BUtgb vzw - UBAtc asbl

ATG 3322

PRODUCTS FOR MAIN WORKS

BUILDING BASE ISOLATION SYSTEMS

CDM Stravitec Elastomeric Building Base Isolation Solutions

Valid from 29/08/2024 to 28/08/2029

Approval Holder:

CDM Stravitec NV
Reutenbeek 9-11
3090 Overijse
Tel.: +32 (0)2 687 79 07
Website: https://cdm-stravitec.com/
E-mail: info@cdm-stravitec.com

ATG 3322

A technical approval is a favourable assessment of a construction product by a competent, independent and impartial approval operator appointed by the UBAtc, for a specified intended use.

The technical approval documents the results of the approval examination. This examination is organised as follows:

- identification of the relevant product properties taking into account its intended use and method of installation (or execution),
- product conception,
- production reliability.

The technical approval provides a high level of reliability, due to the statistical interpretation of control results, recurrent monitoring, adjustments in order to keep abreast of the latest technical developments and quality control by the approval holder.

For technical approval to be maintained, the approval holder must continuously provide evidence that he is taking all necessary steps to demonstrate that the product is fit for the intended use. In this respect, monitoring the conformity of the product with the technical approval is essential. This monitoring is entrusted by the UBAtc to a competent, independent and impartial certification operator.

The technical approval and certification of conformity of the product with the technical approval are independent of individual construction works. The contractor and/or architect remain fully responsible for the conformity of the completed works with the provisions contained in works' specifications.

Apart from specifically introduced provisions, the technical approval does not cover site related safety provisions, health aspects and the sustainable use of raw materials. As a result, the UBAtc cannot be held responsible, under any circumstances, for any damage caused by the failure of the approval holder, contractor(s) and/or architect to respect provisions relating to site related safety, health aspects and the sustainable use of raw materials.

Approval operators

Buildwise

Kleine Kloosterstraat 23 1932 Sint-Stevens-Woluwe
info@buildwise.be - www.buildwise.be

SECO Belgium

Siège social : Cantersteen 47 1000 Bruxelles
Bureaux : Hermeslaan 9 1831 Diegem
mail@seco.be - www.groupseco.be

Certification operator*

BCCA

Siège social : Cantersteen 47 1000 Bruxelles
Bureaux : Hermeslaan 9 1831 Diegem
mail@bcca.be - www.bcca.be

* Certification Operator designated by UBAtc asbl operates in compliance with a system that is set to be accredited by BELAC (www.belac.be).

FOREWORD

This document concerns a new version of the approval text.

Technical approvals are updated regularly. It is recommended to always use the version published on the UBAtc website (www.butgb-ubatc.be).

The most recent version of the technical approval can be consulted by scanning the QR code on the front page.

NORMATIVE AND OTHER REFERENCES

AGCR-RGAC	30-06-2022	UBAtc General Regulations for Approval and Certification
BS 6177	1982	Guide to Selection and use of elastomeric bearings for vibration isolation of buildings (withdrawn: 2013)
NBN EN ISO 845	2009	Cellular plastics and rubbers – Determination if apparent density
NBN ISO 48-4	2021	Rubber, vulcanized or thermoplastic: Determination of hardness, Part 4: Indentation hardness by durometer method (Shore hardness
NBN EN ISO/IEC 17067	2013	Conformity assessment - Fundamentals of product certification and guidelines for product certification schemes
EN 1990/A1/AC	2010	Eurocode - Basis of structural design
NBN EN 1990 ANB	2021	Eurocode 0 - Basis of structural design - National annex
LTS 10	2023	Test specifications for elastomeric bearings (see annex I)

1 Object

This ATG covers elastomeric Building Base Isolation (BBI) solutions used in different building applications as noise and vibration isolation elements. The objective of those solutions is to protect the buildings from ground-borne vibration typically generated by railways and heavy roadways. Those ground-borne vibrations propagate in the building, generating structure-borne noise exceeding the acceptable comfort limits (ref to §7.6).

