FIRE AND MATERIALS
Fire Mater. (in press)
Published online in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/fam.879

New data for sandwich panels on the correlation between the SBI test method and the room corner reference scenario

Jesper Axelsson and Patrick Van Hees*,†

SP Swedish National Testing and Research Institute, Borås, Sweden

SUMMARY

Assessment of the fire behaviour of sandwich panels is continuously under discussion. The fire behaviour of these panels is a combination of material characteristics such as the core material and mechanical behaviour of the panels such as joints, dilations etc. The use of small or intermediate scale tests can be questioned for such types of products.

Within the proposed European product standard for sandwich panels (prEN 14509) the intermediate scale test method SBI (EN 13823) has been suggested as the fire test method to certify panels. The standard does, however, use quite an artificial mounting procedure, which does not fully reflect the end-use conditions of the panels.

In a previous research project conducted by Nordtest it was shown that the correlation between the SBI test method and both the ISO 9705 and ISO 13784 part 1 was insufficient. The test data produced for the SBI test method, however, did not use the above mentioned mounting technique.

In this article new data for a number of products are added to the database using the mounting procedure of the product standard. The data are compared with the previous data and show that the mounting method of the product standard results in slightly more severe conditions but that there are still discrepancies with the full-scale test results. The data also show an unacceptable level of repeatability due to the fact that small dilations result in a wide variation of classification result. The new data together with the old data show once more that it is dangerous to make a fire safety assessment of a sandwich panel based on small or intermediate scale tests. Copyright © 2004 John Wiley & Sons, Ltd.

KEY WORDS: sandwich panels; SBI test; prEN 14509; fire test; ISO 9705

1. BACKGROUND

Sandwich panels are built up as composite construction products. In most cases they consist of two metal sheets with inner core insulation. This core insulation can be either combustible or non combustible. The metal can cause a delay of ignition but still transfers heat to the core.

The number of fires involving sandwich panels with combustible cores has increased substantially and they are considered to be a growing fire problem within fire safety of buildings,

*Correspondence to: Patrick Van Hees, SP Swedish National Testing and Research Institute, SP, Box 857, SE 501 15 Borås, Sweden.
†E-mail: Patrick.van.hees@sp.se

Received 3 December 2003
Accepted 8 August 2004

especially in food factories but also in cold storage rooms, warehouses etc. Fires in so-called food factories in the UK have caused much concern for insurance companies and fire fighters. For example the total loss from fires in the UK food industry where sandwich panels are often used was more than 30 M€ in 1995 and is increasing every year [7].

When assessing the fire risk of sandwich panels, most small-scale tests are insufficient because they cannot predict the behaviour of joints and mechanical fastenings during fire. ISO TC92 SC1 understood this and produced two large scale tests for sandwich panels which were published in 2002 as ISO 13784 part 1 and 2 [3,4]. ISO 13784 part 1 [3] especially can be considered as a specific version of ISO 9705 [2,5] suitable for a full end-use mounting of sandwich panels.

In a previous Nordtest project [6] it was shown that the correlation between the ISO 9705 (reference scenario for the SBI method [9] with respect to wall and ceiling linings) and ISO 13784 part 1 on the one hand and the SBI method on the other hand was insufficient. Criticism was, however, expressed that the tests were not performed according to the proposed product standard. A first set of extra tests was performed in 2001 and was reported at the Fire and Materials conference [8] and at Interflam during 2001 [10]. Still no correlation was seen. After this presentation new changes were introduced in the standardization process of the product standard. Therefore it was decided to check again the correlation with a new set of data according to prEN 14509 [11]. The new data are reported and discussed in this article and compared with the old data.

2. SPECIMENS USED IN THE STUDY

The products involved in this article are given in Table I. The table only gives a generic description of the products. Since the object of this project was not to compare products but only to investigate the different test procedures, the description is kept to a minimum. Selection of the products is from both the Nordic and European markets.

The results from the different products in this study are not necessarily representative for all panels with similar construction.

Product A was not included in the study as it showed similar results in the previous study and hardly reacted in the SBI method due to its nearly incombustible core product. For product B it was impossible to retrieve the same product as in the former tests and this product was not tested. For Product C the same product was still available from the supplier. For Product D the product was available but the producer could not guarantee that the PUR foam was the same as in the panel tested previously. Before deciding to run the SBI tests it was checked whether the foam in the newly bought product had similar properties the older one. This was done by means

Table I. Specimen description.

