

BS EN 14509:2013



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Self-supporting double skin metal faced insulating panels — Factory made products — Specifications

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National foreword

This British Standard is the UK implementation of EN 14509:2013. It supersedes BS EN 14509:2006 which is withdrawn.

EN 14509:2013 is a candidate “harmonized” European Standard and fully takes into account the requirements of the European Commission mandates M/121, Internal and external wall and ceiling finishes, and M/122, Roof coverings, roof lights, roof windows and ancillary products, given under the EU Construction Products Directive (89/106/EEC), and is intended to lead to CE marking. The date of applicability of EN 14509:2013 as a “harmonized” European Standard, i.e. the date after which this Standard may be used for CE marking purposes, is subject to an announcement in the *Official Journal of the European Communities*.

EN 14509:2013 is the subject of transitional arrangements agreed under the European Commission mandate. The Member States have agreed a nominal transition period of twelve months for the co-existence of EN 14509:2013 and its corresponding national standard(s). At the end of this co-existence period, the national standard(s) will be withdrawn.

Additional information: design combination coefficients and safety factors

The UK applies specific design combination coefficients and safety factors to take into account the weather conditions and loadings relevant to the UK. For UK applications, the values for combination coefficients given in Table E.7 may be used as an alternative to Table E.6.

The UK participation in its preparation was entrusted by Technical Committee B/542, Roofing and cladding products for discontinuous laying, to Subcommittee B/542/12, Double skin metal faced sandwich panels for roofing and cladding.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Amendments/corrigenda issued since publication

Date	Text affected
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English Version

Self-supporting double skin metal faced insulating panels - Factory made products - Specifications

Panneaux sandwichs autoportants, isolants, double peau
à parements métalliques - Produits manufacturés -
Spécifications

Selbsttragende Sandwich-Elemente mit beidseitigen
Metalldeckschichten - Werkmäßig hergestellte Produkte -
Spezifikationen

This European Standard was approved by CEN on 18 July 2013.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

Foreword

This document (EN 14509:2013) has been prepared by Technical Committee CEN/TC 128 "Roof covering products for discontinuous laying and products for wall cladding", the secretariat of which is held by NBN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2014, and conflicting national standards shall be withdrawn at the latest by October 2014.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 14509:2006.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

Annex F provides details of significant technical changes between this European Standard and the previous edition.

Data obtained from earlier tests in accordance to EN 14509:2006 may be used without the need for further testing to the revised procedures (6.2.2) providing the declared data does not change significantly.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

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1 Scope

This European Standard specifies requirements for factory made, self-supporting, double skin metal faced insulating sandwich panels, which are intended for discontinuous laying in the following applications:

- a) roofs and roof cladding;
- b) external walls and wall cladding;
- c) walls (including partitions) and ceilings within the building envelope.

The insulating core materials covered by this European Standard are rigid polyurethane, expanded polystyrene, extruded polystyrene foam, phenolic foam, cellular glass and mineral wool.

NOTE Polyurethane (PUR) includes polyisocyanurate (PIR).

Panels with edge details that utilise different materials from the main insulating core are included in this European Standard.

Panels used in cold store applications are included in this European Standard. Panels, put on the market as a component of a cold storage room, building and/or building envelope kit are covered by ETA-Guideline 021 "Cold storage premises kits".

This European Standard does not cover the following:

- i. sandwich panels with a declared thermal conductivity for the insulating core greater than 0,06 W/m·K at 10 °C;
- ii. products consisting of two or more clearly defined layers of different insulating core materials (multi-layered);
- iii. panels with perforated facing(s);
- iv. curved panels.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 485-2, *Aluminium and aluminium alloys - Sheet, strip and plate - Part 2: Mechanical properties*

EN 485-4, *Aluminium and aluminium alloys - Sheet, strip and plate - Part 4: Tolerances on shape and dimensions for cold-rolled products*

EN 508-1, *Roofing products from metal sheet - Specification for self-supporting products of steel, aluminium or stainless steel sheet - Part 1: Steel*

EN 826, *Thermal insulating products for building applications - Determination of compression behaviour*

