Deutsches Institut für Bautechnik

Approval Authority for Construction Products and Building Types
Government Inspection Agency
An institution established under public law by the German Federation and states
Member of the EOTA, UEAtc and WFTAO

General Building Inspectorate Approval

Date:	**Reference:**
22.02.2017	III 11-1.23.34-116/16

Approval number:
Z-23.34-1989

Period of validity
from: **22 February 2017**
to: **22 February 2020**

Applicant:
FRANZ ROTTNER bi-foam Schaumglas GmbH
Einsteinstraβe 131
06785 Oranienbaum-Wörlitz

Subject of approval:
"Bi-foam glass foam: BFS 160 bi-foam ballast"
fill made from glass foam ballast
as load-bearing thermal insulation under foundation slabs

A general building inspectorate approval is hereby granted for the above-mentioned subject of approval.
This general building inspectorate approval consists of nine pages and two enclosures.

I GENERAL PROVISIONS

1 The general building inspectorate approval serves as proof of the usability and/or applicability of the subject of approval within the context of the state building regulations.

2 If the general building inspectorate approval contains requirements relating to the particular expertise and experience of the people entrusted to manufacture construction products and building types in accordance with § 17 subsection 5 of the model building regulations while taking into account state building regulations, it should be noted that proof of this particular expertise and experience can also be provided in the form of equivalent proof from other member states of the European Union. If necessary, this will also apply to equivalent proof provided within the framework of the Agreement on the European Economic Area (EEA) or other bilateral agreements.

3 The general building inspectorate approval does not replace the permits, consents and certificates required by law in connection with the implementation of building projects.

4 The general building inspectorate approval is granted without prejudice to the rights of third parties, particularly private property rights.

5 Without prejudice to further regulations in the "Special provisions", manufacturers and distributors of the subject of approval are to make copies of the general building inspectorate approval available to the user or owner of the subject of approval and are to point out that the general building inspectorate approval must be kept at the place of use. Copies of the general building inspectorate approval are to be made available to the authorities involved on request.

6 The general building inspectorate approval may only be reproduced in its entirety. Publication in the form of extracts will require consent from the Deutsche Institut für Bautechnik. Texts and drawings from promotional literature must not contradict the general building inspectorate approval. Translations of the general building inspectorate approval must include the note "Translation of the German original document not verified by the Deutsche Institut für Bautechnik".

7 The general building inspectorate approval may be revoked at any time. The provisions in the general building inspectorate approval may be added to or amended at a later date, especially in response to new technical knowledge.

II SPECIAL PROVISIONS

1 Subject of approval and field of application

1.1 Subject of approval

The general building inspectorate approval applies to the manufacture of loose glass foam ballast and its use as loose fill thermal insulation.

Glass foam granulate (to be referred to hereinafter as thermal insulation material) is an artificial broken aggregate that is produced from 10/80 mm recycled glass granules by means of foaming.

At the place of use, a thermal insulating layer is produced using the thermal insulation material by means of tipping and compacting.

The name of the thermal insulation material is

"bi-foam glass foam: BFS 160 (bi-foam ballast)".

1.2 Field of application

The thermal insulation material may be used in a compacted state (compaction ratio v = 1.3:1) as load-bearing thermal insulation under foundation slabs with mainly static loads.

The thickness of the compacted thermal insulating layer must not be less than 160 mm and must not exceed 900 mm.

The thermal insulation material may also be used outside the sealed area in locations where there is soil moisture and non-standing seepage water[1].

It is not permissible for the thermal insulation material to be used in the capillary fringe of groundwater (as a rule 30 cm above the highest groundwater level) or within areas where there is infiltrating water. The existing soil must be highly permeable to water. Drainage in accordance with the standard DIN 4095[2] is to be provided in areas where there is cohesive or stratified soil and water accumulation or stratification can occur.

2 Provisions relating to the construction product

2.1 Properties and composition

2.1.1 Composition and manufacturing method

In terms of composition and the manufacturing method used, the thermal insulation material must correspond to those on which the approval tests were based.

Details on the composition and manufacturing method are kept by the Deutsche Institut für Bautechnik.

Modifications are only permitted with consent from the Deutsche Institut für Bautechnik.

