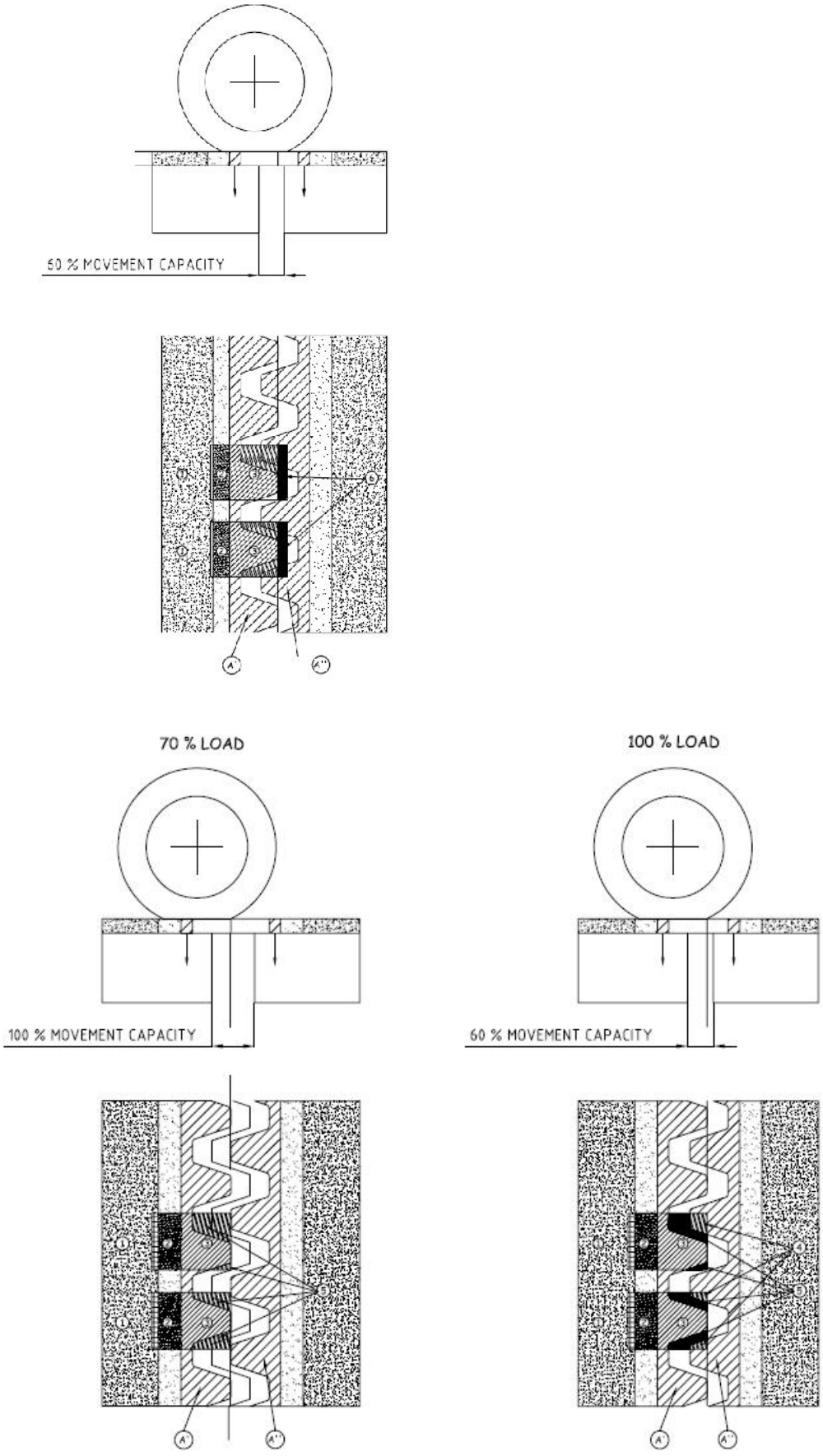
The actions, loads and combinations of loads and opening positions to be used for verification are given in Annex G of Part 1 of this ETAG N° 032.

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

The fact, 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.

For the load distribution, Figure 5.1.1.1 applies in the following way:

- The loads on the areas of zones 4 and 5 shall be added on the supporting area of zone 3,
- Load on zone 6 is not added to the load on expansion joint area A'.



For Key, see Figure G1 in Part 1.

Figure 5.1.1.1: Principles of wheel load application

5.1.1.2 Mechanical resistance

5.1.1.2.1 General

See Part 1 of this ETAG N° 032.

For Cantilever 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.

ULS verification

For the verification under ULS, the load shall be applied on the most adverse position of the cantilever expansion joint kit, related to the concerned ULS design situations according to 4.1.1.2 and Figure 5.1.1.1.

> **Note 1**: As the ULS displacement capacity is limited by the requirement of "No contact allowed between intersecting cantilevers at the heading end", the displacement capacity of a particular joint under ULS conditions should be considered in the selection procedure of the suitable product.
>
> **Note 2**: Background for derivation of loads for $ULS_{Annex\ G}$ verification: See Annex 6.Q.

SLS verification

For the verification under SLS, the load shall be applied on the most adverse position of the cantilever expansion joint kit, related to the concerned SLS design situations according to 4.1.1.2 and Figure 5.1.1.1.

> **Note**: Background for derivation of loads for $SLS_{Annex\ G}$ verification: See Annex 6.Q.

5.1.1.2.2 Calculation

See also Part 1 of this ETAG N° 032.

Cantilever Expansion Joints shall be calculated based on relevant standards. In addition, particular attention shall be paid to the pre-stress effects in the anchorage area between finger plate and base plate.