In particular, this technical approval covers all types of elastomeric bearings (EB), which for the purpose of vibration isolation, act as load bearing components :

- Plain elastomer bearings: Elastomers including rubbers and polyurethane.
- Plain elastomeric composite bearings: same as above but manufactured from an elastomer composite material. An elastomeric composite material is an elastomeric compound modified by the inclusion of homogeneously dispersed cellular particles (average 0.5mm diameter) bounded with the elastomer and optionally reinforced by a textile layer at the bearing surface.
- Sandwich Elastomeric bearings: it consists of a plain elastomeric pad bonded between two parallel steel plates which form the bearing surface and restrain the lateral movement of the pad.
- Multiple sandwich elastomeric bearings: It consists of a series of sandwich elastomeric bearings.

Depending on project requirements, the bearing dimensions will be custom made and cut to a specific thickness and "shape factor" (Sf[1]) to achieve the requirement. In this ATG, mainly the following shapes are covered:

- Rectangular bearings (based on shape factor ($S_f > 0.2$));
- Point shaped or discrete square shaped bearings (thickness ≤ width);
- Discrete bearings with vertical holes.

All bearings are suitable for concrete, steel or wood building applications.

2 Intended use / limits of use

This document provides the necessary information about the elastomeric solutions with the objective of facilitating a safe application of the solutions in practice.

This technical approval covers the design principles, manufacture and installation recommendations of the CDM Stravitec elastomeric BBI solutions. The information provided in this approval is intended to enable full application from the design stage, through the implementation phase, up to and including the use of the structure, whereby the safe support of the structure can be ensured.

Because each project is different, the structural design study for a specific construction project of the structural elements is not within the scope of this technical approval. The structural design is the responsibility of the structural engineer.

Also, the acoustic design study for specific projects, if applicable, shall be the responsibility of the engineering office/architect.

CDM Stravitec's engineering/technical service supports the project owner by designing the BBI solutions based on the input provided by the project design team and (if applicable) provides support with regards to the structural elements integrating a vibration isolation.

Once the BBI solution is approved by the structural engineering office/architect and/or acoustician, CDM Stravitec manufactures and supplies the CDM Stravibase solutions.

The technical approval contains the necessary data and guidelines that can be used for the structural and dynamic calculation of the construction in which the solutions are integrated. These are explained throughout the technical approval where necessary.

[1] $S_f = \frac{l \times w}{2t\,(l+w)}$; with: l = length, w = width, t = thickness.

3 Materials

This section describes the main elements which could be integrated to the solutions. The elastomeric products used in CDM Stravibase solutions can cover both rubber and polyurethane product families while, if required, the lost formwork can be of different materials such as steel, cement bonded particle boards, etc.

3.1 Elastomers

Elastomeric solutions are usually prescribed for resonance frequencies > 5 Hz. The elastomeric products cover both rubber like products or polyurethane. For solutions with the need for higher load bearing capacities elastomer types incorporating a textile at the loading surface are being used.

Their main characteristics are defined on the basis of the test methods given below in Table 1:

Table 1 – Characteristics describing the elastomers

Characteristic	Measurement method
Density	NBN EN ISO 845
Shore Hardness	NBN ISO 48-4
Stiffness (static/dynamic)	LTS-10 [2]

The main characteristics of these basic materials of the CDM Stravitec BBI solutions have been established during the initial type testing in the framework of this approval. The conformity of these materials to the initially established requirements are part of the agreed quality control plan and are regularly checked under the certification linked with this technical approval.

3.2 Lost formwork

The formwork can be metallic or not (e.g. cement bonded particle board or High Pressure Laminate, HPL), depending on the loading conditions, the operating environment and the project owners requests. The presence of formwork ensures a correct positioning onsite during installation and may serve as formwork for concrete casting in a later construction stage.

