BubbleDeck Fire Resistance Tests & Reports

Test Report D3

German Test Certificate No. P-SAC 02/IV-065
Fire Resistance Rating F30 to F180 - March 2001

English Translation June 2002

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I, Geoffrey Pearl, Member of the Institute of Translation and Interpreting, Member of the Institute of Linguists, care of Language Services International Ltd., Bournemouth, Dorset, UK, declare that the attached twelve page translation from the German is to the best of my knowledge and belief a complete, true and faithful rendering of the copy of the German Language Test Certificate Number P-SAC 02/IV-065 issued by the Materialforschungs- und Prüfungsanstalt für das Bauwesen Leipzig e.V., done to the best of my ability as a professional translator.

17 June 2002

This translation of the original German version has not been checked by the Materialforschungs- und Prüfungsanstalt für das Bauwesen Leipzig, e.V.

MATERIALFORSCHUNGS- UND PRÜFUNGSANSTALT FÜR DAS BAUWESEN LEIPZIG e.V. **MFPA LEIPZIG**
OFFICIALLY APPROVED TESTING OFFICE FOR BUILDING MATERIALS, COMPONENTS AND CONSTRUCTION TYPES
Scientific Director: University Professor Dr. Ing. Habil R. Thiele
Managing Director: Dr.-Ing. H. Meichsner

Department for Structural Fire Protection
Testing Office for the Fire Behaviour of Components

General Construction Inspection Test Certificate

Test Certificate Number:	P-SAC 02/IV-065
Object:	Reinforced concrete slabs of normal concrete according to DIN 1045 with hollow plastic spheres (Bubble Deck®). Fire resistance rating F30 to F180 according to DIN 4102-2 (09/77) (abbreviation F30-AB to F180-AB) and solid and live load sound insulation according to DIN EN ISO 140, assessed according to DIN ISO 717.
Applicant:	BubbleDeck AG Oberallmendstr. 20a – P. O. Box 140 CH-6301 Zug – Switzerland
Date of issue:	22.03.2001
Valid until:	21.03.2006

According to this General Construction Inspection Test Certificate, the above-mentioned object can be used in accordance with the Regional Building Regulations.

This General Construction Inspection Test Certificate consists of 6 pages and 3 annexes.

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1. Object and range of application

1.1 Object

The General Construction Inspection Test Certificate applies for the manufacture and use of load-bearing, room enclosing floors of reinforced concrete with a slab thickness of 22 to 47 cm, produced from cast-in-place concrete, respectively from partly prefabricated elements with an upper layer of cast-in-place concrete, known as "BubbleDeck®" and its application as a type of construction of fire resistance rating F30 to F180 (abbreviated name F 30-AB to F 180-AB) according to DIN 4102-2 (09/77)[1] as a function of the concrete floor exposed to fire from one side, as well as the requirements for sound insulation.

The reinforced concrete slabs are to be made from cast-in-place normal concrete according to DIN 1045 (07/88) with hollow plastic spheres without joints according to Section 2.

1.2 Application

1.2.1 The General Construction Inspection Test Certificate applies exclusively for fire and sound insulation, otherwise the pertinent regulations apply.

1.2.2 The space enclosing reinforced concrete slabs may be used as a type of construction for erecting load-bearing, internally located floors in a horizontal fitment position.

1.2.3 Sockets, switch boxes, distributor boxes, etc., may not be incorporated directly opposite (on the upper and lower side).

1.2.4 The requirements of DIN 4102-4 (03/99) apply.

1.2.5 Where glazing or fire protective closures with a specific fire resistance rating are to be incorporated in a room enclosing floor construction, with a specific fire resistance rating, the suitability of these fittings in conjunction with the slab must be verified in accordance with DIN 4102-5 (09/77), respectively DIN 4102-13 (05/99); additional suitability tests are required, e.g. as part of a general construction inspection permit.

1.2.6 The components that reinforce and support the floor must at least comply with the fire resistance rating of the floor where their reinforcing and supporting effect are concerned.

1.2.7 Connections to neighbouring classified solid components must be of a sealed design. In this regard, DIN 4102-4 (03/99), Section 3.6, must be observed.