EN 1172, *Copper and copper alloys - Sheet and strip for building purposes*

CEN/TS 1187, *Test methods for external fire exposure to roofs*

- EN 1363-1, *Fire resistance tests - Part 1: General Requirements*
- EN 1364-1, *Fire resistance tests for non-loadbearing elements - Part 1: Walls*
- EN 1364-2, *Fire resistance tests for non-loadbearing elements - Part 2: Ceilings*
- EN 1365-2, *Fire resistance tests for loadbearing elements - Part 2: Floors and roofs*
- EN 1396, *Aluminium and aluminium alloys - Coil coated sheet and strip for general applications - Specifications*
- EN 1602, *Thermal insulating products for building applications - Determination of the apparent density*
- EN 1607, *Thermal insulating products for building applications - Determination of tensile strength perpendicular to faces*
- EN 1990, *Eurocode - Basis of structural design*
- EN 10088-1, *Stainless steels - Part 1: List of stainless steels*
- EN 10143, *Continuously hot-dip coated steel sheet and strip - Tolerances on dimensions and shape*
- EN 10169, *Continuously organic coated (coil coated) steel flat products — Technical delivery conditions*
- EN 10204, *Metallic products - Types of inspection documents*
- EN 10346:2009, *Continuously hot-dip coated steel flat products - Technical delivery conditions*
- EN 12085, *Thermal insulating products for building applications - Determination of linear dimensions of test specimens*
- EN 12114, *Thermal performance of buildings - Air permeability of building components and building elements - Laboratory test method*
- EN 12865, *Hygrothermal performance of building components and building elements - Determination of the resistance of external wall systems to driving rain under pulsating air pressure*
- EN 13162, *Thermal insulation products for buildings - Factory made mineral wool (MW) products - Specification*
- EN 13163, *Thermal insulation products for buildings - Factory made expanded polystyrene (EPS) products - Specification*
- EN 13164, *Thermal insulation products for buildings - Factory made extruded polystyrene foam (XPS) products - Specification*
- EN 13165, *Thermal insulation products for buildings - Factory made rigid polyurethane foam (PU) products - Specification*
- EN 13166, *Thermal insulation products for buildings - Factory made phenolic foam (PF) products - Specification*
- EN 13167, *Thermal insulation products for buildings - Factory made cellular glass (CG) products - Specification*
- CEN/TS 13381-1, *Test methods for determining the contribution to the fire resistance of structural members - Part 1: Horizontal protective membranes*

ENV 13381-2, *Test methods for determining the contribution to the fire resistance of structural members - Part 2: Vertical protective membranes*

EN 13501-1, *Fire classification of construction products and building elements - Part 1: Classification using test data from reaction to fire tests*

EN 13501-2, *Fire classification of construction products and building elements - Part 2: Classification using data from fire resistance tests, excluding ventilation services*

EN 13501-5, *Fire classification of construction products and building elements - Part 5: Classification using data from external fire exposure to roofs tests*

EN 13823, *Reaction to fire tests for building products - Building products excluding floorings exposed to the thermal attack by a single burning item*

EN 14135, *Coverings - Determination of fire protection ability*

EN 15254-5, *Extended application of results from fire resistance tests - Non-loadbearing walls - Part 5: Metal sandwich panel construction*

EN ISO 354:2003, *Acoustics - Measurement of sound absorption in a reverberation room (ISO 354)*

EN ISO 717-1, *Acoustics - Rating of sound insulation in buildings and of building elements - Part 1: Airborne sound insulation (ISO 717-1)*

EN ISO 1182, *Reaction to fire tests for products - Non-combustibility test (ISO 1182)*

EN ISO 1716, *Reaction to fire tests for products - Determination of the gross heat of combustion (calorific value) (ISO 1716)*

EN ISO 6270-1, *Paints and varnishes - Determination of resistance to humidity - Part 1: Continuous condensation (ISO 6270-1)*

EN ISO 6892-1, *Metallic materials - Tensile testing - Part 1: Method of test at room temperature (ISO 6892-1)*

EN ISO 6946, *Building components and building elements - Thermal resistance and thermal transmittance - Calculation method (ISO 6946)*

EN ISO 9445 (all parts), *Continuously cold-rolled stainless steel - Tolerances on dimensions and form (ISO 9445)*

EN ISO 10140 (all parts), *Acoustics - Laboratory measurement of sound insulation of building elements (ISO 10140)*

EN ISO 10211, *Thermal bridges in building construction - Heat flows and surface temperatures - Part 1: Detailed calculations (ISO 10211)*

EN ISO 10456, *Building materials and products - Hygrothermal properties - Tabulated design values and procedures for determining declared and design thermal values (ISO 10456)*

EN ISO 11654, *Acoustics - Sound absorbers for use in buildings - Rating of sound absorption (ISO 11654)*