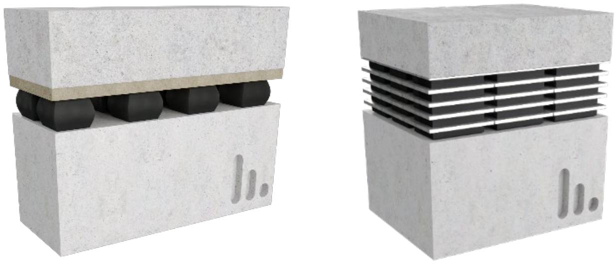
The minimum requirements for the formwork material are given below in Table 2:

Table 2 – Formwork minimum requirements

Characteristic	Measurement method
Bending tensile modulus	≥ 9,0 N/mm^2

4 Building Base Isolation solutions

The vibration isolation systems covered by this technical approval are the so called Stravibase SEB and Stravibase VHS solutions. These two isolation solutions use elastomeric products as main isolators. Fig. 1 displays the two types of solutions.



Stravibase SEB Stravibase VHS

Fig. 1 – CDM Stravitec Building Base Isolation solutions

[2] CDM Stravitec test method, see Annex I.

4.1 Stravibase SEB

Stravibase SEB consists of a series of elastomer pads. These pads may be supplied with or without a formwork on one or both sides. These bearings can be designed for natural frequencies between 5 Hz and 20 Hz, and can be manufactured in a variety of sizes to accomodate the building loads.

The main design characteristics for variants with either rubber or polyurethane are given in the Table 3:

Table 3 – Stravibase SEB design characteristics

Characteristic	Rubber	PU
Thickness (mm)	10 – 120	12,5 – 100
Frequencies (Hz)	5 – 25	5 – 25
Design loads[3] (MPa)	0,2 – 10 or higher [4]	0,35 – 9 or higher [4]

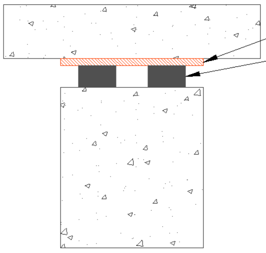


Fig. 2 – Principle of Stravibase SEB

4.2 Stravibase VHS

Stravibase VHS consists of alternating layers of high-resilience elastomer pads and steel plates. They are available in different sizes and are designed to attenuate natural frequencies between 7 Hz and 16 Hz. “VHS” stands for “Very High Stress” and can support acoustic design loads up to 12 MPa.

Depending on the function of the building and the different loadings, the client can request to integrate additional features to the solutions. In this regards, the Stravibase VHS itself could be accommodated with structural failsafes stravibase VHS-FS (see Fig. 3) or additional lateral resistance (shear-key principle).

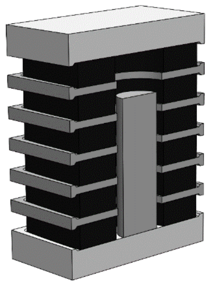


Fig. 3 – Stravibase VHS-FS (with failsafe)

Table 4 – Stravibase VHS design characteristics

Stravibase VHS Properties 2 to 7 successive layers of natural rubber and galvanised steel						
Stravibase VHS type	Without Failsafe					With Failsafe
	VHS			VHS-2LB		
Thickness of elastomeric layers (mm)	20		30	20		20
Commercial name	VHS-100	VHS-150	VHS-150-L30	VHS-2LB-200	VHS-2LB-200300	VHS-150-FS
Bearing footprint (mm²)	100 x 100	150 x 150	150 x 150	200 x 200	200 x 300	150 x 150
Minimum/maximum service load range (kN)	70 - 120	150 - 280	120 - 205	300 - 460	450 - 730	100 - 240
Frequencies (Hz)	7 - 16					

Note:

- For practical reasons, the Stravibase VHS can be supplied with top and/or bottom steel plates or can be glued to a lost formwork panel (see § 3.2)
- The Failsafe of the VHS-FS is welded to the bottom steel plate (Fig. 3) and will be used to prevent accidental deflections in case of major accidents (such as explosions, fires, ...etc).
- VHS-2LB bearing has a higher load bearing capacity using a textile reinforced rubber.