2.1.2 Environmental compatibility

In respect of environmental compatibility, the thermal insulation material must meet the requirements specified in "Principles for assessing the effects of construction products on soil and groundwater"[3] based on the no effect levels of the Federal State Water Consortium (cf. Appendix I-D.1 in these principles).

1 Water load within the context of DIN 18195-4: Waterproofing of buildings - Part 4: Waterproofing against ground moisture (capillary water, retained water) and non-accumulating seepage water under floor slabs and walls, design and execution

2 DIN 4095:1990-06 Subsoil; Planning, design and installation of drainage systems to protect structures against water in the ground

3 Principles for assessing the effects of construction products on soil and groundwater; 2011 version of publications issued by the Deutsche Institut für Bautechnik

The relevant elements for the thermal insulation material are to be taken from Table 1.

2.1.3 Loose bulk density

Each individual value relating to the loose bulk density of the thermal insulation material must be at least 130 kg/m^3 and no more than 170 kg/m^3 during testing in accordance with the standard DIN EN 1097-3[4] in conjunction with Appendix 1, section 1 in a measuring vessel with a capacity of at least 20 litres.

2.1.4 Thermal conductivity

During the testing of thermal conductivity in accordance with the standard DIN EN 12667[5] or the standard DIN EN 12939[6] in conjunction with Appendix 1, sections 1 and 2, the thermal insulation material (in a compacted state, v = 1.3:1) must not exceed the value λ_{limit} = 0.0848 W/(m·K).

2.1.5 Water absorption when submerged in water

When the thermal insulation material (in a compacted state, v = 1.3:1) is submerged in water after pre-treatment in accordance with Appendix 1, section 1 and testing in accordance with Appendix 1, section 3, the level of water absorption must not exceed 10.0% by volume.

2.1.6 Compressive stress with 10% compression

Each individual value relating to compressive stress with 10% compression must be at least 550 kPa during testing of the thermal insulation material in accordance with the standard DIN EN 826[7] in conjunction with Appendix 1, sections 1 and 4. At least five measurements are to be carried out.

2.1.7 Behaviour during the freeze-thaw cyclic test

During the testing of 5 test specimens in accordance with the standard DIN 52104-1[8], method G, there should be no significant visible changes to the test specimens after 20 freeze-thaw cycles.

2.2 Manufacture and marking

2.2.1 Manufacture

The provisions specified in subsection 2.1 are to be observed during the manufacture of the thermal insulation material.

4	DIN EN 1097-3:1998-06	Tests for mechanical and physical properties of aggregates - Part 3: Determination of loose bulk density and voids
5	DIN EN 12667:2001-05	Thermal performance of building materials and building products – Determination of thermal resistance by means of guarded hot plate and heat flow meter methods – Products of high and medium thermal resistance; German version of EN 12667:2001
6	DIN EN 12939:2001-02	Thermal performance of building materials and building products – Determination of thermal resistance by means of guarded hot plate and heat flow meter methods – Thick products of high and medium thermal resistance; German version of EN 12939:2000
7	DIN EN 826:2013-05	Thermal insulating products for building applications; Determination of compression behaviour; German version of EN 826:2013
8	DIN 52104-1:1982-11	Testing of natural stone; Freeze-thaw cyclic test; methods A to Q

2.2.2 Marking

The packaging or the delivery note relating to the construction product must be marked by the manufacturer with the mark of conformity (Ü) in accordance with the ordinance on marks of conformity of the Federal states. Marking is only permitted if the prerequisites in accordance with subsection 2.3 have been met.

In addition, the following details are also required to be shown alongside the mark of conformity:

Glass foam ballast: "bi-foam glass foam: BFS 160 (bi-foam ballast)", with 10/80 mm granules, for use as load-bearing thermal insulation under foundation slabs in accordance with general building inspectorate approval no. Z-23.34-1989

- nominal value for thermal conductivity: λ = 0.13 W/(m·K)
- nominal value for compressive stress: f_{cd} = 170 kPa
- "non-combustible" (building material class DIN 4102-A1)
- FRANZ ROTTNER bi-foam Schaumglas GmbH, 06785 Oranienbaum-Wörlitz, Germany
- manufacturing works[9] and date of manufacture[9]

2.3 Certificate of conformity

2.3.1 General information

Confirmation that the construction product complies with the provisions in this general building inspectorate approval must be provided for each manufacturing works in the form of a certificate of conformity based on a factory production control system and regular external monitoring including an initial inspection of the construction product in accordance with the following provisions.