Product	Insulation material	Thickness of the panel (mm)
A	Stone wool	100
B	Polystyrene	100
C	PIR	100
D	PUR	100

of comparing cone calorimeter data (ISO 5660). The results of HRR and ignition time revealed that the foam of the newly bought product D showed slightly worse fire properties compared with that used in the Nordtest project [6].

3. MOUNTING IN THE SBI FOR THE NEW TEST SERIES

The mounting was performed according to prEN 14509 [11], annex C, with a vertical joint positioned 200 mm from the inside of the corner. Steel corner flashings were used in the inner corner and the outer corner with screws at every 400 mm. The vertical joint was screwed at 40 mm from top and bottom on both front and back sides of the sample. All cut edges were uncovered. The backing board was placed 40 mm behind the sample and the space was completely ventilated. A sketch of the mounting is given in Figure 1.

4. TEST RESULTS

The classification results for ISO 9705 and ISO 13784-1 were based on the limits given in annex A of the classification standard EN 13501-1. This assumes of course that the selection of one of these ISO sandwich panel tests as the reference scenario on a European basis is correct. ISO 9705 has already been chosen as the reference scenario for wall and ceiling linings. The choice of an alternative reference scenario for sandwich panels has not been decided or discussed yet. So for the time being this is the only available option. ISO 13784-1 was also chosen as it is very similar to the ISO 9705. All other full scale tests with sandwich panels differ substantially from ISO 9705 with respect to ignition source, configuration, dimensions, etc.

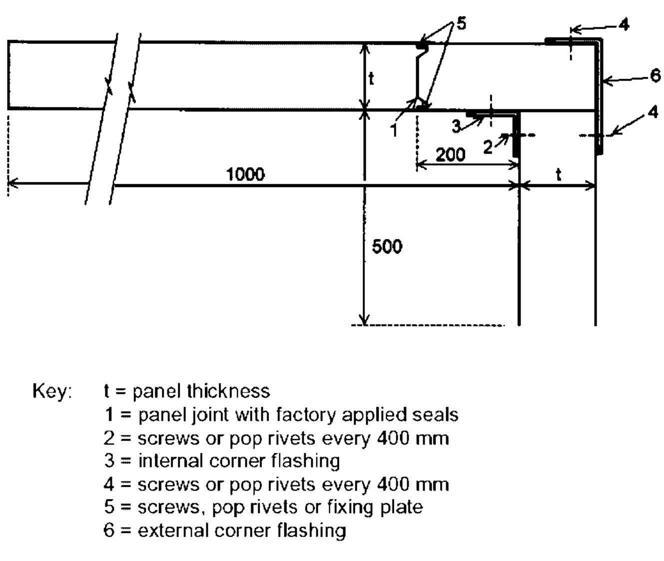

Figure 1. Mounting used for the SBI tests (quote from prEN 14509).

The classification for the SBI was based on Table I in EN 13501-1 but without conducting the small flame test given in EN ISO 11925-2. This means that the classifications given below are the highest possible. It is possible that the panels fail when conducting the small flame test. However, here the product standard (in contradiction to the SBI test) allows the use of protective flashing if this is the end-use. This means that the flame shall be applied both to the surface of the specimen (most likely steel) and to the protected cut edge of the specimen (also most likely steel). So common sense tells us that there will be no changes in classification as it is not expected that there will be flame propagation on a steel surface provided that there is no combustible surface coating.

4.1. Summary of previous data from the Nordtest project [6,8,10]

Tables II–IV show the results from the previous test series both for the full-scale tests and for the SBI tests.

Table II. Full-scale test results for sandwich panels according to ISO 9705 and ISO 13784 part 1.

Flashover time (time to 1000 kW) (min:s)				
	Product A	Product B	Product C	Product D
ISO 9705	No FO	6:54	No FO	14:42
Freestanding ISO 13784-1	No FO	12:08	11:44	9:10
Max HRR (kW) 0–20 min				
	Product A	Product B	Product C	Product D
ISO 9705	74	>900	317	>700
Freestanding ISO 13784-1	195	>700	>700	>900

Table III. Previous SBI test results for sandwich panels [6,8,10].

Product	FIGRA (W/s)	THR (MJ)	SMOGRA (m^2/s^2)	TSP (m^2)	Droplets	Euroclass
Product A	0	0.4	4	46	No	Bs1d0
Product B	92	1.8	38	87	No	Bs2d0
Product C	60	5.5	30	377	No	Bs3d0
Product D	36	2.9	16	164	No	Bs2d0

Table IV. Comparison of Euroclasses according to the different test methods in a previous study [6,8,10].