[3] Design load refers to the acoustic design load (ADL). Ref §7.2. Higher loads are possible in specific cases.

[4] The upper limit depends on the material type and the bearing shape factor.

5 Production and placement on the market

5.1 Production and internal control

The Stravibase SEB and Stravibase VHS solutions are manufactured by CDM Stravitec NV and are also marketed by CDM Stravitec NV in Belgium.

The internal controls include :

- Incoming goods: identification, certificates of analysis and additional entry checks/regular verifications;
- End products: Manufacturing, dimensions, performance tests with a fixed frequency.

The internal quality control is subject to certification, according to the product certification scheme 5 of NBN EN ISO/IEC 17067, carried out by the certification operator.

5.2 Packaging

All CDM Stravitec bearings are assembled in the production facilities of CDM Stravitec. The bearings are clamped sufficiently strong to hold the various bearing components in their correct positions during handling, transportation and installation.

Prior to shipping, CDM Stravitec elastomeric bearings are grouped per zone, stacked on a pallet and wrapped with a protective foil to resist weather conditions. The documentation attached to the pallets consists of installation plans and a packaging list which details the zone and the content of the pallet.

Each bearing is labelled with the following information:

- The manufacturers name,
- The project number,
- The product name,
- A reference to the patent (for the Stravibase VHS only)
- The position of the bearing.

6 Use of the ATG mark

The ATG logo, including the ATG designator (ATG 3322), is affixed by the ATG holder to any packaging as close as possible to the product.

The ATG logo and the ATG designator may also be used by the ATG holder in accompanying or commercial documents related to the product.

7 Design

7.1 Design considerations

Elastomeric bearings are tailored to the need of each project and depend on:

1. The acoustic requirements:
   - The required performance for the isolation bearings is defined by the acoustical consultant of the project, in terms of the resonance frequency of the isolation bearings in [Hz], or, the transmission loss of the isolation system in [dB] at the dominant excitation frequency. In practice, an isolated building is assumed as a simplified SDOF (mass-spring) system and the transmission loss can be formulated as a function of the resonance frequency of the SDOF system.
2. The load bearing requirements:
   - Elastomeric bearings used in a context of building base isolation are intended to be an integral part of the structural elements. For each project, the structural engineer will provide the load schemes to the engineers of CDM Stravitec to ensure that each bearing will support the necessary loads.
3. The available footprint:
   - To achieve the acoustic and load requirements, a design will be shared with the structural engineer. If the size of the bearing is larger than the available supporting area, the available surface of the structural element is redesigned or a bearing type with higher load capacity is selected.

7.2 Load considerations

For dimensioning, the Eurocode 0 (NBN EN 1990) applies. According to Eurocodes 0, the following actions and safety factors are considered:

- Dead Load and Superimposed Dead Loads (G + G') - Permanent actions:
  - Loads representing the self-weight of the structures, fixed equipment and floor covering and indirect actions caused by shrinkage and uneven settlements.
- Live Loads / Variable actions (Q):
  - imposed loads on building floors, beams and roofs, wind actions (F_W) or snow loads. The wind load can be applied in different directions: (+/-) x-direction or (+/-) y-direction, resulting in vertical and lateral reactions at the bearing supports.
- Accidental actions (A):
  - Fire, explosion, impact and earthquakes.

The bearings will be designed under the Acoustic Design Load (ADL) while checked to be performant under load cases described in Table 5.

The isolation bearings are supposed to be performant within a load range up to 125% of the bearing design load. Being performant means the bearings should remain consistent in terms of the acoustic and structural performance: e.g. 25% deviation from the designed, static deflection and resonance frequency.