The manufacturer of the construction product is to call in a recognised certification body as well as a recognised inspection body in connection with the issuing of a certificate of compliance and external monitoring.

The certification body is to send a copy of the certificate of conformity it has issued to the Deutsche Institut für Bautechnik for information.

A declaration is to be made by the manufacturer confirming that a certificate of conformity has been issued by marking the construction products with the mark of conformity (Ü) and indicating the intended use.

The Deutsche Institut für Bautechnik is also to be sent a copy of the initial test report for information.

2.3.2 Factory production control system

A factory production control system is to be set up and implemented at each manufacturing works. The term ‘factory production control system’ is understood to refer to the continuous monitoring of production to be carried out by the manufacturer in order to ensure that the construction products that it manufactures comply with the provisions specified in this general building inspectorate approval.

The factory production control system is to include at least the measures shown in Table 2.

A statistical evaluation of the compressive strength of the thermal insulation material determined is to be carried out as part of the factory production control system activities. Determination of the 5% quantile value $f_{c,0.05}$ is to be carried out as specified in Appendix 2.

9 Manufacturing works and date of manufacture can also be indicated in an encoded format.

This will involve testing the environmental compatibility of the glass powder used to produce the thermal insulation material. If the glass powder is obtained from various suppliers, the environmental compatibility of the various supplies is to be tested alternately. The supplier of the glass powder is to be indicated in the test report. In addition, at least once every 3 months the elements of the thermal insulation material in accordance with Table 1, lines 1 to 8 are to be determined with aqua regia digestion in accordance with DIN EN 13657[10] as well as after elution in accordance with LAGA Notice 33[11] (EW 98S, standard method). In the process, proof of compliance with the requirements specified in "Principles for assessing the effects of construction products on soil and groundwater"[3] is to be provided by means of comparison with the values stored by the DIBt.

Table 1:

Line	Element	Analytical method
1	Arsenic (As)	DIN EN ISO 11969[12] or DIN EN ISO 11885[13]
2	Lead (Pb)	DIN 38406-6[14] or DIN EN ISO 11885[13]
3	Cadmium (Cd)	DIN EN ISO 5961[15] or DIN EN ISO 11885[13]
4	Chromium total (Cr)	DIN EN 1233[16] or DIN EN ISO 11885[13]
5	Copper (Cu)	DIN 38406-7[17] or DIN EN ISO 11885[13]
6	Nickel (Ni)	DIN 38406-11[18] or DIN EN ISO 11885[13]
7	Mercury (Hg)	DIN EN 1483[19]
8	Zinc (Zn)	DIN 38406-8[20] or DIN EN ISO 11885[13]

The results of the factory production control system activities are to be recorded and evaluated. The records must contain at least the following details:

- designation of the construction product or the starting material and its components
- type of check or test
- date of manufacture and testing of the construction product or the starting material or its components
- result of the checks and tests and, if relevant, comparison with the requirements
- signature of the person responsible for the factory production control system

The records are to be kept for at least five years and presented to the monitoring body called in to carry out external monitoring. They are to be presented to the Deutsche Institut für Bautechnik and the responsible highest building supervisory authority on request.

10	DIN EN 13657:2003-01	Characterisation of waste – Digestion for subsequent determination of aqua regia soluble portion of elements in waste
11	LAGA Notice 33	LAGA EW 98 "Guideline on the procedure for physical and chemical analyses of waste, contaminated soil and materials from contaminated sites (2002 version)
12	DIN EN ISO 11969:1996-11	Water quality - Determination of arsenic by means of atomic absorption spectrometry (hydride technique)
13	DIN EN ISO 11885:1998-04	Water quality - Determination of 33 elements by means of inductively coupled plasma atomic emission spectrometry
14	DIN 38406-6:1998-07	German standard methods for the examination of water, waste water and sludge – Cations (group E) - Part 6: Determination of lead by means of atomic absorption spectrometry (AAS) (E 6)
15	DIN EN ISO 5961:1995-05	Water quality - Determination of cadmium by means of atomic absorption spectrometry
16	DIN EN 1233:1996-08	Water quality - Determination of chromium by means of atomic absorption spectrometry
17	DIN 38406-7:1991-09	German standard methods for the examination of water, waste water and sludge – Cations (group E); Determination of copper by means of atomic absorption spectrometry (AAS) (E 7)
18	DIN 38406-11:1991-09	German standard methods for the examination of water, waste water and sludge – Cations (group E); Determination of nickel by means of atomic absorption spectrometry (AAS) (E 11)
19	DIN EN 1483:1997-08	Water quality - Determination of mercury
20	DIN 38406-8:2004-10	German standard methods for the examination of water, waste water and sludge – Cations (group E) - Part 8: Determination of zinc by means of atomic absorption spectrometry (AAS) using an air-ethine flame (E 8)

