Research Programme of the Research Fund for Coal and Steel

FIre and Seismic performances of Hybrid fire WALLs in case of single-storey industrial and commercial steel buildings (FISHWALL)

Amendement proposal for EN 15254-5

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WP 5: Development of design rules, recommendations and innovative solutions

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ABSTRACT

It is well known that the intrinsic fire resistance of single-storey unprotected steel-framed buildings is largely sufficient to guarantee the evacuation of occupants in the event of fire. In consequence, for this type of building, the main concern of national fire regulations in Europe is how to prevent the spread of fire to the whole building. To achieve this objective, two performances shall be usually satisfied, namely, the appropriateness of constructive systems to ensure that there is no progressive collapse between fire compartments, and the efficiency of fire walls to stop the fire inside the initial compartment regardless of the state of structures exposed to fire. In practice, many constructional solutions can be implemented in order to preserve the integrity of the fire walls, while accepting that the fire exposed part of the structure may collapse. One of the most common solutions is to place a non-load bearing wall between two independent steel structures and to connect it to them by means of "fusible" links. In fire situation, these fusible links have to allow the wall to be disconnected from the structure affected by fire without endangering the separating function of the wall, which shall remain fixed to the steel structure on the other side of the wall and therefore not exposed to fire. However, due to the lack of corresponding scientific evidence, questions are being very often raised about the real efficiency of such systems in fire situation, which, in certain cases, have also to provide an adequate seismic resistance, if they are used in seismic areas.

Today, concrete or masonry wall solutions are frequently used for the compartmentation of buildings, predominately for low-rise commercial and industrial steel buildings. However, as an alternative, lightweight sandwich panels (comprising two thin flat metal faces and an insulated core) could become an appropriate steel fire wall solution, offering numerous benefits in comparison to other solutions, including fire resistance, durability, flexibility, easy dismounting and fast construction times. But, there is an evident lack of technical information about the adequate fire performance of such type of wall solutions when they are implemented in single-storey buildings with unprotected steel structure, which constitutes a major obstacle for their large use.

In this context, the overall goal of the FISHWALL project is to develop a design guidance and recommendations for an innovative hybrid fire wall solution based on lightweight steel-faced sandwich panels associated with unprotected steel structure under both fire and seismic actions but considered individually. This will be achieved through the following specific tasks: i) Establishing of a full range of experimental evidence about the fire and seismic behaviour of the investigated hybrid fire wall solution by carrying out a number of tests; ii) Investigating intensively the fire and seismic performances of the above hybrid fire wall solution in combination with unprotected single-storey steel structures through a variety of parametric numerical studies by means of validated FE numerical models; iii) Developing both cost-effective and innovative “fusible” connection systems for fire walls to be used in combination with unprotected steel structures of single-storey buildings; and iv) Developing a design guidance and practical recommendations for the studied hybrid fire wall and fusible links solutions, on the basis of above studies, from which engineers can carry out very efficient design.

Based on the project outputs, this report recommends modifications to the EN 15254-5 rules to extend the span of mineral wool sandwich panels.

1 INTRODUCTION

Based on the large-dimensional tests and their interpretation carried out in the Fishwall project, the research carried out by the PPAeurope/DIBT/IFBS consortium and the current work undertaken by CEN TC127 to revise the EN 15254-5 standard, a proposed modification to the rules for extending the span of mineral wool sandwich panels is presented in this deliverable.

These extrapolation rules have been formulated in accordance with the findings detailed in deliverable D2.4 [7] and references [1] through [14], as well as Annex A.

The rules that are proposed here are based on mineral wool sandwich panels with steel facings tested simultaneously in small spans according to EN 1364-1 and in large spans according to this same standard (see appendix A).

As a result, the scope of these rules within the framework of this deliverable is limited to panels that meet the minimum requirements associated with the sandwich panel typology tested as part of the FISHWALL project. Further full-scale tests, particularly those used in [13], will be essential to definitively validate these rules of extended application.