Table 5 – Design load cases

Design load case	Considered loads
Serviceability Limit State (SLS) – Permanent load (permanent)	$G_k + G_k'$
Serviceability Limit State (SLS) – Quasi permanent load (acoustical design load)	$G_k + G_k' + \psi_2 \times Q_k$ (with ψ_2=0,3 in EU [(1)])
Serviceability Limit State (SLS) – Permanent load with effect of variable loads and wind	$G_k + G_k' + MAX(Q_k + 0.7 \times F_w ; 0.7 \times Q_k + F_{wk})$
Ultimate Limit State – Strength Check (ULS-STR) load case	$1.35 \times (G_k + G_k') + 1.5 \times MAX(Q_k + 0.7 \times F_{wk} ; 0.7 \times Q_k + F_{wk})$ (no cracks and no large deformation)
Ultimate Limit State-Static Equilibrium check (ULS-EQU) – Permanent load with positive effect of wind (uplift)	$0.9 \times (G_k + G_k') - 1.5 \times F_{wk}$

[(1)]: A similar calculation method, with a quasi-permanent load factor ψ_2 = 0,25, is used in North America

7.3 Ultimate Limit State (ULS)

The load information is always provided by the structural engineer (DL", "LL" and "WL" and the envelope of ultimate limit state load combinations).

The stability check consists on the following:

1. Load capacity of the bearings under the worst case load combinations: SLS Max and ULS, ULS-STR and ULS-EQU
2. Differential deflection between the bearing location under ADL is limited to 20% of the average bearing deflection

Once the bearings are designed and stability verification carried out, the structural engineer will receive all CDM Stravitec calculations, including dimensions, loads, dynamic stiffness of each bearing, their natural frequency and their expected deflection. The structural engineer will be able to carry out the verifications in the structural members and conduct specific finite element analysis if necessary.

With regards to lateral and uplift loads, CDM Stravitec will propose additional structural elements to maintain the stability/planeity of the elastomeric bearings and the structural element in general. Those structural elements can be shear dowels, shear keys and uplift restraints. The structural engineer will receive all the proposals from CDM Stravitec and will evaluate the suitability of the proposal and undertake the usual checks.

7.4 Dynamic stiffness

The dynamic stiffness of isolation bearings is a crucial parameter in determining their performance. Due to the viscoelastic nature of elastomeric bearings, their dynamic stiffness is higher than their static stiffness. The ratio of dynamic to static stiffness (known as the R-factor) can vary from 1 to 3, depending on the material type and the amplitude of dynamic excitation.

Currently, there is no standardised test method that is applicable for the BBI solutions included in this technical approval. Therefore, the manufacturer has established a test method, based on well-known principles from literature, that enables to determine the static and dynamic stiffness of the elastomeric materials as well as those of the individual products. The test method LTS-10 is described in Annex I. The values for static and dynamic stiffness as well as the resonance frequencies of the products that are included in the manufacturer's datasheets are determined according to this test methodology.

The material database of CDM Stravitec was validated during the approval process by means of representative testing in the presence of the UBAtc.

7.5 Creep

All products need to respect an average creep rate which doesn't exceed 2% logarithmic decade/minute of the initial height under service load (ADL).

A bearing should be capable of sustaining a compressive test load corresponding to at least 1,5 times the design load (ADL) for at least 6h without damage or undue creep.

Note: it is important to mention that creep can be considered once the bearings stand under the full design load.

7.6 Acoustic and vibration control

BBI solutions are prescribed for new or existing buildings subjected to ground-borne vibrations generated from different vibration sources such as railways, subways, etc. These ground-induced vibrations can generate, inside a building, structure-borne noise which might exceed the acoustic comfort levels.

Buildings as receivers of those vibrations are decoupled from their surroundings thanks to BBI solutions such as the Stravibase SEB or Stravibase VHS described in this technical approval. These solutions will mitigate the structure-borne noise and the perceptible vibrations by controlling the transmission of the ground-borne vibrations coming from the ground.

The design will closely depend on:

- The level of the vibrations measured which, in turn, depends on the vibration source and the soil in which the wave propagates;
- The intended use of the building : depending on the type of the intended use of the building, different acoustic comfort levels are prescribed;
- The building type and the load scheme;
- The available footprint in each support.

7.7 Seismic behaviour

For zones of low seismicity, for which ag.S ≤ 0.10 g, reduced or simplified design and calculation methods can be used, depending on the construction type or construction category (see NBN EN 1991 + ANB).