1.2.8 The maximum span of the slabs is determined in accordance with DIN 1045, Section 17.7.2 in line with one of the two equations:

general: $l_i/h \leq 33$; for partition walls and for $l_i > 4.30$ m: $l_i / h \leq 143 / l_i$,

according to the "flexure" test report of the TH Darmstadt dated 09.02.1999. The lower figures apply (details for l_i and h in (m)).

1.2.9 Industrial and residential construction primarily with a dead load.

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[1] Through dated and undated references, this General Construction Inspection Test Certificate contains specifications from other standards. The references to standards are quoted at the pertinent places in the text and the standards are listed on page 6. With dated references, subsequent alterations or transcriptions of these standards must be taken into account in this General Construction Inspection Test Certificate. With undated references, the last edition of the standard or regulation referred to applies.

1.2.10 The Applicant has stated that no products are used in the construction products that are subject to the Hazardous Substances Directive, the Prohibited Chemicals Ruling or the Halogenated CFC Prohibitions Ruling, respectively that the Applicant complies with the requirements from the above-mentioned directives (in particular the labelling obligation). In addition, the Applicant has stated that where procedures must be taken regarding hygiene, health protection or environmental protection with regard to the trading and marketing or use of the construction product, these procedures have been initiated, respectively publicized in the requisite manner. Consequently, the Testing Office sees no reason to test the effects of the type of construction in the installed state on health and environmental protection.

2 Regulations for the type of construction

2.1 Characteristics and parameters

2.1.1 The reinforced concrete components must be manufactured from normal concrete of at least quality B25 and reinforcing steel BSt 500 S according to DIN 1045 (07/88). Hollow plastic spheres according to Section 2.1.2 must be used.

2.1.2 The hollow plastic spheres consist of high density polyethylene (PE-HD) and must at least comply with construction material category B2 according to DIN 4102-1 (see also Annexe 2). The hollow plastic spheres must withstand the fresh concrete pressure without a loss of format. The correct position of the hollow spheres during concreting must be ensured. The cross-sectional geometry must comply with Annexe 1.

2.2 Design

Table 1: Minimum concrete cover min. c (cm) of the lower reinforcement as a function of the period of fire resistance and the steel stresses under the computed working load (the concrete coverings were determined during the trials).

Steel stress [2] σ_s (MN/m²)≤	Steel utilization [2] σ_s (MN/m²)/286 (MN/m²) * 100%	Fire resistance (min)				
		30	60	90	120	180
190	66%	1.7 cm	1.7 cm	1.7cm*	1.7cm*	---
286	100%	1.7 cm	2.9 cm	3.5 cm	4.2 cm	5.5 cm

* The figures were determined on single-axis tensioned slabs. The total creditable longitudinal reinforcement consists of 65-75% of the steel cross-section in the 1st layer (below the transverse reinforcement) and 25-35% of the steel cross-section in the 3rd layer above the transverse reinforcement (e.g. from the bottom booms of the lattice girders). The steel tensions σ_s can be computed according to DIN 1045 (07/88), Section 17.1.3 equation (6).

The minimum bearing depth for the linear rotor bearings of the slab is 10 cm.

The concrete cover listed in the table is to be taken as min. c. The concrete cover nom. c is computed according to DIN 1045 Section 13.2.

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[2] Translator's comment: All subscripts must be checked against the original document, since these were almost illegible on the copy provided for translation purposes.

2.3 Dimensions

The dimensions specified in Sections 1.2 and 2.1 and also in Annexes 1 and 2, apply for fulfilling the requirements for fire resistance category F30 to F180. Detection of the stability and suitability for use is unaffected. Dimensioning of the floors must be carried out separately.

2.4 Details of the sound insulation

The rated sound insulation dimension R_w, measured according to DIN EN ISO 140-3 on the test rig, computed according to DIN ISO 717-1 in the frequency range from 100 Hz to 3150 Hz with the spectrum adaptation values C and C_{tr} is for a

thickness of 23 cm:

$$R_w (C; C_{tr}) = 55 (-2; -7) \text{ dB}.$$ [3)]

Additional spectrum adaptation values according to ISO 717-1 are obtained for

$C_{50\text{-}3150}$: -2 dB	$C_{50\text{-}5000}$: -1 dB	$C_{100\text{-}5000}$: -1 dB
$C_{tr\ 50\text{-}3150}$: -8 dB	$C_{tr\ 50\text{-}5000}$: -10 dB	$C_{tr\ 100\text{-}5000}$: -8 dB