If the test result is insufficient, the necessary measures to rectify the defect are to be taken by the manufacturer immediately. Construction products which do not meet the requirements specified are to be handled in such a way that they cannot be confused with ones which do meet the requirements. After the defect has been rectified, the relevant test is to be carried out again immediately, if it is technically possible and necessary in order to prove that the defect has been rectified.

Table 2: Tests for the purpose of providing proof of conformity

Property in accordance with subsection	Test in accordance with subsection	Minimum frequency	
		Factory production control system	External monitoring
Loose bulk density 2.1.3	2.1.3	Once a day	Twice a year
Thermal conductivity 2.1.4	2.1.4	-	Twice a year
Water absorption when submerged in water 2.1.5	2.1.5	-	Once a year
Compressive stress with 10% compression 2.1.6	2.1.6	Once a day	Twice a year
Behaviour during the freeze-thaw cyclic test 2.1.7	2.1.7	-	Once a year
Environmental compatibility of elements[21] in accordance with Table 1	Table 1	Once every 3 months[22]	Twice a year

2.3.3 External monitoring

At each manufacturing works, the factory production control system is to be checked regularly by means of external monitoring but at least twice a year.

An initial inspection of the construction product is to be carried out as part of the external monitoring, samples are to be taken and tested in accordance with the prescribed test plan and samples may also be taken for the purpose of carrying out random checks. Sampling and testing are the responsibility of the recognised monitoring body in each case.

At least the tests in accordance with Table 2 as well as the check on the marking are to be carried out.

In addition, at least twice a year the elements of the thermal insulation material in accordance with Table 1, lines 1 to 8 are to be determined with aqua regia digestion in accordance with DIN EN 13657[23] as well as after elution in accordance with LAGA Notice 33[24] (EW 98S, standard method). In the process, proof of compliance with the requirements specified in "Principles for assessing the effects of construction products on soil and groundwater"[3] is to be provided by means of comparison with the values stored by the DIBt.

21 While taking into account the values being stored by the DIBt

22 The results of external monitoring may be counted towards the results of the factory production control system activities.

23 DIN EN 13657:2003-01 Characterisation of waste – Digestion for subsequent determination of aqua regia soluble portion of elements in waste

24 LAGA Notice 33 LAGA EW 98 "Guideline on the procedure for physical and chemical analyses of waste, contaminated soil and materials from contaminated sites (2002 version)

The results of certification and external monitoring are to be kept for at least five years. They are to be presented to the Deutsche Institut für Bautechnik and the responsible highest building supervisory authority on request by the certification body or the monitoring body.

3 Provisions relating to design and dimensioning

3.1 Design

Proving the stability of the foundations is not covered by this general building inspectorate approval.

The maximum stress on the compacted thermal insulation layer perpendicular to its plane used for the purpose of proving stability must not exceed the design value for compressive stress specified in subsection 3.2.3.

The compacted thermal insulation layer may be loaded parallel to its plane if the provisions specified in subsection 3.2.3 are observed.

If the compacted thermal insulation layer is installed under a load-bearing component, deformation will arise as a result of the compression of the thermal insulation layer which is to be taken into account.

3.2 Dimensioning

3.2.1 Thermal conductivity

By way of deviation from the standard DIN 4108-2[25], subsection 5.2.2, the load-bearing thermal insulation may be taken into account when verifying the thermal insulation by means of calculation in accordance with the provisions specified in this general building inspectorate approval, even if it is used outside the sealed area.