Special measures in case of earthquake prone areas are not included in this technical approval. If the products are used in earthquake-prone zones, this must also be taken into account in the design.

8 Installation

The elastomeric bearings covered by this ATG are intended to be an integral part of structural elements. The interactions with other elements is therefore of main importance. In this respect, installations must be carried out in accordance with CDM Stravitec's instructions, as follows:

- The bearing support surface in contact with an elastomeric bearing should be accurately prepared to ensure uniformity of loading in accordance with the design assumption. Spaces in the adjacent bearing support surface must be filled before installation of the bearings. If necessary, shims can be used for height compensation or if irregularities are superior to 1-2 mm. For irregularities which are superior to 3mm, a suitable mortar bed can be used for height compensation.
- Bearings and adjacent components need to be kept free from chemical and physical influences as well as contamination.
- The surface of the adjacent components must be swept clean and free of oil, grease and release agents.
- Standing water must be avoided. Adequate drainage to prevent accumulation of water or other liquids must be foreseen.
- Bearings must be protected from direct sunlight.
- Clearances around the bearing should be such as to permit movement to its loaded profile without restriction. The bulging surfaces of the bearing must be free to move in their planned deformation. They should include adequate allowances for creep of the bearing and for possible deterioration.
- Care should be taken that restraint to a bearing is not caused through interference either by structural parts of by accumulation of surplus grout or other debris in its vicinity.
- In the case where contact surfaces of the substructure and superstructure are not plane, the manufacturer needs to be informed.

Note: The load transfer on elastomeric bearings lead to load concentrations on the substructures. It is therefore important to consider this load concentration in the reinforcement design of concrete elements.

During installation, CDM Stravitec provides the general installation manuals to the contractors and gives specific instructions to ensure proper installation. If agreed upon, CDM Stravitec can supervise the installation.

9 Durability, maintenance, inspection and replacement/repair

9.1 Durability

The experience with elastomeric bearings has shown that the resistance to normal degradation of such elements is as good as, and may indeed be better than, that of conventional materials such as steel and concrete. It is recommended that the effective life of a system of resilient isolation bearings conform to the recommendations of the BS 6177 to be taken to 50 years if the building load conditions remain unchanged.

9.2 Maintenance and inspection

Bearings are often installed at an early stage of the construction and deflect progressively as the building structure load (self-weight) increases gradually. Due to the flexibility of elastomeric bearings, it is important that the contractor monitors the distribution of building loads during and at the end of construction by measuring bearing's deflection. An inspection of the bearings at the end of the construction works is recommended, to check the total deflection of the bearings and identify possible acoustic bridges.

9.3 Replacement/repair

The need for replacement of a bearing is unlikely, but provision for it may be economically desirable where:

- the structure may be altered or extended;
- the intended use of the building change, with alteration to the loading leading to a significant change in the anticipated deflection;
- the expected life of the structure is long enough to suggest a significant possibility that a bearing will need replacement because of deterioration or as a result of accidental or deliberate damage. Designing for replacement will involve the provision of room for jacks or other means of temporary support while the replacement of the bearings could be easily accomplished using the frozen bearing technology, a patented technology by CDM Stravitec.

CONDITIONS FOR THE USE AND MAINTENANCE OF THE ATG

A. This technical approval applies exclusively to the construction products referred to on the cover page of this document.

B. The approval holder and, if applicable, the distributor are not permitted to make any use of the name of the UBAtc, its logo, the ATG mark, the technical approval or the approval reference to claim assessments of products which do not comply with the technical approval or for a product (and its properties or characteristics) which is not the subject of the technical approval.

C. The technical approval is based on the available technical and scientific knowledge and information, together with the information provided by the applicant and completed by an approval examination taking into account the specific nature of the product. Nevertheless, users remain responsible for selecting the product as described in the technical approval, for specific uses intended by the user.