The rated standard impact sound level $L_{n,w}$, measured according to DIN EN ISO 140-6 on the test rig, computed according to DIN ISO 717-2 with the spectrum adaptation values C_I and $C_{50\text{-}3150}$ is:

$$L_{c,w} (C_I , C_{50\text{-}3150}) = 78 (-11; -12) \text{ dB}$$

thickness of 34 cm:

$$R_w (C; C_{tr}) = 57 (-2; -7) \text{ dB}.$$

Additional spectrum adaptation values according to ISO 717-1 are obtained for

$C_{50\text{-}3150}$: -3 dB	$C_{50\text{-}5000}$: -2 dB	$C_{100\text{-}5000}$: -2 dB
$C_{tr\ 50\text{-}3150}$: -9 dB	$C_{tr\ 50\text{-}5000}$: -7 dB	$C_{tr\ 100\text{-}5000}$: -9 dB

The rated standard impact sound insulation level $L_{n,w}$, measured according to DIN EN ISO 140-6 on the test rig, computed according to DIN ISO 717-2 with the spectrum adaptation values C_I and $C_{50\text{-}3150}$ is:

$$L_{c,w} (C_I , C_{50\text{-}3150}) = 76 (-13; -13) \text{ dB}$$

2.5 Construction

Floors according to this General Construction Inspection Test Certificate may only be produced by companies that have adequate experience in this sector and employ suitably trained personnel. The constructing companies must be informed by the Applicant of the requirements of the General Construction Inspection Test Certificate and on the production of the type of construction, provided with training and remain in contact for a constant exchange of experience. The Applicant must maintain a list of the companies that have adequate expertise in producing the type of construction due to the instructions given by the Applicant.

3 Conformity verification

A notification of conformity of the type of construction known as Bubble Deck® with the requirements of this General Construction Inspection Test Certificate must be provided by

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[3)] Translator's comment: All subscripts must be checked against the original document, since these were almost illegible on the copy provided for translation purposes.

a conformity declaration from the manufacturer (company) on the basis of the factory's own production control.
The company that produces the floors must issue a written declaration to the Applicant, with which it certifies that the floor that it has manufactured complies with this General Construction Inspection Test Certificate.

4 Legal basis

This General Construction Inspection Test Certificate is issued on the basis of § 21a of the Saxony Building Regulations (SächsBO) in the version dated 18.03.1999 in conjunction with the List of Building Regulations A, PART 3; Serial No. 1, edition 2000/1. Equivalent legal provisions are included in the Regional Building Regulations of the other Federal German States.

5 Notification of legal remedies

An appeal can be lodged against this General Construction Inspection Test Certificate within one month of its issue. The appeal is to be submitted in writing or for the record to the Managing Director of the Materialforschungs- und Prüfungsanstalt für das Bauwesen Leipzig, e.V. Richard-Lehmann-Straße 19, 04275 Leipzig.

6 General information

6.1 The General Construction Inspection Test Certificate does not replace the specified statutory permits, approvals and certificates that are required for carrying out the construction project.

6.2 The General Construction Inspection Test Certificate is issued irrespective of the rights of third parties, in particular private industrial rights.

6.3 Irrespective of additional regulations, the manufacturers, respectively distributors of the type of construction must provide the user of the type of construction with copies of the General Construction Inspection Test Certificate.

6.4 The General Construction Inspection Test Certificate may only be reproduced in full. A partial publication requires the approval of the Materialforschungs- und Prüfungsanstalt für das Bauwesen Leipzig, e.V.

6.5 Texts and drawings of advertising matter must not contradict the General Construction Inspection Test Certificate. Translations of the General Construction Inspection Test Certificate must include the notification "This translation of the original German version has not been checked by the Materialforschungs- und Prüfungsanstalt für das Bauwesen Leipzig, e.V.".

6.6 The Contractor must keep a copy of the General Construction Inspection Test Certificate available at the building site.

Leipzig, 22.03.2001

signature, Dr-Ing. H. Meichsner, Managing Director

signature, Dr.-Ing. W. Jank, Manager of the Testing Office

Seal of the Materialforschungs- und Prüfungsanstalt für das Bauwesen Leipzig, e.V.