5.1.1.2.3 Calculation assisted by testing

If parts of the kit cannot be verified by calculation, or components consist of non standardized materials, or components cannot be verified as a whole against standards or approvals for this intended use, tests for the concerned parts shall be carried out.

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 6.N.

5.1.1.3 Resistance to fatigue

5.1.1.3.1 General

For Cantilever Expansion Joints resistance to fatigue shall be verified by calculation, calculation assisted by testing or testing only. Verification shall be carried out with 60 % of the nominal opening position.

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 $\Delta\varphi_{fat}$ = 1,3 as mentioned in ETAG N° 032, Part 1, 5.1.1.3, and included in Annex G, 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).

> **Note**: 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 engineering principles.

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.

The test method is given in Annex 6.O.

5.1.1.3.4 Full scale testing of the kit

If calculation, based on standards, of the load transfer in the joint and the introduction into the main structure is not possible, verification shall be done by means of full scale tests, simulating realistic boundary conditions, loads and imposed deformations.

Full scale testing may also be done as an alternative to calculation assisted by testing or calculation only.

The test method is given in Annex 6.P.

5.1.1.4 Seismic behaviour

See Part 1 of this ETAG N° 032.

The intrinsic movement capacities of Cantilever Expansion Joints may not allow movements in all directions. In this case, the result of the evaluation procedure that indicates which 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.

5.1.1.5 Movement capacity

See Part 1 of this ETAG N° 032.

The verification of the nominal movement capacity under unloaded conditions can be done by analysis of the technical file. In this case verification by testing according to ETAG N° 032, Part 1 is not compulsory.

For the verification of the movement capacity at SLS and ULS conditions according to ETAG N° 032, Part 1, the values for the requirements stated below shall be declared by the manufacturer:

at SLS	minimum opening position between finger tips and the opposite element, minimum intersection,
at ULS	minimum opening position between finger tips and the opposite element.

The influence of longitudinal slopes shall be also verified.

5.1.1.6 Cleanability

See Part 1 of this ETAG N° 032.

In case of relevance, the verification shall be done by analysis of the design. It includes good accessibility for cleaning devices and dismountability of the cantilever plate, when relevant.

5.1.1.7 Resistance to wear

Not relevant for this family product.

5.1.1.8 Watertightness

See Part 1 of this ETAG N° 032.

For Cantilever Expansion Joints where the watertightness is ensured by means of a seal, for verification Annex L of ETAG N° 032, Part 1 applies.

Where watertightness is ensured by an additional device (gutter), Annex L of ETAG N° 032, Part 1, does not apply. The durability of the gutter and its discharge capacity are considered to be the crucial aspects and have to be verified. For durability aspects of the gutter, the concerned requirements and verification methods, given in 4.2 and 5.2, 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

See Part 1 of this ETAG N° 032.

5.1.4.1.2 Level differences in the running surface

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

See Part 1 of this ETAG N° 032.

5.1.4.3 Drainage capacity

See Part 1 of this ETAG N° 032.

In case of a gutter/drainage device, its discharge capacity shall be demonstrated either by calculation or testing.

For durability aspects of the drainage system (e.g. gutter/seal), the concerned verification methods, given in 5.2 of this family Part, 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 and fuel oil for materials, where this is relevant according to 4.1.7.2 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)		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 10293, 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 ***Note**: Selection depending on chosen materials*	EN 1999 Extruded aluminium: EN 755-2 Cast aluminium: EN 1706
Supporting substructure	Plates, profiles, steel beam grid	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
	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	See “Plates, profiles”		
Anchorage 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
	Stud bolts	Steel	Relevant load bearing capacity	Relevant specification

Table 5.2 (continued)

Parts of the kit	Components of the parts	Material	Required characteristics	Standard/ specification
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"*	
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	See reference 1 below this table
		Metal (steel, stainless steel, Grade 1.44xx or 1.45xx)	Resistance to corrosion	EN ISO 12944 EN 10088
			Resistance to de-icing agents *Remark: Covered by resistance to corrosion.*	
	Fixing elements	Metal	See "Connecting devices"	
Connectors to the watertight membrane	According to the relevant specification			
Transition 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	Relevant technical specification
			- Resistance to fragmentation - Polished Stone Value (PSV) Mortar: - Compressive strength	EN 1097-2 EN 1097-8
Covers	Plates	Steel minimum: S235xx Stainless steel, Grade 1.44xx or 1.45xx	Yield point Tensile strength Elongation at rupture Chemical composition (C-eq.)	EN 10025 EN 10088
Covers	Plates	Aluminium: Plate material: Grade 5xxx Extruded material: Grade 6xxx excluded: grades given in EN 1999-1-3, 3 (2007) Cast material: Grade xxx	Chemical composition Tensile strength Yield point Stress-strain Elongation at rupture Ductility Charpy-V value ***Note**: selection depending on chosen materials*	EN 1999 Extruded aluminium: EN 755-2 Cast aluminium: EN 1706

1) Relevant technical specification with respect to the concerned performance characteristics (Standards see Table 4.2).

Testing conditions for specific items:

- Resistance to ageing: ISO 48, 37, 188 (7 days in hot air 70 °C);
- Resistance to de-icing agents: ISO 1817 (14 days 23 °C, 4 % natrium- chloride solution or equivalent);
- Resistance to ozone: 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 pphm);

- Low brittleness temperature: ISO 812 (2006), Method B

  a) at brittleness temperature of -25 °C for operating temperature down to -20 °C according to ETAG N° 032, Part 1, 2.3.2,
  b) at brittleness temperature of -40 °C for operating temperature down to -30 °C according to ETAG N° 032, Part 1, 2.3.2,
  c) at brittleness temperature of -55 °C for operating temperature down to -40 °C according to ETAG N° 032, Part 1, 2.3.2;

- Thermo gravimetric analysis (TGA): ISO 9924-1 and -2.