D. Only the approval holder and, if applicable, the distributor may assert rights based on the technical approval.

E. Any references to the technical approval shall be accompanied by the ATG reference.ATG 3322 and the validity period.

F. The approval holder and, if applicable, the distributor obliged to comply with the examination results specified in the technical approval when making information available to third parties. The UBAtc or the certification operator may take any appropriate action if the approval holder [or the distributor] fails to do so (sufficiently) on its own initiative.

G. Information made available in any way by the approval holder, distributor or a recognized contractor or by their representatives to (potential) users of the product covered by the technical approval (e.g. for clients, contractors, architects, consultants, designers, etc.), may not be incomplete or contradict the content of the technical approval or information referred to in the technical approval.

H. The UBAtc, the approval operator and the certification operator cannot be held responsible for any damage or adverse consequences caused to third parties as a result of the failure of the approval holder or distributor to comply with the provisions of this document.

I. This technical approval shall remain valid, provided that the product, its manufacture and all related processes:

- are maintained, in order to achieve, as a minimum, the examination results specified in this technical approval;
- are continuously monitored by the certification operator, which confirms that the certification continues to be valid.

If these conditions are no longer met, the technical approval shall be suspended or withdrawn and the technical approval shall be removed from the UBAtc website. Technical approvals are regularly updated. It is recommended to always use the version published on the UBAtc website.

J. The approval holder is at all times obliged to inform in advance the UBAtc, the approval operator and the certification operator of any possible adjustments made to raw materials and products, installation instructions and/or the manufacturing and installation processes and equipment. Depending on the information provided, the UBAtc, the approval operator and the certification operator will assess whether or not it is necessary to adapt the technical approval.

This technical approval has been published by UBAtc, under the responsibility of the approval operator, SECO/Buildwise, and based on a favourable opinion by specialised group "MAIN WORKS & CONSTRUCTION SYSTEMS", expressed on 17 April 2024.
In addition, the certification operator, BCCA, confirmed that the production process meets the conditions for certification and that a certification agreement has been signed by the ATG holder.

Date of issue: 29 August 2024.

For the **UBAtc**, as validating the approval process	Eric Winnepenninckx General Secretary	Frederic De Meyer Director

For the operators

Buildwise	Olivier Vandooren Director
SECO Belgium	Bernard Heiderscheidt Director
BCCA	Olivier Delbrouck Director

BUtgb vzw - UBAtc asbl

Belgische Unie voor de technische goedkeuring in de bouw vzw

Union belge pour l'Agrément technique de la construction asbl

Registered address and offices:

Kleine Kloosterstraat 23
1932 Sint-Stevens-Woluwe

Phone: +32 (0)2 716 44 12
info@butgb-ubatc.be
www.butgb-ubatc.be

VAT: BE 0820.344.539
RLP Brussels

UBAtc asbl is notified by the FPS Economy within the framework of Regulation (EU) 305/2011.

UBAtc asbl is an approval body member of:

EOTA® UEAtc WFTAO WORLD FEDERATION OF TECHNICAL ASSESSMENT ORGANISATIONS

ANNEXES

Annex I – Test method for static and dynamic behaviour of BBI materials

This Annex describes the LTS-10 method, the method developed by CDM Stravitec to define the static and dynamic behaviour of elastomeric materials and the BBI solution products described in this ATG.

I. Description of specimens

To define the static and dynamic behaviour of elastomer materials, samples are cut from sheets in the required dimensions. To increase accuracy multiple samples might be tested parallel to each other.

II. Test procedure

The following subchapters describe the test procedure, named LTS-10 throughout this document. The below graph shows the subsequent loading steps throughout the test.