When verifying the thermal resistance by means of calculation, the following design value for thermal conductivity is to be used for the thermal insulation layer:

$$\lambda = 0.13 \text{ W/(m·K)}$$

3.2.2 Design thickness

The design thickness is to be used when calculating the thermal resistance. The design thickness is the minimum thickness of the thermal insulation layer compacted in a ratio of v = 1.3:1.

3.2.3 Proof of stability of the foundations

When proving stability by means of calculation, the nominal value for compressive stress f_{cd}[26] in respect of the compacted thermal insulation layer may be used as a maximum in accordance with Table 3.

The nominal value for compressive stress f_{cd}[26] in respect of the compacted thermal insulation layer in Table 3 is produced from the nominal value for compressive strength $f_{c,nom}$ divided by the partial safety factor for the material properties γ_M[27] and the adjustment factor α[28].

25	DIN 4108-2:2013-02	Thermal insulation and energy economy in buildings - Part 2: Minimum thermal insulation requirements
26	defined as	c = compression, d = design
27	defined as	partial safety factor for the building material or product property (see DIN 1055-100: Actions on structures - Part 100: Basis of design – Safety concept and design rules, subsection 8.3)
28	defined as	production-specific adjustment factor

The standards DIN EN 1997-1[29], DIN EN 1997-1/NA[30], DIN 1054[31] and DIN 1054/A1[32] are definitive for proving the stability and suitability for use of the foundations.
When assessing settlement, the deformation of the thermal insulation layer is also to be taken into account.
The thermal insulation layer along with the relevant constrained modulus E_S in accordance with Table 3 is to be taken into account in the settlement calculations.
Horizontal forces may be diverted into the thermal insulation layer. In the process, the nominal value for shear stress must not exceed a value equal to 30% of the nominal value for normal stress in respect of the associated action combination.

Table 3

Designation	Nominal value for compressive strength $f_{c,nom}$ (kPa)	Nominal value for compressive stress $f_{cd} = f_{c,nom}/(\gamma_M^{27} \cdot \alpha^{28})$ (kPa)	Constrained modulus of the thermal insulation layer E_S (kPa)
bi-foam glass foam: BFS 160 (bi-foam ballast)	550	170	5000

3.2.4 Fire behaviour

The thermal insulation material is a non-combustible building material (building material class DIN 4102-A1) in accordance with DIN 4102-4[33].

4 Provisions relating to execution

The thermal insulation material is to be used in accordance with the processing instructions provided by the manufacturer.
The thermal insulation material is to be poured loose and compacted in a ratio of v = 1.3:1.
The thickness of the loose material while taking into account the compaction specified above is to be such that the specified design thickness of the thermal insulation layer is complied with across the whole layer.
In the case of design thicknesses of more than 300 mm, the thermal insulation material is to be poured in two layers and compacted in each case. The maximum permissible layer thickness after compaction is 300 mm.
In order to protect the thermal insulating layer during the laying of the foundation slab, a separation layer, e.g. PE film, is to be laid on top of the thermal insulating layer, or other suitable measures are to be taken.
The lateral edge region is to be designed in accordance with the processing instructions provided by the manufacturer.

Frank Iffländer
Head of Unit

Authenticated

[round stamp: Deutsches Institut für Bautechnik]

29 DIN EN 1997-1:2009-09 Eurocode 7: Geotechnical design, calculation and dimensioning – Part 1: General rules; German version of EN 1997-1:2004 + AC:2009
30 DIN EN 1997-1/NA:2010-12 National Annex – Nationally determined parameters – Eurocode 7: Geotechnical design, calculation and dimensioning – Part 1: General rules
31 DIN 1054:2010-12 Subsoil – Verification of the safety of earthworks and foundations – Supplementary rules to DIN EN 1997-1
32 DIN 1054/A1:2012-08 Subsoil - Verification of the safety of earthworks and foundations – Supplementary rules to DIN EN 1997-1:2010; Amendment A1:2012
33 DIN 4102-4:1994-03 Fire behaviour of building materials and elements; Composition and use of classified building materials, elements and special elements

General building inspectorate approval
No. Z-23.34-1989 dated 22 February 2017

Appendix 1

Tests

1 Pre-treatment of the test material

Test material which has been pre-treated in a positive mixer while observing the loose bulk density specified in subsection 2.1.3 of the Special Provisions in this approval in each case is to be used for the purpose of testing. The loose bulk density after pre-treatment in the positive mixer is to be specified.