EN ISO 11925-2, *Reaction to fire tests - Ignitability of products subjected to direct impingement of flame - Part 2: Single-flame source test (ISO 11925-2)*

ISO 12491, *Statistical methods for quality control of building materials and components*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

auto-adhesion

self adhesion of the core to the face(s) occurring automatically without the use of an adhesive

3.2

bending moment capacity

maximum bending moment recorded during a test on an individual panel

3.3

bending resistance

characteristic value of bending moment capacity determined on the basis of a test series

3.4

bond, bonding

adhesion between the face(s) and the core normally provided by an adhesive

3.5

ceiling

covering over an internal area

3.6

core

layer of material, having thermal insulating properties, which is bonded between two metal faces

3.7

durability

ability of the panel to withstand the environmental effects and accommodate the consequent decrease in mechanical strength with time caused by factors such as temperature, humidity, freeze-thaw cycles and their various combinations

3.8

edge, longitudinal edge

side of the panel where adjacent panels join together in the same plane

3.9

face, facing

flat, lightly profiled or profiled thin metal sheet firmly bonded to the core

3.10

flat facing

facing without any rolled or pressed profile, or raised strengthening rib

3.11

incompletely bonded face

metal face whose bond to the core is adequate for sandwich action but does not include the entire surface of the core

Note 1 to entry: An example is a trapezoidally profiled face that has voids between the raised profiles and the core.

3.12

incompletely bonded panel

panel in which one or both faces is incompletely bonded

3.13

joint

interface between two panels where the meeting edges have been designed to allow the panels to join together in the same plane

Note 1 to entry: The joint may incorporate interlocking parts that enhance the mechanical properties of the system as well as improving the thermal, acoustic and fire performance and restricting air movement.

Note 2 to entry: The term 'joint' does not refer to a junction between cut panels or a junction where the panels are not installed in the same plane.

3.14

lamella

core material consisting of mineral wool that has been cut and orientated with the fibres perpendicular to the facings prior to bonding

3.15

lightly profiled facing

facing with a rolled or pressed profile not exceeding 5 mm in depth

3.16

pre-manufactured, pre-formed

component or material that is supplied to the manufacturer ready for direct incorporation into the sandwich panel

3.17

sandwich panel

building product consisting of two metal faces positioned on either side of a core that is a thermally insulating material, which is firmly bonded to both faces so that the three components act compositely when under load

3.18

self-supporting panel

panel capable of supporting, by virtue of its materials and shape, its self-weight and in the case of panels fixed to spaced structural supports all applied loadings (e.g. snow, wind, internal air pressure), and transmitting these loadings to the supports

3.19

shift

period of production during a working day, normally 6 h to 8 h but can be less

3.20

side lap

folded area of one or both of the facing materials along the longitudinal edge of the panel which engages with the adjacent panel to form an interlocking or overlapping joint

3.21

wrinkling strength

characteristic value of wrinkling stress

3.22

wrinkling stress

stress in the compressed face of a panel undergoing failure in bending where the failure mode takes the form of a "wrinkle" extending over the full width of the panel near the section of maximum bending moment

4 Symbols and abbreviations

For the purposes of this document, the following symbols and abbreviations apply.

- A* cross-sectional area (may be full width of panel or per unit width)
- B* flexural rigidity (may be full width of panel or per unit width), overall width of the panel/specimen,
- C* ratio
- D* overall depth of the panel
- E* modulus of elasticity
- F* force, load, support reaction
- G* shear modulus, permanent action
- I* moment of inertia
- L* span, distance, width of support (L_s)
- M* bending moment
- N* axial compressive force
- Q* variable action
- R* resistance, sound reduction index (R_w), reflectivity (R_G), tensile strength (R_{DUR} , R_{24})
- S* shear rigidity, value of a load effect, effect of an action
- T* temperature
- U* thermal transmittance, thermal transmittance including the influence of the joints $U_{d,s}$
- V* shear force
- a* distance apart of clips (A.10.4)
- b* width of test specimen, width of plate, width of ribs/valleys, bowing
- d* depth of face profile or stiffeners, depth of core (d_c)
- e* distance between centroids of faces, base of natural logarithms ($e = 2,718\ 282$)
- f* strength, yield stress, thermal transmittance contribution factor (f_{joint})
- h* height of profile, thickness (e.g. glue)
- k* parameter (E.4.3.2 support reaction capacity), correction factor
- l* length, deviation
- m* mass
- n* number of tests, number of screws, number of webs
- p* pitch of profile
- q* live load