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

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

6.0 TABLE LINKING THE ESSENTIAL REQUIREMENTS TO PRODUCT REQUIREMENTS

ER	Characteristics specified in the mandate	ETAG paragraph on product performance to be assessed	Class, use category, criterion		No performance determined option
1	Mechanical resistance	6.1.1.2	Carriageway	Pass/fail	No
			and/or Footpath	Pass/fail	No
			and/or options: - Accidental load on footway	Pass/fail	No
			- Collision on kerb	Pass/fail	No
	Resistance to fatigue	6.1.1.3	Caused by traffic loads on the expansion joint	Pass/fail	No
			Caused by bridge movements under traffic (without consideration of traffic loads on the joint)	Pass/fail	Yes
	Seismic behaviour	6.1.1.4	Declaration of selected approach and relevant information (aspects, etc.)		Yes
	Movement capacity	6.1.1.5	Declared value		No
	Cleanability	6.1.1.6	Pass/fail		Yes
	Resistance to wear	6.1.1.7	Not relevant		
	Watertightness	6.1.1.8	Pass/fail		Yes
2	Not relevant				
3	Release of dangerous substances	6.1.3	Indication of dangerous substances incl. concentration, etc. Or: "No dangerous substances"		Yes
4	Allowable surface gaps and voids	6.1.4.1.1	Gap/voids		
			For vehicle	Pass/fail	Yes
			Gap for use in longitudinal axis	Pass/fail	Yes
			Gap/voids/slots		
			- 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		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	See 6.2 in this Part	No
			Ageing resulting from		No
			- temperature		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.

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 cantilever 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.

Assessment is not of relevance in case of Cantilever Expansion Joints without a gutter/seal.

6.1.1.7 Resistance to wear

Not relevant for this family product.

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 N° 032: Not relevant.

6.1.3 Hygiene, health and environment (ER 3)

6.1.3.1 Release of dangerous substances

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 including expression of the discharge capacity, according to 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 5.1.7.3.

6.2 COMPONENTS

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

Table 6.2 below presents assessment criteria for materials according to 4.2 and 5.2 of this ETAG family Part. For component materials not covered in the table below, appropriate assessment criteria shall be used. The Approval Body shall assess the fitness for purpose of the components based on the 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)		Structural steel, Cast steel, Cast iron, Stainless steel	Yield point	MDV
			Tensile strength	
			Elongation at rupture	
			Energy absorption	
			Ductility	
			Charpy-V value	
			Chemical composition (including CEV)	
		Aluminium (Grade according to 5.2)	Chemical composition Tensile strength Yield point Stress-strain Elongation at rupture Ductility Charpy-V value	
Supporting substructure	Plates, profiles, steel beam grid	Steel Stainless 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	See “Plates, profiles”		
Anchorage 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*	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
	Stud bolts	Steel	Relevant load bearing capacity	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	*Remark: See “Covers”*	

Parts of the kit	Components of the parts	Material	Required characteristics	Assessment criteria
Drainage devices	Gutter/seal including their connections and its butt joints	Elastomer (optionally reinforced), plastics (reinforced) (e.g. Polyamide, PVC, Polyethylene), etc.	Depending on the concept 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: Pass/fail (Decrease of hardness ≤ 5; Increase of volume ≤ 10 %); - Resistance to ozone: Pass/fail (No visible cracks); - 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 Resistance to de-icing agents *(Remark: Covered by resistance to corrosion)*	MDV or Pass/fail criterion, where this applies
	Fixing elements	Metal	See “Connecting devices”	
Connectors to the watertight membrane	According to the relevant specification			
Transition 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
Covers	Plates	Steel minimum S235xx Stainless steel, Grade 1.44xx or 1.45xx	Yield point Tensile strength Elongation at rupture Chemical composition (C-eq.)	MDV
Covers	Plates	Aluminium (Grade according to 5.2)	Geometry Chemical composition Tensile strength Yield point Stress-strain Elongation at rupture Ductility Charpy-V value ***Note**: Selection depending on chosen materials*	MDV

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.

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 component seal)	Density	Y	Each batch[1)] or certificate according to EN 10204 (2004), type 3.1
	Hardness IRHD	Y	
	Tensile strength	Y	
	Elongation at break	Y	
	Rheometric characteristics	Y	
	Hardness IRHD	Y	Each lot (sequence of batches with identical composition)[1)] or certificate according to EN 10204 (2004), type 3.1
	Tensile strength	Y	
	Elongation at break	Y	
	Resistance to ageing	Y	
Elastomer, plastics (for the component drainage devices)	Relevant performance characteristics according to the individual concept	Y	Certificate according to EN 10204 (2004), type 2.1 at each batch
Steel, stainless steel(for the component drainage devices)	Resistance to corrosion Resistance to de-icing agents (Remark: Covered by resistance to corrosion.)	Y where relevant (see also Table 8.2)	Certificate according to EN 10204 (2004), type 3.1, at each delivery
Structural steel, cast steel, cast iron, stainless steel (fingerplate)	Yield point	Y	Certificate according to EN 10204 (2004), type 3.1, at each delivery
	Tensile strength	Y	
	Elongation at rupture	Y	
	Energy absorption	Y	
	Ductility	Y	
	Charpy-V value	Y	
	Chemical composition	Y	
Aluminium (fingerplate)	Yield point	Y	Certificate according to EN 10204 (2004), type 3.1, at each delivery
	Tensile strength	Y	
	Elongation at rupture	Y	
	Chemical composition	Y	
	Stress-strain	Y	
	Ductility	Y	
	Charpy-V value	Y	
	Note: Selection depending on chosen materials		
(Stainless) Steel (kerbs, cover plates)	Yield point	Y	Certificate according to EN 10204 (2004), type 3.1, at each delivery
	Tensile strength	Y	
	Elongation at rupture	Y	
	Chemical composition	Y	