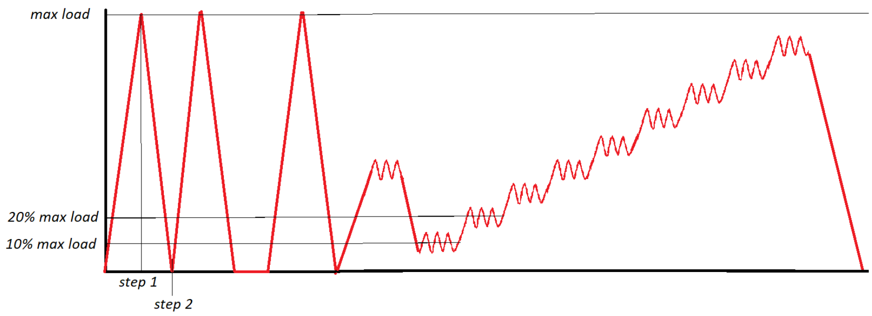


Fig A.1 – Loading steps during test procedure

a. Test procedure for static test

The static test has the following procedure:

- Apply a force, F_{max} in 60 seconds;
- Go to zero load in 60 seconds;
- Repeate this cycle of loading and unloading one more time;
- Wait on zero load for 30 seconds;
- Apply a force, F_{max} in 60 seconds;
- Go to zero load in 60 seconds;
- Calculate the static stiffness, k_{ST}, according the following formula where d_{SP} (mm) is the displacement when the applied force is increased from F_1 (being 0,03 kN) to F_{max}:

$$k_{ST} = \frac{F_{max} - F_1}{d_{SP}} \left(\frac{kN}{mm}\right)$$

b. Test procedure for dynamic test

A cycle force is applied, normal to the test specimen, at a constant frequency of 15 Hz. The dynamic test has the following procedure:

- Pre-cycle: go to 40% of F_{max} in 5 s and apply 150 cycles of a sinusoidal perturbation of 4% of F_{max} at a frequency of 15 Hz;
- Step 1: go to 10% of F_{max} in 5 s and apply 120 cycles of a sinusoidal perturbation of 1% of F_{max} at a frequency of 15 Hz;
- Step 2: go to 20% of F_{max} in 5 s and apply 120 cycles of a sinusoidal perturbation of 2 % of F_{max} at a frequency of 15 Hz;
- Step 3: go to 30% of F_{max} in 5 s and apply 120 cycles of a sinusoidal perturbation of 3% of F_{max} at a frequency of 15 Hz;
- Step 4: go to 40% of F_{max} in 5 s and apply 120 cycles of a sinusoidal perturbation of 4% of F_{max} at a frequency of 15 Hz;
- Step 5: go to 50% of F_{max} in 5 s and apply 120 cycles of a sinusoidal perturbation of 5% of F_{max} at a frequency of 15 Hz;
- Step 6: go to 60% of F_{max} in 5 s and apply 120 cycles of a sinusoidal perturbation of 6% of F_{max} at a frequency of 15 Hz;
- Step 7: go to 70% of F_{max} in 5 s and apply 120 cycles of a sinusoidal perturbation of 7% of F_{max} at a frequency of 15 Hz;
- Step 8: go to 80% of F_{max} in 5 s and apply 120 cycles of a sinusoidal perturbation of 8% of F_{max} at a frequency of 15 Hz;
- Step 9: go to 90% of F_{max} in 5 s and apply 120 cycles of a sinusoidal perturbation of 9% of F_{max} at a frequency of 15 Hz;
- go to zero load in 5s.
- Calculate the dynamic stiffness at each step (using 20 last cycles of each) using the following formula:

$$k_{DIN\_STEP\_i} = \frac{F_{MAX\_I} - F_{MIN\_I}}{d_{MAX\_I} - d_{MIN\_I}} \left(\frac{kN}{mm}\right)$$

Where F_{MAX_I} and F_{MIN_I} is the maximum and minimum load at each step in kN. d_{MAX_I} and d_{MIN_I} is the maximum and minimum deflection at each step.

Calculate the natural frequency at each step (using 20 last cycles of each) using the following formula:

$$f_{DIN\_STEP\_i} = \frac{1}{2\pi}\sqrt{\frac{9.81 \cdot 1000 \cdot k_{DIN_{STEP_i}}}{L_{mean}}}\ (Hz)$$

Where L_{mean} is the average load at each step.