r	radius
s	length of web (s_{w1})
t	thickness of face sheet
v	variance factor
w	deflection, displacement, compression, cover width
x, y, z	coordinates
α	parameter (A.5.5.4), coefficient of thermal expansion, sound absorption (α_w), ratio (A.4.5.3)
β	parameter (A.5.5.4 and Table E.10.2 design formulae)
δ	deviation
ϕ	angle
γ	shear strain, partial safety factor
λ	thermal conductivity, λ_{Design} (design value), ratio (A.4.5.3)
φ	creep coefficient
θ	parameter (Table E.10.1 design formulae)
σ	stress, compressive strength σ_m , standard deviation
τ	shear stress
ψ	combination coefficient (Annex E), linear thermal transmittance of joints (A.10.3)
ρ	coefficient, density

Subscripts

C	core
D	declared value (R_D)
F	face, action (γ_F)
G	self-weight, degree
M	material (γ_M)
Q	variable action
S	sandwich part of the cross-section
adj	adjusted
b	bending, elastic extension
c	compression, core, carrier (C.4.3.2), clip ($f_{\text{joint},c}$)

d	design
e	external, additional thickness of main profiles (Δe)
eff	effective
f	load, facing (λ_{fi})
i	internal (λ_{fi})
i, j	index
k	characteristic value
lin	linear
m	material
n	nominal
nc	without clip ($f_{joint,nc}$)
obs	observed (e.g. result)
q	uniform load
s	support (L_s = support width), stiffeners, surface (R_{s1})
t	tension, time
tol	tolerance (normal or special)
tr	traffic (C_{tr})
u	ultimate (F_u)
v	shear, variance
w	wind, web, wrinkling (σ_w), weighted (R_w)
y	yield
0	basic value, unit width, time (e.g. $t = 0$)
1	external face, upper face
2	internal face, lower face

Abbreviations

CG	cellular glass
CWFT	classified without further testing
EPS	expanded polystyrene
FPC	factory production control

ITT	initial type test
MW	mineral wool
NPD	no performance determined
PCS	gross calorific potential
PUR	rigid polyurethane foam (the abbreviation PUR includes polyisocyanurate foam (PIR))
PF	phenolic foam
XPS	extruded polystyrene foam

5 Requirements, properties and test methods

5.1 Requirements for component materials

5.1.1 General

The product shall be manufactured with materials and components conforming to 5.1.2 to 5.1.4.

5.1.2 Metal facings

5.1.2.1 Steel

5.1.2.1.1 Steel faces

Steel faces (other than stainless steel) shall be a construction steel according to EN 10346:2009, Table 1 and have a minimum yield strength of 220 N/mm² and shall conform to the requirements of the appropriate standard given in Table 1.

For steels according to EN 10346:2009, Table 1, the steel grade, nominal thickness and tolerance system of each face shall be declared. Tolerances on thickness shall be according to the “special” or “normal” tolerances as described in the relevant standards.

Table 1 – Standards for steel with metallic coating

Metallic coating	European Standard
Zinc, 5 % Al-Zn, 55 % Al-Zn and Aluminium-silicon	EN 10346
The minimum nominal metallic coating masses shall be as specified in EN 508-1. Differential zinc coating shall be permitted for the external face of a panel exposed to the climate for all core materials.	

Organic protective coatings shall be selected according to their durability in the application environment. Organic coated steel sheets shall conform to the requirements of EN 10169. Multi-layer coatings shall conform to EN 508-1.

The panel manufacturer shall state the metal grade, thickness and tolerance system of each face. Tolerances on thickness shall be according to “special” or “normal” tolerances as described in the relevant standards. The thickness of steel facing sheets shall be determined in accordance with EN 10143.

NOTE Not all steels in Table 1 are suitable for sandwich panels in all the intended end uses.

5.1.2.1.2 Backface coating

If the metal face is bonded over its whole area to a rigid foam core with a closed cell structure, the reverse side metallic coating mass shall be a minimum of 50 g/m².

When relevant to intended end use application, resistance of metallic protective coatings and organic back face coat (duplex coating) against corrosion shall be ensured by laboratory tests. Minimum resistance of backing coat shall be CPI2 according to EN 10169. Additionally to the requirements in EN 10169 only slight colour change ($DE < = 2,0$) shall be acceptable in the condensation-water test (EN ISO 6270-1) over 1 000 h.

