Expert opinion No. GA- 2018/028 - Mey dated 24/04/2018

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Gutachterliche Stellungnahme Nr. GA 2018/028 – Mey vom 24.04.2018

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English translation – Original version in German language

Client:	Fachverband Strohballenbau e.V. Artilleriestraße 6 D-27283 Verden
Order dated:	29/03/2018
Order signed by:	Ms Imhoff
Order received	29/03/2018
Order content:	General expert opinion on the fire behaviour of load-bearing, separating wall constructions in timber frame construction with a cavity insulation of construction straw in connection with various design variants based on the general building authority inspection test certificate No. P-3048/817/08-MPA BS with regard to classification as fire resistance class F 30 or F 90 according to DIN 4102-2: 1977-09 with one-sided fire exposure
Construction project:	This expert opinion only applies to construction projects in the Federal Republic of Germany

This expert opinion comprises 10 pages.

Contents

1 Order and reason

In an e-mail dated 27/07/2017, IBB GmbH of Groß Schwülper was commissioned by the Fachverband Strohballenbau e.V. to provide an expert opinion on the fire behaviour of load-bearing, separating wall constructions in timber frame construction with a cavity insulation of construction straw in connection with various design variants based on the general building authority inspection test certificate No. P-3048/817/08-MPA BS with regard to classification as fire resistance class F 30 or F 90 according to DIN 4102-2: 1977-09 with one-sided fire exposure for construction projects in the Federal Republic of Germany.

This expert opinion was required as there is not a general usability certification (general building authority test certificate) for all the construction details for the above-mentioned wall constructions in timber panel construction.

2 Fire protection requirements

The above-mentioned load-bearing, separating wall constructions in timber frame construction must, according to the requirements of the building inspection and fire protection concepts, be able to be designed in such a way that the load-bearing, separating wall constructions in a timber frame construction with cavity insulation of construction straw in connection with various design variants in one-sided fire exposure are able to be classified according to the uniform temperature time curve (ETK) pursuant to DIN 4102-2: 1977-09 in fire resistance class F 30 or F 90 pursuant to DIN 4102-2: 1977-09.

This expert opinion is only valid in terms of fire protection safety. Further requirements may arise from the technical building regulations and respective regional building regulations and regulations for special constructions relating to wall constructions, e.g. building physics, structural analysis, electrical engineering, ventilation technology or similar.

This expert opinion does not include the evaluation of the structural design, dimensioning of the wall constructions or the possibly implemented thermal insulation composite systems. It is, however, assumed that there is mathematical proof for use in this regard.

The overall fire protection concept of buildings is not the subject of this expert opinion.

3 Foundations and documents pertaining to this expert opinion

This expert opinion on the load-bearing, room-enclosing wooden beam structures is based on the following:

[1] the general building authority test certificate no. P-3048/817/08-MPA BS dated 08/12/2014 relating to load-bearing, room-enclosing wall construction in fire resistance class F 30 and F 90 pursuant to DIN 4102-2: 1977-09 in the event of one-sided fire exposure, issued to the Fachverband Strohballenbau e.V., Verden,

[2] the general building authority approval no. Z-23.11-1595 DIBt dated 03/01/2014 relating to thermal insulation material made from construction straw bales, issued to the Fachverband Strohballenbau e.V., Verden,

[3] test report no. 3798/999/13 – NB dated 18/02/2014 relating to testing a 360 mm-thick, load-bearing, space-enclosing wooden beam wall construction with straw bale insulation and lime plaster applied to both sides to determine the fire resistance duration in the event of one-sided fire exposure, issued to the Fachverband Strohballenbau e.V., Verden,

[4] the master's thesis on the topic of "The fire protective effect of historic cob plaster on timber ceilings" by Mr H. Opitz, HTWK Leipzig and MFPA Leipzig, September 2017,

[5] DIN 4102-2: 1977-09,

[6] DIN 4102-4: 2016-05,

[7] DIN EN 1363-1: 2012-10,

[8] DIN EN 1365-1: 2013-08,

[9] DIN EN 13501-2: 2016-12,

[10] he handbook on wood fire protection, Kordina, Meyer-Ottens, Deutsche Gesellschaft für Holzforschung e.V. (German Society for Wood Research), Munich, 2nd edition 1994, as well as

[11] the specialist publication "Loam construction rules, terms – building materials – components" (Lehmbau Regeln, Begriffe – Baustoffe – Bauteile), Ed: Dachverband Lehm e.V., Volhard, Franz; Röhlen, Ulrich, 3rd revised edition 2009, Springer Vieweg Verlag.