Standards and regulations

DIN 4102-2, Publication date:1977-09 Fire Behaviour of Building Materials and Building Components; Building Components; Definitions, Requirements and Tests

DIN 4102-4, Publication date:1994-03 Fire behaviour of building materials and building components; synopsis and application of classified building materials, components and special components

DIN 4102-5, Publication date:1977-09 Fire Behaviour of Building Materials and Building Components; Fire Barriers, Barriers in Lift Wells and Glazings Resistant against Fire; Definitions, Requirements and Tests

DIN 4102-9, Publication date:1990-05 Fire behaviour of building materials and elements; seals for cable penetrations; concepts, requirements and testing

DIN 4102-13, Publication date:1990-05 Fire behaviour of building materials and elements; fire resistant glazing; concepts, requirements and testing

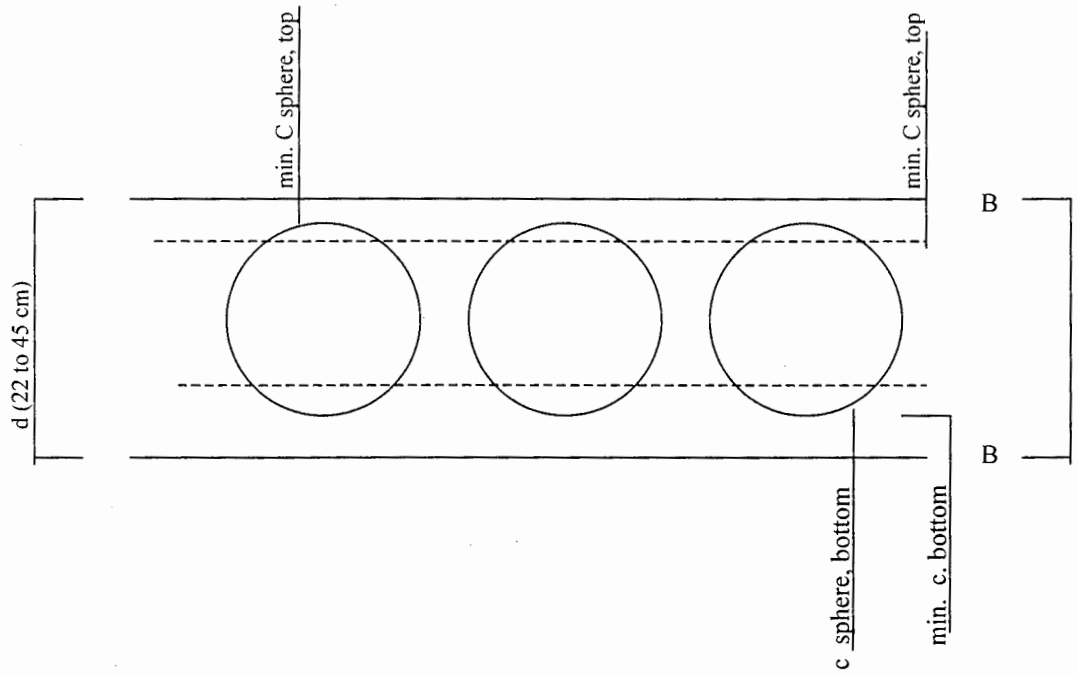
(see original document for diagrams)

Schematic depiction of the lower reinforcement mesh and the spheres

Schematic depiction of the upper reinforcement mesh and the spheres

(see original document for diagrams)

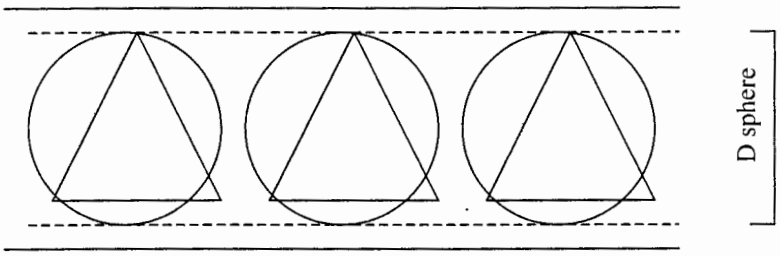
Section A-A



min. c, bottom – according to Table 1
min. c sphere, bottom > min. C, bottom – 0.5 cm
min. C top > 2.5 cm
min. c sphere, top > 2.5 cm
Distance a of the lower reinforcement as a function of the sphere diameter according to Table 2