NOTE The requirements in 5.1.2.1.2 are only applicable to back face coatings.

5.1.2.2 Stainless steel faces

Stainless steel facings shall have a minimum yield strength of 220 N/mm². The chemical composition of stainless steel faces and their physical properties shall conform to EN 10088-1.

The panel manufacturer shall state the metal grade, thickness and tolerance system of each face. Tolerances on thickness shall be according to “special” or “normal” tolerances as described in the relevant standards. The thickness of stainless steel facing sheets shall be determined in accordance with EN ISO 9445

NOTE Not all stainless steels in EN 10088-1 are suitable for sandwich panels in all the intended end uses. Reference can be made to EN 508-3, grades suitable for roofing.

5.1.2.3 Aluminium faces

Aluminium facings shall have a minimum design value of the stress at the 0,2 %-strainlimit (for simplification called “yield strength”) of 140 N/mm². The chemical composition, temper and mechanical properties of aluminium shall conform to EN 485-2 or EN 1396.

Organic coated aluminium sheets shall conform to the requirements of EN 1396.

The panel manufacturer shall state the metal grade, thickness and tolerance system of each face. Tolerances on thickness shall be according to “special” or “normal” tolerances as described in the relevant standards. The thickness of aluminium facing sheets shall be determined in accordance with EN 485-4 or EN 1396.

NOTE Not all aluminium alloys covered by EN 485-2 or EN 1396 are suitable for sandwich panels in all the intended end uses. Reference can be made to EN 508-2.

5.1.2.4 Copper faces

Copper facings shall have a minimum design value of the stress at the 0,2 %-strainlimit (for simplification called “yield strength”) of 180 N/mm². The chemical composition, temper, mechanical properties and thickness tolerances of copper faces shall conform to EN 1172.

The panel manufacturer shall state the metal grade, thickness and tolerance system of each face. Tolerances on thickness shall be according to “special” or “normal” tolerances as described in the relevant standards. The thickness of copper facing sheets shall be determined in accordance with EN 1172.

Not all copper facings in EN 1172 are suitable for sandwich panels in all the intended end uses. Reference should be made to EN 506.

NOTE Only R240 and R290 grades satisfy the requirement of 180 N/mm².

5.1.3 Core materials

5.1.3.1 Thermal performance

The declared and design thermal conductivity of core materials shall be determined in accordance with 5.2.2.

5.1.3.2 Thermal stability of core materials

The thermal stability of the core materials in a sandwich panel shall be evaluated through the durability testing in accordance with 5.2.3.

5.1.4 Adhesives and bonding

Adhesives and bonding shall conform to 5.2.1.6 and 5.2.3.1.

The adhesion between the core and the faces of the panel has a fundamental role in the satisfactory performance of the panel. The surface preparation of the facing material shall be appropriate for the adhesive or the method of adhesion.

5.2 Properties of panels

5.2.1 Mechanical resistance of the panel

5.2.1.1 General

For mechanical properties, unless stated otherwise, the mean value and the characteristic value (5 % fractile value assuming a confidence level of 75 % for each population of test results) shall be determined according to ISO 12491.

Declared values shall be given to either two or three significant figures as specified in Annex ZA.

5.2.1.2 Shear strength (f_{cv}) and shear modulus (G_c)

The declared values of the shear strength and shear modulus of the core shall be determined using the appropriate test procedures from A.3 or A.4 in accordance with Table 2. The same test procedure shall be used to determine both the shear strength and shear modulus of a panel. In principle, each test method is suitable for panels with flat, lightly profiled or profiled facings.

The declared value of the shear strength shall be less than or equal to the characteristic value and shall be declared by the manufacturer in megapascals (MPa).

Only the mean value of the shear modulus obtained from the available test results shall be declared. The 5 %-fractile value shall be recorded for FPC purposes in accordance with A.3 or A.4.

Table 2 – Alternative shear test methods

Test procedure	Core and face materials	Formula for evaluation		Comments
		Shear strength	Shear modulus	
A.3 – 2 load points (on small sample)	All core and face materials	A.5	A.7	Basic procedure. May be used in all situations unless practical requirements dictate otherwise.
A.4 – 2 load points (on full panel)	All core materials. Flat or lightly profiled faces	A.10	A.7	Alternative to A.3. For panels with one or two profiled faces wrinkling of the faces may occur
	One or both faces profiled	A.12	A.11	
A.4 – Vacuum chamber or air bag loading	All core materials. Flat or lightly profiled faces	A.10	A.13	Alternative to the use of 2 load points.
	One or both faces profiled	A.15	A.14	

5.2.1.3 Creep coefficient (ϕ_t)

The creep coefficient shall be determined according to A.6 and expressed as a number.