In addition to these documents, the author's own extensive experience in the field of fire protection is included in this expert opinion on load-bearing, space-enclosing wall constructions in timber frame construction with regard to the fire safety assessment. The engineers of IBB GmbH, Groß Schwülper, have over 30 years of professional experience working in recognised testing institutes.

4 Description of the constructions

4.1 General

The description of the constructions is based on the information provided by the client. Only the most important details relating to fire safety will be described in the following. The assessed wall constructions are load-bearing wooden framed walls with a supporting structure (columns, sleepers, plates) made of solid wood sections, with interposed thermal insulation of compacted construction straw, crossovers made of sheet steel strips fastened to the timber support structure, and two-sided plaster application on a reed mesh plaster base attached to the wooden structure.

The maximum permitted height of the walls is 5.0 m. The maximum stress on the column cross sections is limited to $\sigma = 1.93$ N/mm².

4.2 Wall constructions “F 30” and “F 90”

Notwithstanding the general building authority test certificate (abP) no. P-3048/817/08-MPA BS, see [1], the load-bearing, room-enclosing wall construction in fire resistance class “F 30” and “F 90” should be built to the following specifications:

4.2.1 Substructure (see abP, [1], Section 1.2.1 and 2.2.1.1)

According to the structural requirements, the wooden frame should have a minimum cross section of b x d ≥ 60 mm x 260 mm for wall constructions in class “F 30” and b x d ≥ 60 mm x 360 mm for wall constructions in class “F 90”. The axial dimension for the wooden frames should be a ≤ 1050 mm for both versions.

The attachment of the sleeper and top plate to the frames should be structurally anchored with either two steel screws ≥ 8 x 200 mm, both with three chipboard screws ≥ 6 x 140 mm or with at least two L-shaped sheet steel angles (width and side length approx. 90 mm) with a rib and ring shanked nails Ø x length = 4.0 mm x 40 mm per side. Furthermore, connections should be made using a pin or dovetail according to the structural layout.

Stainless steel spiked bands with a thickness of 2-3 mm (incl. connections to the sleeper and top plate) should be mounted crosswise on the wooden support structure. Alternatively, instead of the above-mentioned spiked bands for stiffening the structure and the wooden composite boards attached to the structure (building class at least B2, bulk density ≥ 600 kg/m²), materials such as, e. g. “OSB” or plywood or solid wood panels (building class at least B2 pursuant to DIN 4102-1 and at least E pursuant to DIN EN 13501-1, bulk density ≥ 330 kg/m³, thickness d ≥ 10 mm) can be used. The dimensioning of the above-mentioned wooden composite boards and plywood or solid

wood panels and the fastening elements should be according to the structural specifications. However, the fasteners (screws or clamps) must be embedded to a minimum depth of ≥ 30 mm into the wooden structure.

Furthermore, wooden planks, d x b ≥ 40 mm x 100 mm, used as struts or for fastening suspended loads (e.g. cabinets) should be built into the walls (embedded depth of the planks or struts in the cavity insulation = 40 mm).

As an alternative to the information of the abPs [1], the retaining ledges (screwed wooden profile b x d = 20 mm x 20 mm or triangular wooden boarders d x d = 38 mm x 58 mm) can be omitted on timber needles for the installation of the fitted straw bales (“construction straw”) in the “F 30” class wall construction.

4.2.2 Insulation (see abP [1], see Sections 2.1 and 2.2.1.1)

The wall cavity should be fitted with ≥ 260 mm thick cavity insulation for class “F 30” and ≥ 360 mm for class “F 90” made from straw bales (“construction straw”) between the studding in accordance with general building authority approval no. Z-23.11-1595.