	Product A	Product B	Product C	Product D
ISO 9705	$\geqslant$B	D	$\geqslant$B	C
Freestanding ISO 13784-1	$\geqslant$B	C	C	D
SBI	Bs1d0	Bs2d0	Bs3d0	Bs2d0

4.2. New data

Table V. New SBI test results for Product C and D.

Product	FIGRA (W/s)	THR (MJ)	SMOGRA (m^2/s^2)	TSP (m^2)	Droplets	Euroclass
C test 1	80	3.2	57	493	No	Bs3d0
C test 2	92	3.9	53	442	No	Bs3d0
C test 3	99	4.0	57	370	No	Bs3d0
D test 1	25	3.6	32	412	No	Bs3d0
D test 2	73	6.1	46	587	No	Bs3d0
D test 3	111	14.2	61	770	No	Cs3d0
D test 4	136	18.7	80	1081	No	Ds3d0

5. DISCUSSION

1. Looking to the results of the new SBI tests in Table V it can be seen that the repeatability of the results for Product C is satisfactory. For Product D this is, however, not the case. This can be seen very clearly in Figure 2. During the tests it was observed that the behaviour of the joint and the possible ignition of the smoke gases on top of the samples were probably the two major key factors causing the bad repeatability between the samples. However, this could not be proven since it is a question of very small influencing factors. More data are needed to investigate this further.
2. Comparing the previous SBI data with the new SBI data (Table III and Table V) the major differences can be seen for product D. Product C obtains the same class. The FIGRA, SMOGRA and TSP values are higher but on the other hand the THR is lower for the new data set. For Product D the new data set revealed a large spread in results. One data point is similar to previous results while the others are more severe. Classification for sandwich panels seems to be determined mainly by the THR values, not by FIGRA. In full scale, the classification is based on the flashover time which for wall and ceiling linings was correlated mainly with the FIGRA and not the THR [13]. This indicates that it will be difficult to obtain a good correlation between SBI and full scale for sandwich panels. The smoke classification is always worse in the new data set. For two products no data are available. In one case (product A) it was decided that it would add little information to re-run a panel with an almost incombustible core. In the other case (product B) it was unfortunately impossible to obtain the same product. For this product it can, however, be expected that the class would be E or worse. This is due to the fact that the test mounting procedure prescribes open edges (not corresponding with end-use) and from experience it is known that this type of core-material will first melt, ignite and then burn intensively as it was not fire retarded [12].
3. Finding a correlation between the new test data and the full-scale test data in Table VI is difficult. The new data did not change the conclusion that it is still questionable if the SBI test method can reflect the real scale behaviour of sandwich panels. Panels with a non-melting combustible core will obtain the highest combustible class (B) which is not always confirmed in full scale tests. On the other hand it could be that the proposed product standard is more severe to products with melting insulation cores due to the fact that the

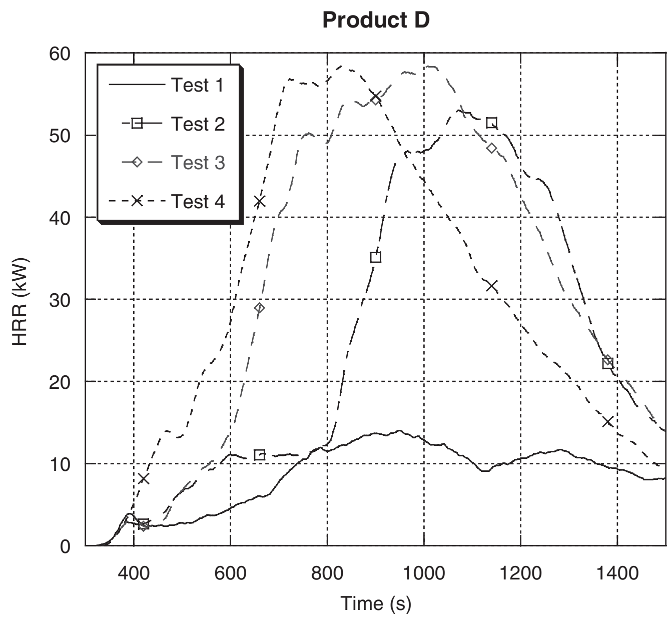

Figure 2. Heat release rate from the four SBI tests on Product D with a mounting according to prEN 14509.

Table VI. Comparison of Euroclasses according to the different test methods including new data.