Table 8.1 (continued)

Material/products	Characteristics (1)	FPC	Frequency
Aluminium (kerbs, cover plates)	Yield point	Y	Certificate according to EN 10204 (2004), type 3.1, at each delivery
	Tensile strength	Y	
	Elongation at rupture	Y	
	Chemical composition	Y	
	Stress-strain	Y	
	Ductility	Y	
	Charpy-V value	Y	
(Stainless) Steel (Components for support structure and anchorage)	Yield point	Y	Certificate according to EN 10204 (2004), type 3.1, at each delivery
	Tensile strength	Y	
	Elongation at rupture	Y	
	Chemical composition	Y	
	Energy absorption (in case welded connection with transition strip)	Y	
Steel (Reinforcement bars/loops for support structure)	Yield strength	Y	Certificate according to EN 10204 (2004), type 3.1, at each delivery
	Tensile strength	Y	
	Ductility	Y	
	Weldability	Y	
	Bendability	Y	
	Bond property	Y	
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 + resin mortar/grout (anchor)	Equivalent to those for bolts	Y	Delivery note with indication of material grade and specification at each delivery
Resin mortar for transition 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 respectively 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 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
Finger plates				
Manufacturing of each pair of fingerplates	Dimensions, thickness Corrosion protection including layer thickness measurement	Internal procedure	Each part	Conformity to the design drawings
Support structure, anchorage devices and kerb elements				
Plates, profiles	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 taken at the factory is not relevant for cantilever 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 Table 8.3 below includes all kind of verifications (e.g. testing, calculation, deemed to satisfy provisions, etc.).

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
Structural steel, cast steel, cast iron, stainless steel for fingerplate	Performance characteristics in accordance with Table 4.2	Y	Certificate according to EN 10204 (2004), type 3.1
Aluminium for fingerplate	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
(Stainless) Steel (Components for drainage devices)	Performance characteristics in accordance with Table 4.2	Y	Certificate according to EN 10204 (2004), type 2.1
Steel (reinforcement bars/loops for support structure)	Geometry Yield strength Tensile strength Ductility Weldability Bendability Bond property	Y	Certificate according to EN 10204 (2004), type 3.1
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)	Geometry Grade or quality class (according to the type of component) Tensile strength Yield strength	Y	Certificate according to EN 10204 (2004), type 3.1
Steel + resin mortar/grout (threaded rod)	Equivalent to those for bolts	Y	
Steel + resin mortar/grout	Equivalent to those for bolts	Y	
Resin mortar, cement mortar (for transition 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 FOR CANTILEVER EXPANSION JOINTS

See Part 1 of this ETAG N° 032.

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, if relevant.

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 6-A to 6-L: for this family Part correspond to Annexes A – L in Part 1 of this ETAG N° 032, if applicable.

ANNEX 6.M:
EXAMPLES OF FINGER SHAPES FOR CANTILEVER EXPANSION JOINTS

This annex does not provide any design. It only illustrates different shape of cantilevers.