4.2.3 Plaster application (see abP [1], see Section 2.2.1.3)

Clay plasters (bulk density ≥ 1600 kg/m³) made by various manufacturers (e.g. CONLUTO clay plaster terra coarse damp, CLAYTEC clay base plaster, base plaster) pursuant to DIN 18947 (LPM 0/4 f – S II - 1.8) and according to the loam construction rules of the Dachverband Lehm e.V., see [11], should be applied at an overall thickness of d ≥ 8 mm.

As an alternative to the fibre-reinforced lightweight lime-cement-based plaster mentioned in the abP [1] (lightweight plastering mortar LW, GRÄFIX 73 Pajalith), a comparable 10 mm-thick lime-cement plaster (solid mortar density ≥ 800 kg/m³) made by another manufacturer (e.g. lightweight plastering mortar LW, HESSLER HP 9L) should be used.

As an alternative to the reed mat plaster base described in the abP [1] for applying ≥ 8 mm-thick clay plaster or ≥ 10 mm-thick lightweight lime-cement-based plaster, a 9.5 mm-thick wood fibre panel (building class of at least B2) should be used as a plaster base throughout the entire area and tightly screwed into the wooden frame or wooden substructure pursuant to the specifications of the abP [1], Section 2.2.1.3.

Further description of the constructions will be omitted as these are sufficiently described above and otherwise performed in accordance with the design principles and constraints of the general building authority test certificate no. P-3048/817/08-MPA BS.

When working with the described construction products or construction components, the valid instructions of the manufacturer must be observed.

5 Fire safety assessment of the construction

5.1 Fire safety assessment

From the fire safety perspective of IBB GmbH, Groß Schwülper, the beam cross-sections described in Section 4.2 and the insulating layer of construction straw for the "F 30” class wall construction does not deviate from the general building authority test certificate. Therefore, according to [3] et al., a wooden stud wall consisting of timber studding b x d = 60 mm x 360 mm with cavity insulation made of 360 mm-thick, tightly packed construction straw between the wooden components with spiked bands on one side and a 10 mm-thick lime-cement plaster layer on both sides applied to a reed mat fulfils the performance requirements of DIN EN 1363-1 with regard to the load-bearing capacity, space enclosure and thermal insulation over a test duration of > 90 minutes. Based on the above-mentioned test results, we can derive that, according to the uniform temperature time curve and pursuant to DIN 1363-1, reducing the beam and insulation material thickness to 260 mm over a reduced fire exposure period of 30 minutes will result in compliance with regard to required performance criteria pertaining to preserving the load-bearing effect, thermal insulation and space enclosure. The marginal increase of the distances (5% increase) between the wooden shafts in Section 4.2.1, which are slightly larger by 50 mm, does not significantly or negatively impact the fire protection performance of the walls.

The alternative fortifications of the wooden shafts using steel angles on the sleepers and plates, as well as carpentry wood joints as stated in Section 4.2.1 can be approved, as these only relate to attachments to ensure the positioning of the shafts and therefore have no significant impact on the static load transfer.

The use of spiked bands with an increased steel thickness of 3 mm and alternative use of wooden composite boards, as well as plywood and solid wood panels for bracing the walls can be readily agreed to, as these do not significantly or not adversely affect the basic structures in terms of their fire safety and, in the case of wooden composite boards and plywood or solid wood panels, their additional effect as an insulation or wear layer improve the fire resistance of the wall structures in the event of a fire. Utilising the specified design of the attachment of the wooden composite boards

or plywood / solid wood panels with a minimum embedment depth of 30 mm into the timber support construction sufficiently ensures that the wall coverings, including the plaster base and the plaster, are kept sufficient or do not fall away prematurely in the event of fire exposure.

From a fire protection perspective, the 40 mm-thick wooden struts described in Section 4.2.1 can be used for reinforcement and 40 mm-thick wooden planks may be used for fixing loads, as they only reduce the thickness of the insulating layer of construction straw locally and by 40 mm in the immediate installation area. However, if softwood is used for this purpose, it can compensate for the reduced insulating layer thickness as it has a burn rate of approx. 0.8 mm / min.