	Product A	Product B	Product C	Product D
ISO 9705	⩾B	D	⩾B	C
Freestanding ISO 13784-1	⩾B	C	C	D
SBI old results	Bs1d0	Bs2d0	Bs3d0	Bs2d0
SBI new results	Not tested[a]	Not tested[b]	Bs3d0	B to Ds3d0

[a] It is not expected that the major classification would change for this product due to the nature of the core insulation.
[b] Due to the fact that the edges are open and from the experience of other test results with this type of insulation core, the panel is probably going to obtain an E class [12].

melt insulation comes in contact with the burner and ignites. This, however, needs to be confirmed by more data.

6. CONCLUSIONS

New data on sandwich panels have been generated by using the mounting procedure in the proposed European product standard prEN 14509. The data are compared with data from tests in a previous Nordtest project.

The following conclusions can be drawn:

1. The mounting procedure in the product standard does not lead to repeatable results. For a panel showing bad full-scale results, the results in the SBI can all be from D to B. It can

therefore be questioned if reproducibility is guaranteed. Proof of reproducibility should be demonstrated before proceeding with the product standard. This means that more work has to be done before this product standard can be used.

2. The correlation between full-scale behaviour in the used set-ups and the new SBI data is still not satisfactory.
3. The mounting for the SBI method as described in the product standard prEN 14509 no longer reflects the end use conditions. The solutions now are unfair to systems that obtain good fire performance by means of advanced joint and mounting systems. It is exactly the simulation of these end-use conditions in a realistic way, which is very important when evaluating the burning behaviour of sandwich panels.
4. The use of the SBI method for CE marking of sandwich panels will give irreproducible results and classifications which do not reflect the real fire behaviour of the panel. This can lead to unsafe conditions in buildings. It will also not help to change the position of the insurance industry, which has introduced a number of full-scale tests to guarantee the fire safety of buildings. This means that the CE-mark on its own will not be sufficient in areas where the insurance industry has its own requirements, thus resulting in increased cost for the sandwich panel industry.

REFERENCES

1. EN 13501-1. *Fire Classification of Construction Products and Building Elements—Part 1: Classification Using Test Data from Reaction to Fire Tests*. CEN: Brussels, 2002.
2. ISO 9705:1993(E). *Fire Tests-Full-scale Room Test for Surface Products*. ISO: Geneva, 1993.
3. ISO 13784 Part 1. *Fire Tests Reaction to Fire Part 1: Small-scale Room Test for Sandwich Panel Products for Industrial Buildings*. ISO: Geneva, 2002.
4. ISO 13784 Part 2. *Fire Tests Reaction to Fire Part 2: Large-scale Room Test for Sandwich Panel Products for Industrial Buildings*. ISO: Geneva, 2002.
5. NT FIRE 025. Edition 2. *Surface Products-Room Fire Tests in Full-scale*. Nordtest, 1991.
6. Van Hees P, Johansson P. *Development of a Test Procedure for Sandwich Panels using ISO 9705 Philosophy*. Nordtest project nr 1432-99. SP Rapport 2000:26, SP Swedish National Testing and Research Institute, Fire Technology, Borås, 2001.
7. Serious fires in food industry premises during 1995. *Fire Prevention* 1997; **302**.
8. Van Hees P, Johansson P. Full scale tests on free standing industrial sandwich panels and comparison with ISO 9705 test. *Proceedings of Fire and Materials 2001 Conference,* San Francisco. Interscience Communications: London, 2001.
9. EN 13823. *Reaction to Fire Tests for Building Products-Building Products Excluding Floorings-Exposed to the Thermal Attack by a Single Burning Item*. CEN: Brussels, 2002.
10. Van Hees P, Johansson P. The need for full-scale testing of sandwich panels. Comparison of full-scale tests and intermediate scale tests. *Interflam 2001 Proceedings*. Interscience Communications: London, 2001.
11. DRAFT prEN 14509. *Self-supporting Double Skin Metal Faced Insulating Sandwich Panels-Factory Made Products-Specification*. CEN: Brussels, 2002.
12. *Full Scale Test Report of a Sandwich Panel According to ISO 13784 Part 1, Test Conducted at the General Assembly of Panama International*. SP Test Report, Borås, June 2001.
13. Sundström B, Thureson P, Van Hees P. *Results and Analysis from Fire Tests of Building Products in ISO 9705, the Room/Corner Test*. SP Report 1998:11, SP Swedish National Testing and Research Institute, Fire Technology, Borås, 1998.