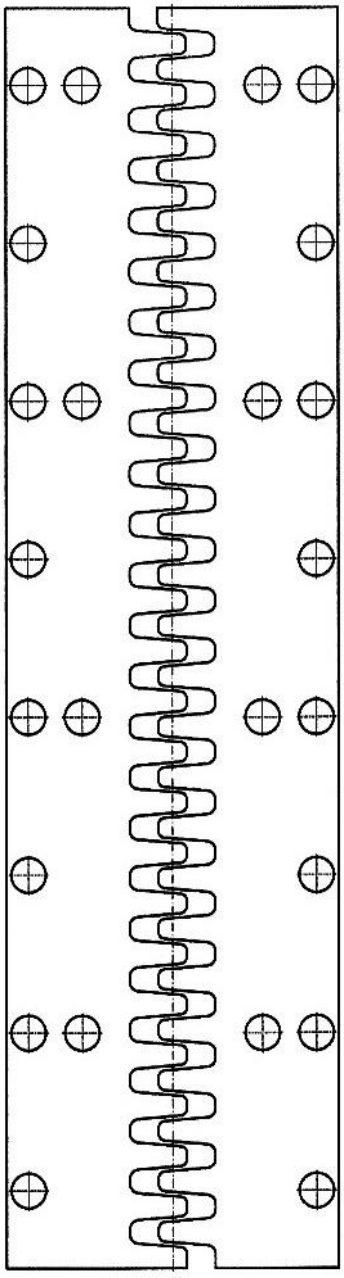


Figure 6.M.1

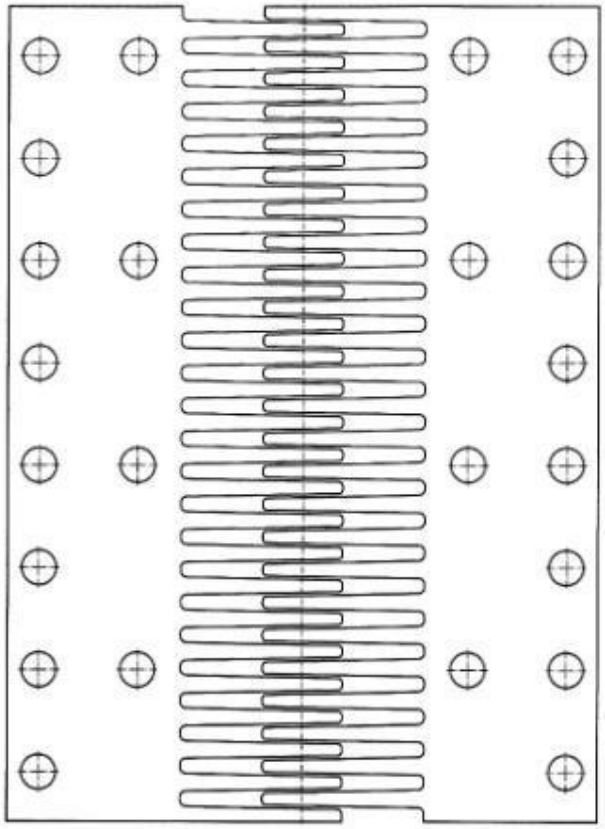


Figure 6.M.2

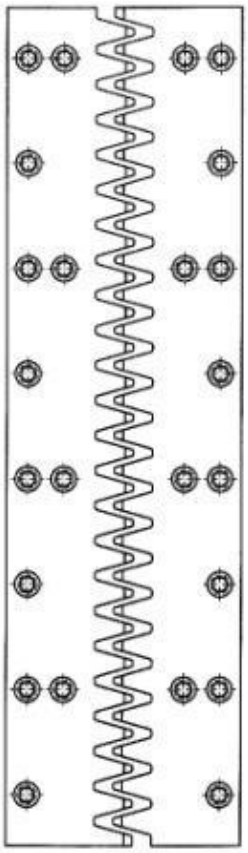


Figure 6.M.3

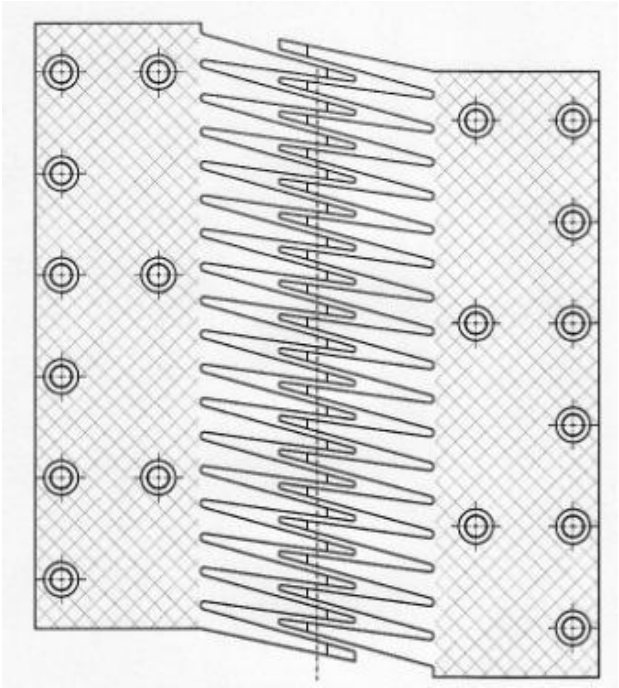


Figure 6.M.4

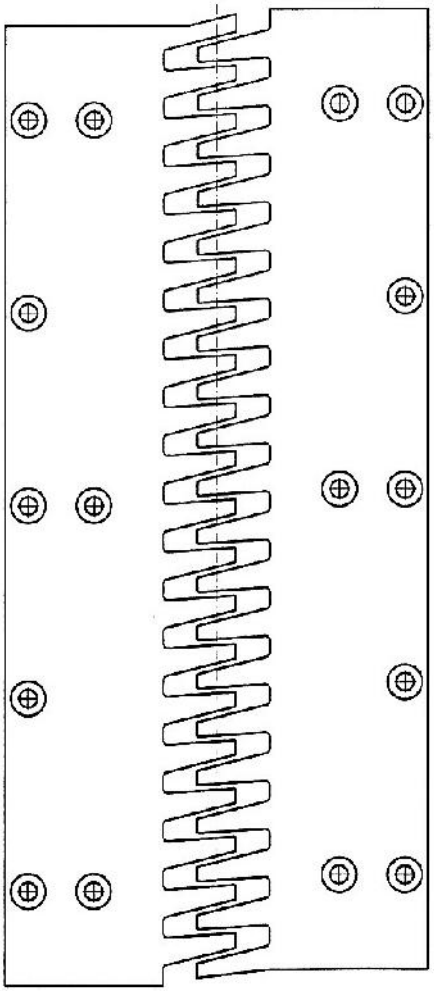


Figure 6.M.5

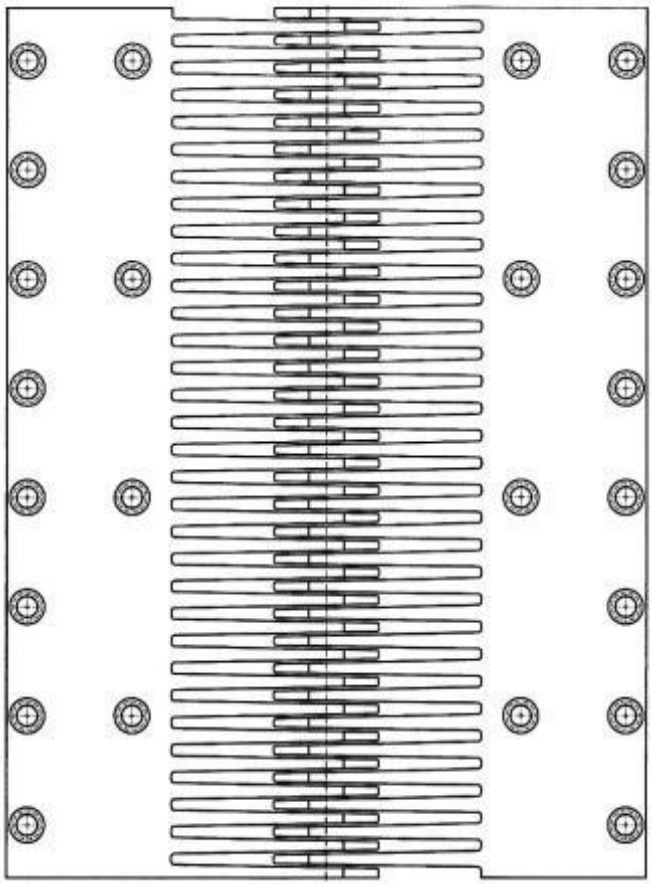


Figure 6.M.6

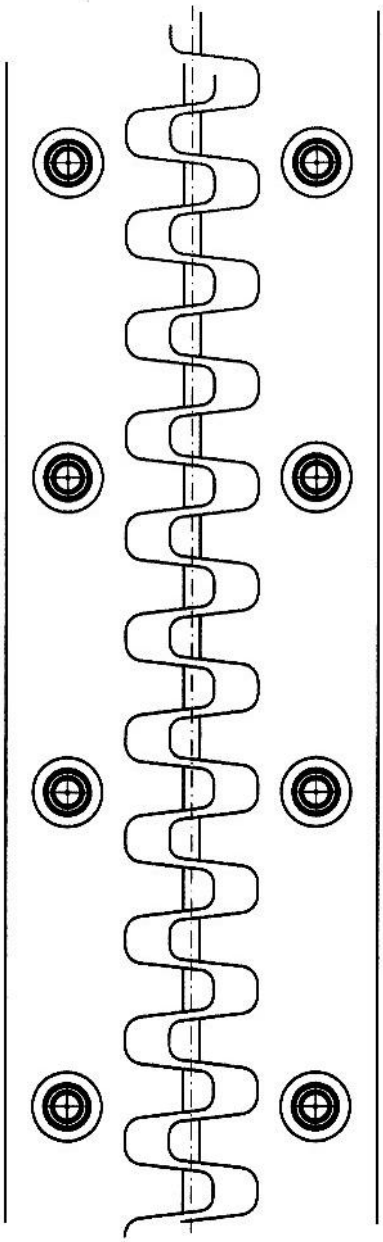


Figure 6.M.7

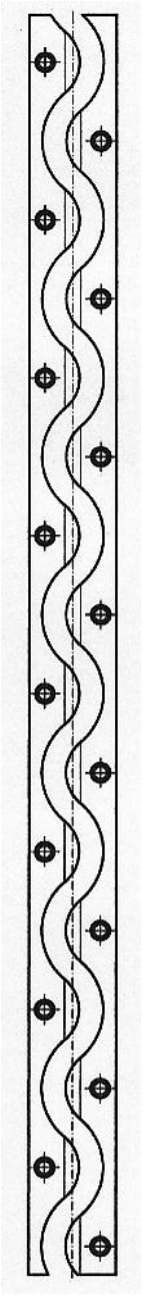


Figure 6.M.8

Annex 6.N:
MECHANICAL RESISTANCE TEST METHOD
(Full scale component test)

6.N.1. SCOPE

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

6.N.2. PRINCIPLES

The principle of this test is to apply a load, derived from calculations, representing the design situations and to investigate the behaviour for the design situations 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 range of types according to 5.1.1.2.1 in this ETAG Part. For each of them, at least three specimens shall be tested.

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

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

6.N.4. LOAD ARRANGEMENTS

6.N.4.1 TEST LOADS

The concerned test loads for the concerned design situations at SLS and ULS shall be derived from the relevant design situations in accordance with 5.1.1.2, considering the guidance given in Annex 6.Q.

6.N.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.

6.N.5. TESTING ARRANGEMENT

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

6.N.6. EXECUTION OF THE TEST

The execution shall cover the SLS and ULS design situation derived according to 6.N.4.1.

6.N.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, Part 1, these effects shall be considered (see 6.N.7).

The load shall be increased and decreased respectively with a rate within a range of 2,5 to 5,0 kN/sec.

6.N.6.2 TEST PROCEDURES

6.N.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.

6.N.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 if the equipment allows and to identify the post critical behaviour.

6.N.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.

6.N.8. TEST REPORT