2 NEW EXTENDED APPLICATION RULES PROPOSED FROM IFBS/DIBT/PPA-EUROPE 2019 PROJECT

In ref [13] the following rules are proposed:

Then extended application rule for vertical orientation of the panel is the following (see Table 1 and Table 2):

Table 1: New extended application rule for horizontal application proposed in the IFBS/DIBT/PPA Europe project

Tested span length	**Extrapolation**
From 3 m to 6 m	-20 minutes by span meter
From 6 m to 7.5 m	-35 minutes by span meter
From x meter to x+2 m$\leq 10\,m$	-35 minutes by span meter

Table 2: New extended application rule for vertical application proposed in the IFBS/DIBT/PPA Europe project

Tested span length	**Extrapolation**
From 3 m to 6m	-35 minutes by span meter

Both tables are based on the discussion of the CEN TC127 WG1 TG4, which was charged with the task of revising the EN 15254-5.

3 PROPOSED AMENDMENTS TO EN 15254-5

3.1 First amendment – Span extrapolation rules for mineral wool sandwich panel spanning horizontally

With regard to paragraph 5.3.1 of Chapter 5.3 (Variations in Construction), the following modification is required:

"An extension in the span length above 4 m for panel spanning horizontally is possible dependent on the reached fire resistance time compared to the classification by using default values (see Table 3) If the following criteria are all satisfied:

- The performance continues to decrease to the level of the possible lower classification of EN 13501-2 (60, 90, 120, 180) below the level obtained in the 3 m x 3 m tests after the reduction time rules defined below,

And

- A safety gap of a few minutes should be defined in connection with committee 15254-5 (same gap as EN 1364-1 or EN 1634-1),

And:

- The field of application of the extended rules is limited to 7.5 m maximum,

And:

- The extension rules arrive in addition to the extensions which are already allowed in the EN 1364-1 standard,

And:

- There is no beam or column on the reference test following EN 1364-1,

And:

- If we lose the E level, we must be at the same level of E (Rules given by EN 1363-1 and EN 13501-2),

And :

- The minimum characteristic of the mineral wool sandwich panel are the following:
    - DoP following EN 14509 2013,
    - Facing side of fire 0.5mm of nominal thickness minimum,
    - Facing opposite site of fire 0.5mm of nominal thickness minimum,
    - Minimum Yield stress of the facing :280MPa,
    - Minimum panel thickness 175 mm,
    - Mineral wool minimum density: 120 kg/m^{3,}
    - EI 120 at minimum following EN 1364-1.

And:

- Fasteners: carbon steel screws minimum diameter 6.3
- end use conditions: identical as tested following EN 1364-1

Then, the following rules apply to carry out an extrapolation of span in the case of mineral wool sandwich panels spanning horizontally:

Table 3: Extended application rule for horizontal application

Length of the tested span	**Extrapolation**
From 3 m to 6 m	-20 minutes per span meter
From 6 m to 7.5 m	-35 minutes per span meter

3.2 Second amendment: Span extrapolation rules for mineral wool sandwich panel spanning vertically

With regard to paragraph 5.3.1 of Chapter 5.3 (Variations in Construction), the following modification is required:

"An extension in the span length above 4 m for panel spanning vertically is possible dependent on the reached fire resistance time compared to the classification by using default values (see Table 4) If the following criteria are all satisfied:

- The performance continues to decrease to the level of the possible lower classification of EN 13501-2 (60, 90, 120, 180) below the level obtained in the 3 m x 3 m tests after the reduction time rules defined below,

And

- A safety gap of a few minutes should be defined in connection with committee 15254-5 (same gap as EN 1364-1 or EN 1634-1),

And:

- The field of application of the extended rules is limited to 7.5 m maximum,

And:

- The extension rules arrive in addition to the extensions which are already allowed in the EN 1364-1 standard,

And:

- There is no beam or column on the reference test following EN 1364-1,

And:

- If we lose the E level, we must be at the same level of E (Rules given by EN 1363-1 and EN 13501-2),

And:

- The minimum characteristic of the mineral wool sandwich panel are the following:
    - DoP following EN 14509 2013,
    - Facing side of fire 0.5mm of nominal thickness minimum,
    - Facing opposite site of fire 0.5mm of nominal thickness minimum,
    - Minimum Yield stress of the facing :280MPa,
    - Minimum panel thickness 175 mm,
    - Mineral wool minimum density: 120 kg/$m^{3,}$
    - EI 120 at minimum following EN 1364-1.

And:

- Fasteners: carbon steel screws minimum diameter 6.3
- end use conditions: identical as tested following EN 1364-1

Then, the following rules apply to carry out an extrapolation of span in the case of mineral wool sandwich panels spanning vertically:

Table 4: Extended application rule for vertical application"

Length of the tested span	**Extrapolation**
From 3 m to 6 m	-35 minutes per span meter

4 REFERENCES

[1] prEN 15254-5 (2007) Extended application of results from fire resistance tests — non-loadbearing walls - Part 5: Metal sandwich panel construction.