2 Thermal conductivity

The test specimens for determining thermal conductivity in accordance with the standard DIN EN 12667[1] or the standard DIN EN 12939[2] are to be produced by pouring the insulation material into specimen holders measuring approximately 800 mm x 800 mm x 100-200 mm test thickness. The insulation material is to be compacted in a ratio of v = 1.3:1. The measuring surface is 500 mm x 500 mm.

3 Water absorption when submerged in water

The test specimens for determining water absorption are to be produced by pouring the insulation material into a plastic frame with plastic bottom with internal dimensions of approximately 570 mm x 570 mm x 145 mm. The insulation material is to be compacted in a ratio of v = 1.3:1. The top of the plastic frame is to be covered with a perforated plate. Once filled, the plastic frame is to be completely submerged in water in a suitable vessel for 28 days at 23 °C. The immersion depth to be used is 10 cm.
After setting up the plastic frame vertically and allowing it to drip dry for 10 minutes in each case, the level of water absorption is to be determined by performing weighing operations after 1 minute, 14 days and 28 days.

4 Compressive stress with 10% compression

These tests are to be carried out in square test frames measuring 200 mm x 200 mm x approximately 170 mm.
The test material is to be compacted in a ratio of v = 1.3:1 before carrying out the test.

1	DIN EN 12667:2001-05	Thermal performance of building materials and building products – Determination of thermal resistance by means of guarded hot plate and heat flow meter methods – Products of high and medium thermal resistance
2	DIN EN 12939:2001-02	Thermal performance of building materials and building products – Determination of thermal resistance by means of guarded hot plate and heat flow meter methods – Thick products of high and medium thermal resistance

General building inspectorate approval
No. Z-23.34-1989 dated 22 February 2017

Appendix 2

Determination of the 5% quantile value for compressive strength as part of the factory production control system activities

The 5% quantile value for compressive strength is to be determined as follows once a year for each product type and manufacturing works as part of the factory production control system activities by evaluating the random samples taken in accordance with subsection 2.3.2, Table 2, with a confidence factor of 75%.

When evaluating the first 35 samples, the standard deviation is to be estimated (or set as unknown).

With normal distribution, the 5% quantile value for the case "σ unknown" (if the standard deviation is unknown) is:

$$\hat{x}_{0,05} = \hat{x} - K_s \cdot s_x \qquad 0,05 = 0.05$$

where $\hat{x}_{0.05}$ statistical assessed value for the 5% quantile

$\hat{x}$ sample mean value

K_S quantile factors while taking into account the confidence factor set W = 0.75 in accordance with v = n - 1 (n = number of samples) and

s_x standard deviation

Quantile factors K_S in accordance with Table A2.1[3]

v = n - 1	2	3	4	5	6	7	8	9	10	11	12	13	14
K_S value	3.15	2.68	2.46	2.34	2.25	2.19	2.14	2.10	2.07	2.05	2.03	2.01	1.99

Quantile factors K_S in accordance with Table 6[4]

v = n - 1	15	17	19	24	29	34
K_S value	1.98	1.95	1.93	1.90	1.87	1.85

With normal distribution, the 5% quantile value for the case "σ known" (if the standard deviation is known) is:

$$\hat{x}_{0,05} = \bar{x} - K_\sigma \cdot \sigma_x \qquad 0,05 = 0.05$$

where $\hat{x}_{0.05}$ statistical assessed value for the 5% quantile

$\bar{x}$ sample mean value

K_σ quantile factors while taking into account the confidence factor set W = 0.75 with v = n - 1 and

σ_x standard deviation

Quantile factors K_σ in accordance with Table A2.2[3]

v = n-1	2	3	4	5	6	7	8	9	10	11	12	13	14
K_σ value	2.02	1.98	1.94	1.91	1.89	1.87	1.86	1.85	1.85	1.84	1.83	1.82	1.81

Quantile factors K_σ in accordance with Table 5[4]

v = n-1	15	17	19	24	29	39	49	99
K_σ value	1.81	1.80	1.79	1.78	1.77	1.75	1.74	1.71

3 from "Principles for assessing building materials, components and building types as part of the test mark and approval procedure" issued by the IfBt in the version dated May 1986

4 ISO 12491:1997-05 Statistical methods for monitoring the quality of building products and elements