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

- Name of the manufacturer and production centre,
- Name and signature of testing body,
- Model identification (type, theoretical movement capacity, N° of batch),
- Any deviation from this annex,
- Description of the test equipment 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 6.N.7.

ANNEX 6.O:
VERIFICATION OF RESISTANCE TO FATIGUE BY FULL SCALE COMPONENT TESTING

6.O.1. SCOPE

This annex describes the method for verifying the resistance to fatigue of component of Cantilever Expansion Joints by testing.

6.O.2. PRINCIPLES

The principle of this test procedure is to apply loads, derived from calculation for the fatigue loads and 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 two specimens covering the relevant type according to 5.1.1.3.2 in this ETAG Part shall be tested.

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

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

6.O.4. LOAD ARRANGEMENT

6.O.4.1 TEST LOADS AND NUMBER OF CYCLES

The concerned test load shall be derived from the loads on the expansion joint, taking into account the concerned contact pressure, the wheel print and the number of cycles, given in Annex 6.P, in conjunction with an opening position of 60 % of the maximum opening position.

6.O.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.

6.O.5. TESTING ARRANGEMENT

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

6.O.6. EXECUTION OF THE TEST

Execution of traffic load test

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, Part 1, these effects shall be considered (see 6.O.7).

The principles, given in Annex 6.P of this ETAG Part for the full scale test, apply.

If relevant, load reversals (tension/compression) shall be considered.

6.O.7. EXPRESSION OF THE RESULTS

Traffic load test

The following shall be monitored and recorded:

- Applied loads (kN) and cycles, corresponding deformations,
- Cracks (supported by photographs),
- Loosening, breaking.

6.O.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,
- 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 6.O.7.

