Openings in Sandwich Panels

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What is EASIE?

Work Packages:

1. Openings and Joints
2. Design Strategies
3. Global Resistance of Buildings
4. Retrofitting, Durability, Maintenance
5. ELearning
6. Training, Skill Development, Dissemination

Duration 1.10.2008-30.9.2011

www.easie.eu
Small Openings

window

ventilation
Large Openings

windows and doors in two or more panels
Large Openings
Two Problems
Strength and Permeability

1. Aim of EASIE work package 1
2. Permeability requirements of the standard
   a. Test set-up
   b. Test program and results
3. Design model for strength assessment
4. Strength tests on panels with small openings
   a. Without reinforcement
   b. With reinforcement
Aim of EASIE WP1

Investigation into thermal loss in joints between panels

→ concentration on air permeability

Assessment of strength of panels with openings

→ openings without reinforcement
  transfer of load over the joint from one panel to the next
→ openings with reinforcement (frames)
Requirements of the standard

EN 14509

A.12 Air permeability

A.12.1 Principle

Where required, the air tightness of a sandwich panel assembly shall be tested according to EN 12114, including the following additional requirements.

A.12.2 Apparatus

The test apparatus shall be in accordance with EN 12114.

A.12.3 Test specimens

The dimensions of the test assembly shall be as large as necessary to be representative of the intended use. The assembly shall not be less than 1 200 mm x 2 400 mm.

The joints of the modules comprising the test assembly shall be representative, i.e. the same length per m² as in end use. Both horizontal and vertical joints shall be incorporated where these are an intrinsic part of the panel assembly.

A.12.4 Procedure

The test shall be carried out in accordance with EN 12114.

A.12.5 Calculations and results

The air permeability shall be measured with a pressure difference of 50 Pa between the inside and outside of the test assembly. The air permeability (air loss) shall be determined in terms of m³/m² h at 50 Pa.
Requirements of the standard

EN 12207- air permeability of windows and doors

Classification of air permeability relating to the length of joints

<table>
<thead>
<tr>
<th>class</th>
<th>Reference value for air permeability at 100 Pa $m^3/(h \cdot m)$</th>
<th>maximum pressure in Pa</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>not tested</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>12,50</td>
<td>150</td>
</tr>
<tr>
<td>2</td>
<td>6,75</td>
<td>300</td>
</tr>
<tr>
<td>3</td>
<td>2,25</td>
<td>600</td>
</tr>
<tr>
<td>4</td>
<td>0,75</td>
<td>600</td>
</tr>
</tbody>
</table>
Requirements of the standard

DIN 4108-2  Heat insulation and saving of energy

Chapter 7: Requirements regarding the air tightness of building envelopes

…the air tightness of structural elements can be determined according to EN 12114….

…the permeability of joints has to be less than $0.1 \text{ m}^3/(\text{m} \cdot \text{h} \cdot (\text{daPa})^{2/3})$…
Test set-up

displacement transducer

joint

steel frame
Reference measurement:
All joints are sealed
Test set-up

Joint is unsealed

The difference between the two measurements specifies the air stream through the joint.
Test program and results

1. Panels of different producers: groove and tongue joint

Producer A, 100 mm

Producer B, 60 and 100 mm

Producer C, 60 mm
Test program and results
Test program and results

![Graph showing air permeability vs. pressure difference in Pa]

- **A-Value acc. to DIN 4108**
- **EN 12207, class 1**
- **EN 12207, class 2**
- **EN 12207, class 3**
- **EN 12207, class 4**

- A, 100 mm, gap 0.14 mm
- B, 60 mm, gap 3.6 mm
- C, 60 mm, gap 5.0 mm
- B, 100 mm, gap 5.0 mm
- B, 60 mm, gap 3.6 mm

Gap width

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Test program and results

requirement in DIN 4108-2 for joints of structural elements: $a<0.1 m^3/(m*h*(daPa)^{2/3})$

- $a=0.0010 m^3/(m*h*(daPa)^{1.0})$
- $a=0.00019 m^3/(m*h*(daPa)^{0.99})$
Test program and results

- Different gap widths

Problem: Measurement of the real gap width
Test program and results

![Graph showing air permeability in m³/h(m²) against pressure difference in Pa, with data points for different materials and gaps according to DIN 4108.]

- **A-Value acc. to DIN 4108**
- **C, 60 mm, gap 5.0 mm**
- **C, 60 mm, gap 9.0 mm**
- **D, 60 mm, gap 3.5 mm**
- **D, 60 mm, gap 4.8 mm**
WP 1 - Task 1.2
Thermal loss in windows, doors, openings

Tests of existing systems
WP 1 - Task 1.2
Thermal loss in windows, doors, openings
Thermal loss in windows with adhesively bonded frames

No detectable permeability
WP 1 - Task 1.2
interlocked systems - 60 mm panels
WP 1 - Task 1.3
Strength of panels with small openings

Small openings without reinforcement
WP 1 - Task 1.3 /reference to earlier studies
Strength of panels with small openings
Numerical studies on effect of bonding strength

![Graph 1: Relative values on ultimate load](image1)

![Graph 2: Effect of openings on ultimate load](image2)
Strength assessment / reference to earlier studies
Small openings without reinforcement
Strength assessment
Small openings without reinforcement

Load transfer via joints in neighbouring panels
Strength assessment
Small openings with reinforcement
Strength assessment
Small openings with reinforcement

load of the hydraulic cylinder in kN

deflection at midspan (x = 0 mm) and in the corner of the window (x = 400 mm) in mm

- midspan 1
- midspan 2
- window 1
- window 2
Strength assessment
Small openings with reinforcement
Strength assessment
Large openings
Strength assessment
Large openings

Loss of interlock due to large deflections
Summary and Conclusions

Good rules and codes regarding permeability exist. Sandwich panels comply excellent with these rules.

Sandwich panels can be built with openings and without additional girders but sophisticated design rules have to be followed.

More investigations into panels using openings with reinforcement have to be made.

Further research in roof panels will be made.