[2] EN 15254-5 (2009) Extended application of results from fire resistance tests – non-loadbearing walls - Part 5: Metal sandwich panel construction.

[3] EN 15254-5 (2013) Extended application of results from fire resistance tests — non-loadbearing walls - Part 5: Metal sandwich panel construction

[4] EN 15254-5 (2018) Extended application of results from fire resistance tests — non-loadbearing walls - Part 5: Metal sandwich panel construction

[5] Overview of existing methods concerning the extended application for partition walls Pieter Poppe - NBN Belgium - 09/01/2013

[6] EXAP 152545 Extrapolation of height above 4m in partition of metal sandwich panels EGOLF TC2 - Helpdesk 2012-16 EGOLF TC2 N672 Université de Liège

[7] Izabel D., FISHWALL project, RFSC-2020, GAN 101034083, Work Package 2, Deliverable 2.4, Assessment_of_extension_rules_for_sandwich panels, 2023

[8] Deliverable 2.1 tests reports et rapport de classement Joris Ide 3 m x 3 m pose verticale selon EN 1364-120, Pavus Report n°Pr-22-2.232-EN on 2023-01-20

[9] Deliverable 2.1 tests reports et rapport de classement JorisIde 3 m x 3 m pose horizontale selon EN 1364-1, Pavus report N°. Pr-22-2.170-En issued on 2022-09-30

[10] Deliverable 2.1 tests reports et rapport de classement JorisIde 5 m x 6 m pose verticale selon EN 1364-1, Pavus report N°. Pr-22-2.085-En issued on 2022-06-13

[11] Deliverable 2.1 tests reports et rapport de classement JorisIde 5 m x 6 m pose horizontale selon EN 1364-1, Pavus report N°. Pr-22-2.084-En issued on 2022-06-13

[12] Deliverable 2.1 tests reports et rapport de classement JorisIde 5.5 m x 6 m pose verticale selon EN 1364-1 avec ossature horizontale, Pavus report N°. Pr-22-2.231-En issued on 2023-01-17

[13] Deliverable 2.1 tests reports et rapport de classement JorisIde 4.50 m x 6 m pose horizontale selon EN 1364-1 avec ossature verticale, Pavus report N°. Pr-22-2.086-En issued on 2022-06-13

[14] Thomas Ummenhofer, Jürgen Schmied Verifizierung der Extrapolationsregeln in DIN EN 15254 Teil 5 für den Feuerwiderstand von Wänden aus selbsttragenden Sandwichelementen Fraunhofer IRB Verlag August 2021

[15] Appréciation de laboratoire n°EFR-15-000918 en matière de résistance au feu 27 janvier 2016

APPPENDIX A. SYNTHESIS OF THE TEST RESULTS OBTAINED IN THE FISHWALL PROJECT

The results obtained in the field of the FISHWALL project are the following:

	Without intermediate profile				With intermediate profile			
Span	**6 m**				**5.5 m**			
Panels spanning vertically	E tested FISHWALL	E (**) PPA/DIBT	I tested FISHWALL	I (**) PPA/DIBT	E tested FISHWALL	E (**) PPA/DIBT	I tested FISHWALL	I (**) PPA/DIBT
Duration in minutes	**94**	96	**94**	96	**104**	112	**141**	112
Possible classification	**90**	**90**	**90**	**90**	**90**	**90**	**90 (*)**	**90**
Span	**5m**				**4.5 m**			
Panels spanning horizontally	E tested FISHWALL	E (**) PPA/DIBT	I tested FISHWALL	I (**) PPA/DIBT	E tested FISHWALL	E (**) PPA/DIBT	I tested FISHWALL	I (**) PPA/DIBT
Duration in minutes	**126**	176	**126**	(*)	**122**	186	**163**	186
Possible classification	**120**	**120**	**120**	**120**	**120**	**120(*)**	**120**	**120(*)**

(*) If we lose the E level, we must be at the same level of E.
(**) Obtained through the extrapolation rules of PPA/DIBT/IFBS on large scale tests compared with 3 m x 3 m tested panels for a field of application of 6 m maximum with a possible loss of performance in front of a required level (here 120 minutes).