The use of retaining ledges can be dispensed with without issue for wall constructions in class “F 30” with regards to the above-mentioned component testing of a two-sided, plastered wooden stud wall insulated with 360 mm-thick construction straw with one-sided fire exposure according to the uniform temperature time curve pursuant to DIN EN 1363 of over 90 minutes with derivable reserve capacities. Due to the arrangement of the retaining ledges directly beneath the plaster application or plaster base, they are exposed directly to the fire after the plaster cladding has failed, so they do not represent a support for the straw compartment in the event of ongoing, progressive fire development. The retaining ledges are therefore of minor importance and can be considered superfluous in a “F 30” construction.

According to the test report [3], the component test proved, among other things, that a 360 mm-thick compartment insulation of construction straw experienced maximum temperature increases on the side away from the fire of 41 K on average and 56 K as a single value after 90 minutes of fire exposure. These fall significantly short of the maximum permitted temperature increases of 140 K on average and 180 K as a single value for the fire protection performance criteria of insulation. Reduction of the insulation layer to 260 mm for a “F 30” wall construction pursuant to Section 4.2.2 can therefore be accepted without hesitation due to the existing reserve capacities.

Provided that the clay and lime-cement plasters of other manufacturers is fundamentally the same with regard to their composition and material properties, as well as the plaster application thickness as described in Section 4.2.3, we can assume from a fire protection perspective that there would be a comparable adhesion and protective effect in the event of a fire based on the existing test results on various plaster coatings.

There are no concerns with regard to the use of wood fibre panels instead of reed matting as a plaster base [4]. For example, component tests have proven that there is a comparable adhesive bond between clay plaster on wood fibre panels and reed mats in the event of fire exposure.

On the basis of the general building authority test certificate [1], the fire protection evidence given in Section 3 and the further test results on wooden stud walls, the load-bearing, space-enclosing wall constructions in timber frame construction with cavity insulation of construction straw, in conjunction with various design variants over a fire exposure period of 30 minutes or 90 minutes of one-sided fire exposure according to the uniform temperature time curve pursuant to DIN 4102-2: 1977-09 fulfil the required protection goals with regard to

- spatial enclosure,
- the permitted temperature increase above the initial temperature and
- the load-bearing capacity,

insofar as the construction details in Section 4 are adhered to and that the design is otherwise constructed according to the boundary conditions and construction principles of general building authority test certificate no. P-3048/817/08-MPA BS.

5.2 Summary and conclusions

From a fire protection perspective, IBB GmbH, Groß Schwülper recommends that the above-mentioned wall construction with designs pursuant to the information provided in Section 4.1 (wall construction “F 30”) and 4.2 (wall construction “F 90”) in the event of a one-sided fire exposure of 30 minutes or 90 minutes of one-sided fire exposure according to the uniform temperature time curve (ETK) pursuant to DIN 4102-2: 1977-09 are classified as load-bearing, space-enclosing walls in

Fire resistance class “F 30” (“F 30-B” for short)
pursuant to DIN 4102-2: 1977-09

and

Fire resistance class “F 90” (“F 90-B” for short)
pursuant to DIN 4102-2: 1977-09

as the deviations in the insulation, substructure and plaster described in Section 4 have been assessed as being non-essential.

This expert opinion relates exclusively to the fire protection assessment of the above-mentioned construction on the basis of the information provided by the client and the presented foundational information, and makes no statements relating to the structural analysis of the components.

6 Special instructions

- This expert opinion can be used in conjunction with the above-mentioned general building authority test certificate no. P-3048/817/08-MPA BS in construction processes as a basis for proof of conformity, as the deviations described in Section 4 are assessed as being “non-essential” from a fire protection perspective. The issuance of proof of conformity for the construction (with indication that the created construction has “non-essential” deviation from the construction principles and boundary conditions pursuant to the above-mentioned fire protection proof) is the responsibility of the building manufacturer (builder).
- Changes to and additions of construction details (derived from this expert opinion) are only possible after consultation with IBB GmbH, Groß Schwülper.
- This expert opinion is only valid if the subsequent load-bearing (reinforcing or load-discharging) components have at least the same fire resistance class as the assessed walls.
- Proper execution is the sole responsibility of the executing company.
- When using the construction materials or products mentioned in Section 4, the valid processing guidelines of the manufacturers must be observed.
- This expert opinion only applies to construction projects in the Federal Republic of Germany.
- The validity of this expert opinion expires on 24/04/2023.
- The period of validity may be extended on request and depending on the latest technology.