Annex 6.P:
Verification of resistance to fatigue by full scale kit testing

6.P.1. SCOPE

This annex describes the method for verifying the resistance to fatigue of Cantilever Expansion Joints by full scale testing.

6.P.2. PRINCIPLES

The principle of this test procedure is to apply traffic loads, idealised by contact pressures on a defined area and load cycles. In principle, one sample has to be tested. In case of unknown designs more than one sample may be needed. This has to be agreed between the manufacturer, the Approval Body and the testing body based on the principles given in EN 1990.

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

The test specimens shall correspond to the complete design including all features. The length of the test specimen shall be at least 400 mm enlarged with an addition of the load dispersal effect, representative for the transfer of the reaction forces.

6.P.4. LOAD AND MOVEMENT ARRANGEMENTS

6.P.4.1 TRAFFIC LOADS AND NUMBER OF CYCLES

The test loads are to be derived from FLM1EJ and/or FML2EJ for a contact pressure of 0,8 N/mm² and 1,0 N/mm² respectively, in accordance with this ETAG N° 032, Annex G, chapter G3. According to this, the conditions in the following Table 6.P.1 apply.

Table 6.P.1: Load cycles for verification of different fatigue lives in relation to the working life categories

Cantilever 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/mm²	1st 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
	2nd 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/mm² (alternatively to 0,8 N/mm²)	1st stage: vertical and horizontal loads simultaneously applied	0,87 x 10^6	1,3 x 10^6	2,2 x 10^6	3,8 x 10^6 (FLM 1 EJ applies)	3,8 x 10^6
	2nd stage: vertical loads only applied	0,57 x 10^6	0,87 x 10^6	1,5 x 10^6	--	--
	Envelope 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 (10 years category), 4,2 (15 years category) and 7,1 million (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.

Minimum vertical test load per wheel = A_{min} x 0,8 = 300 x 250 x 0,8 = 60 x 10^3 N = 60 kN.

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

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

6.P.4.2 POSITION OF LOAD TO BE APPLIED

The load shall be applied in the most adverse position. The complete surface of the intersecting cantilevers may be considered for the fatigue load transfer, provided that at SLS conditions according to 5.1.1.2 the level differences do not exceed 5 mm. If this condition is not fulfilled the level difference shall not exceed 5 mm under fatigue loads in order to take into account the complete surface of the intersecting cantilevers (see also 5.1.1.3. in this ETAG Part). If both conditions are not fulfilled intersecting cantilevers cannot be taken into account.

6.P.5. TESTING CONDITIONS

The test load shall be derived from 6.P.4 and distributed according to clause G1 and formula G1 in Part 1 of this ETAG N° 032. It shall be applied with an angle according to the vertical and horizontal load ratio given in Annex G of Part 1 of this ETAG N° 032 in the direction of the expansion joint gap (see note in G3.3 in Part 1 of this ETAG N° 032).

The test is carried out under the following conditions:

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

- Number of load cycles: The number of load cycles is determined according to the specified categories of working life (see 2.3.4 and 6.P.4 of this ETAG family Part).

- Positioning of the sample: The test shall be run at 60 % of the maximum opening position. The relative positioning of the travelling loads on the sample in the most unfavourable loading condition shall be agreed between the manufacturer and the Approval Body.

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

6.P.6. TESTING EQUIPMENT

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

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

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

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

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

The measuring tolerances on load shall be ±1 kN.

6.P.7. EXECUTION OF THE TEST

Execution of traffic load test

The test shall be run at ambient temperature (see 6.P.5).

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 (see 6.P.7).

The test shall be run at 60 % of the maximum opening position with related level difference(s) for unloaded conditions with the number of cycles according to 4.1. 60 % is related to the complete range of movement (maximum movement capacity, see also ETAG N° 032, Part 1, Annex G, G.4.2.2).

One cycle includes loading and unloading of the specimen. This includes that at the end of a stroke the wheel has completely lost contact with the joint.

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

During the test, at the stages corresponding to 10 000, 100 000 and every 500 000 load cycles and at the end of test the joint shall be visually inspected and possible damages (e.g. cracking of the rubber, defect of fixing of the rubber profile in its groove, plastic deformation, failure of welding) shall be recorded.

6.P.8. EXPRESSION OF THE RESULTS

Traffic load test

The following shall be monitored and recorded:

- Applied loads (kN) and cycles, corresponding deformations,
- Cracks (supported by photographs),
- Any other changes (e.g. with respect to the butt joint),
- Loosening, breaking.

6.P.9. 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; the consistency of the assessment of how the criteria and guidance of this annex are respected,
- Date of the preparation of specimens, the date of test and the mean test temperature,
- Dimensions of test specimens,
- Expression of monitored phenomena according to 6.P.7,
- Test conditions and operational details not detailed in this document as well as the possible incidents likely to have affected the results.

ANNEX 6.Q:
EXPLANATIONS FOR THE DESIGN SITUATIONS FOR SLS AND ULS

Used in the cantilever 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 6.N of this Part of the ETAG in conjunction with Annex G of ETAG N° 032, Part 1.

6.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 ψ_{Od} = 0,6 for C_{ULS} = 1 according to Annex G, 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 ψ_{OT} = 1,0 for C_{ULS} = 1 according to Annex G, G.4.2.1 and G.4.3.1.

Note 1: 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 $ULS_{Annex\ G}$ verification (see 5.1.1.2 of this ETAG family Part):

The vertical load is 1,35 x 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 the traffic direction (longitudinal) is 0,4 of the vertical test load and the horizontal load perpendicular to the traffic direction (transverse direction) is 0,2 of the vertical test load. If the test specimen is subjected to a combination of vertical and horizontal loads, the combination factors ψ as given in 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). However there is an uncertainty in the quality of the specimen.*

Note 2: Background for derivation of loads for $SLS_{Annex\ G}$ 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, 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, 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.