(see original document for diagrams)

Section B-B



min. c, bottom – according to Table 1
min. c sphere, bottom > min. C, bottom – 0.5 cm
min. C top > 2.5 cm
min. c sphere, top > 2.5 cm
Distance a of the lower reinforcement as a function
of the sphere diameter according to Table 2

Table 2 – Geometric details

Floor thickness d [cm]	Sphere diameter D [cm]	a [cm] *	a_{tiu} [cm] *	a_{10} [cm] *	a_{tio} [cm] *
22 - 27	18 - 22.5	10	13	7	10
28 - 32	22.5 - 27	12.5	16	8	11
33 - 37	27 – 31.5	15	19	10	14
38 - 42	31.5 - 36	17.5	23	11	15
43 – 47	36	20	26	13	18

* The stated data applies for the smallest sphere diameter. For the other sphere diameters, the values are obtained for the distances of the reinforcing steel bars subject to complying with the geometric and static conditions.

Characteristic	Unit		Test Standard
Melt index MFR 190/2, 16	g/10 min	5 - 20	DIN 53735
Density at 23°C	g/cm³	0.955 – 0.970	DIN 53479
Tensile elasticity module	MPa	1500 – 1800	DIN 53457
Pin strain	MPa	30 - 33	DIN 53455
Pin strain	%	6 - 7	DIN 53455
Izod impact strength + 23°C	kJ/m²	NB	ISO 180-1C
Izod impact strength – 20°C	kJ/m²	50-NB	ISO 180-1C
Izod notch impact strength + 20°C	kJ/m²	2.5 – 3.5	ISO 180-1A
Izod notch impact strength – 20°C	kJ/m²	2.4 – 4.0	ISO 180-1A
Victal – B – softening temperature	°C	74 – 76	ISO 306
Dimensional stability temperature	°C	55 – 60	DIN 53461

1. Product designation

Product marking	PE-HD
Chemical designation	Polyethylene (high density)

2. Formulation/details about ingredients

This chemical product is a preparation:

Usual chemical designation	Polyethylene (high density)
Chemical formula	$(-CH_2-CH_2-)_n$
Genus	polyolefin
CAS No.	9002-88-4
Synonym(s)	HDPE
Hazardous additional substances	none

3. Physical and chemical characteristics

Polymer characteristics

Physical condition	solid (at + 20°C)
Colour	as chosen by the manufacturer
Odour	weakly of paraffin
pH	not applicable
Relative density	940 – 965 kg/m³
Melting point/range	127 – 137°C
Softening point/range	123 – 124°C
Solubility in water	insoluble
Solubility in other substances	soluble in some aromatic hydrocarbons and/or n-paraffins ($> C_{14}$) at high temperatures

Safety characteristics:

Decomposition temperature	> 300°C
Flashpoint	> 355°C
Spontaneous ignition temperature	> 355°C

Sample Conformity Declaration

- Name and address of the company that has manufactured the load-bearing, room enclosing reinforced concrete slabs from normal concrete :

- Construction site, respectively building:

- Date of manufacture:

- Fire resistance rating F ..... AB

It is herewith confirmed that the load-bearing, room enclosing reinforced concrete slabs have been produced and fitted from normal concrete according to DIN 1045 with hollow plastic spheres (Bubble Deck®), with fire resistance rating F ..... according to DIN 4102-2 (09/77) (abbreviated F .... AB) with airborne and impact sound insulation according to DIN EN ISO 140, assessed according to DIN ISO 717, in line with the content as well as all the details in a skilled manner and complying with all the regulations of the General Construction Inspection Test Certificate No. P-SAC 02/IV – 065 of the Materialforschungs- und Prüfungsanstalt für das Bauwesen Leipzig, e.V., dated 22 March 2001.

For the construction products or components that are not actually manufactured by the undersigned, this is also confirmed on the basis of

- the available marking of the components according to the regulations of the General Construction Inspection Test Certificate [1]

- own inspections [1]

- pertinent written confirmation from the manufacturer of the construction products or parts, which the undersigned has added to his files. [1]

Place, Date Stamp and Signature

(This certificate must be handed to the client for onward transmission to the pertinent construction supervising authority.)

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[1] Delete where not applicable