6.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 ψ_{Od} = 1,0 for C_{ULS} = 2 according to Annex G, G.4.2.1 and G.4.3.1.

The 70 % SLS load level is related to the conditions, described with ψ_{OT} = 0,7 for C_{ULS} = 2 according to Annex G, 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).

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

Not of relevance for current Cantilever Expansion Joints.

6.Q.4. ALTERNATIVE SIMPLIFIED VERIFICATION PROCEDURE

(Instead of procedure 1 + procedure 2): opening position: 100 % in combination with 100 % SLS load level (ψod and ψot = 1,0)

According to Annex G, G.4.2.1, SLS1 and SLS2 can be covered by an envelope approach with the condition ψ_{Od} and ψ_{OT} = 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 6.R:
EXAMINATION OF REQUESTED LOAD CYCLES AND REQUESTED LOADS FOR VERIFICATION OF FATIGUE RESISTANCE FOR AN ASSUMED FATIGUE LIFE OF 10, 15, 25 AND 50 YEARS[1] AND UNLIMITED FATIGUE LIFE
(informative)

6.R.1. FOREWORD

The objective of this annex is to give sufficient background information on the used loads and load cycles used in Annex 6.P of this Part of the ETAG in conjunction with Annex G of ETAG N° 032, Part 1, and Eurocode 1991-2.

Sources: Annex G, G.3.3 FLM 2, Table G4 + N_{obs} according to EC 1991-2, Table 4.5.

Precondition: If for Cantilever 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.

6.R.2. EQUIVALENT NUMBER OF AXLE RATES FOR CANTILEVER EXPANSION JOINTS AND ANCHORAGE SYSTEMS

Table 6.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	
	Σn_{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 N° 032

$Q_{1k,fat}$ according to Annex G, Table G.4, including $\Delta\varphi_{fat} = 1,3$
$Q_{1lk,fat}$, including $\Delta\varphi_{fat} = 1,0$
Axle number rate according to Annex G, 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).

6.R.3. CONCLUSION FOR REQUESTED LOAD CYCLES FOR AXLE LOADS ON CANTILEVER 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):

   $\Sigma n = (1,34 – 0,80) \times 500\,000 \times 10 = 0,54 \times 500\,000 \times 10 = 2,7 \times 10^6$

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

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

   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 Σn for combination of vertical and horizontal loads in 2.2 has a relative high value, compared to Σn in 2.1 for Fv (see also Fv+h and Fv in Tables 6.R. 2 and 6.R. 3).

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

1. According to the EN 1991-2 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 x 250) = 0,63 N/mm².

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

   Consequence for the test load to be used:

   Due to the geometry and the load path of Cantilever Expansion Joints and the need to consider realistic strain intervals in these structures, for Cantilever 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: $((0,8/p_{requested})^3)$ x load cycles.

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

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

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

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

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: $((0,91/p_{requested})^3)$ x load cycles.

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

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

   The horizontal test load F_{Th} is calculated according to Annex G, G.3.2, as follows:
   $F_{Th} = (0,2/1,3) \times F_{Tv}$.

6.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 Part 1 of this ETAG N° 032.

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

Table 6.R.2: Calculated load cycles

Item		**FLM 2 EJ**				**FLM 1 EJ**
		10 years	**15 years**	**25 years**	**50 years**	**Unlimited**
Cantilever Expansion Joints, including anchorage system (Contact pressure: **0,8** N/mm²)	n_{v+h}	$1,7 \times 10^6$	$2,5 \times 10^6$	$4,2 \times 10^6$	$8,4 \times 10^6$	**$7,4 \times 10^6$**
	n_v	$1,1 \times 10^6$	$1,7 \times 10^6$	$2,9 \times 10^6$	$5,8 \times 10^6$	
Cantilever Expansion Joints, including anchorage system (Contact pressure: **0,91** N/mm²)	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,
4. n = 5 x 10^6 according to EN 1991 for constant amplitude fatigue limit $\Delta\sigma_D$,
5. V = Vertical axle load, H = Horizontal axle load.

*Remark: The 2 x 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 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 Cantilever Expansion Joints.

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

Table 6.R.3: Load cycles for verification of different fatigue lives in relation to the working life categories

Cantilever Expansion Joints (including anchorage system)		**Number of cycles**				
Test description		**FLM 2 EJ**				**FLM 1 EJ**
		10 years	**15 years**	**25 years**	**50 years**	**Unlimited**
Contact pressure: 0,8 N/mm²	1st stage: vertical and horizontal loads simultaneously applied	1,7 x 10^6	2,5 x 10^6	4,2 x 10^6	FLM 1 EJ applies	7,4 x 10^6
	2nd stage: vertical loads only applied	1,1 x 10^6	1,7 x 10^6	2,9 x 10^6	--	--
	Envelope 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/mm² (alternatively to 0,8 N/mm²)	1st stage: vertical and horizontal loads simultaneously applied	0,87 x 10^6	1,3 x 10^6	2,2 x 10^6	FLM 1 EJ applies	3.8 x 10^6
	2nd stage: vertical loads only applied	0,57 x 10^6	0,87 x 10^6	1,5 x 10^6	--	--
	Envelope 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 cycles 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 x 10^6 (10 years category), 4,2 x 10^6 (15 years category) and 7,1 x 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 mm x 250 mm:

- Minimum vertical test load per wheel = A_{min} x 0,8 = 300 x 250 x 0,8 = 60 x 10^3 N = 60 kN,
- Corresponding horizontal test load per wheel = (0,2/1,3) x 56 = 8,4 kN,
- The partial factor $\gamma_{F,f}$ = 1,0.