The creep coefficient shall be determined for all panels used as a roof or ceiling designed to carry long term or permanent loads e.g. snow and self-weight.

5.2.1.4 Compressive strength (σ_m) or compressive stress (σ_{10})

The compressive strength of the core σ_m or its compressive stress at 10 % deformation σ_{10} (whichever is reached first) shall be determined in accordance with the method given in A.2 and shall be declared by the manufacturer in megapascals (MPa).

5.2.1.5 Shear strength after long-term loading (f_{cv} long-term)

Where required, the shear strength after long term loading shall be determined in accordance with A.3.6.

This value shall be determined for all panels used as a roof or ceiling designed to carry long term or permanent loads e.g. snow and self-weight. The declared value shall be less than or equal to the characteristic value (f_{cv}) and shall be declared by the manufacturer in megapascals (MPa).

NOTE The reduction obtained from the small scale long-term test can be applied to panels where the shear strength has been determined on the basis of large scale tests to A.4 or calculated on the basis of A.3.5.3.

5.2.1.6 Cross panel tensile strength (f_{ct})

The characteristic value for tensile strength and cross panel tensile strength perpendicular to the panel faces shall be greater than 0,018 MPa when tested in accordance with A.1 and shall be declared by the manufacturer in megapascals (MPa).

The declared values shall be less than or equal to the characteristic value.

NOTE Low tensile strength can reduce the wrinkling strength and increase its variability. Account is taken of this in A.5.5.5 (k_2 factor).

5.2.1.7 Bending moment capacity (M_u) and wrinkling stress (σ_w)

The bending moment capacity shall be obtained by testing according to A.5.

For panels with flat, lightly profiled or profiled faces, the wrinkling stress shall be calculated in accordance with A.5.5 and the wrinkling strength shall be declared by the manufacturer in megapascals (MPa).

The declared wrinkling stress should generally be determined on the basis of the results of bending tests. However, A.5.5.3 also allows a conservative value of the wrinkling stress to be calculated according to Formula (A.20) and declared.

Wrinkling stress is related to bending moment by a simple mathematical relationship so that it is not necessary to declare both the bending resistance and the wrinkling strength.

For a panel with a profiled face in compression, the bending resistance shall be declared together with the span of the test specimen. Optionally the wrinkling stress can be declared.

If it is intended that design shall be carried out on the basis of calculations in accordance with Annex E, it is preferable to declare the wrinkling strength wherever possible.

NOTE Declaration of the bending moment is essential for design on the basis of testing.

5.2.1.8 Bending moment capacity and wrinkling stress over a central support

Where required, the bending moment capacity over a central support shall be determined in accordance with A.7. For panels with flat or lightly profiled faces, the wrinkling stress shall then be calculated in accordance with A.5.5.

The bending moment capacity over a central support is required when panels which are continuous over two or more spans are to be designed by calculation in accordance with Annex E. In such cases, the comparison of the design values of resistance according to E.2 is usually carried out in terms of stresses. If the panel has one or more profiled faces, the determination of the ultimate compressive (wrinkling) stress from the bending moment capacity requires calculation in accordance with E.7.5. It is recommended that this calculation is carried out at the time of testing.

5.2.2 Thermal transmittance

The thermal transmittance value for the panel (U), incorporating the declared thermal conductivity for the core material ($\lambda_{\text{Declared}}$) and the joints and any profiled facings, shall be determined in accordance with A.10.

Both $\lambda_{\text{Declared}}$ and the $U_{\text{d,s}}$ -value shall be declared.

5.2.3 Durability and other long-term effects

5.2.3.1 Reduction of tensile strength with time as a consequence of ageing (durability)

Panels shall satisfy the criteria for reduction in tensile strength in accordance with the relevant test method DUR1 and DUR2 (see Table 3) as described in Annex B.

Durability tests shall be applied to panels designed for external applications. They are based on the accelerated ageing effect of temperature or humidity, which from long-term experience are critical for each core material.

Where required, the durability tests may be used to assess the performance of internal sandwich panels.

NOTE 1 These tests evaluate the reduction of tensile strength as a result of temperature or humidity on a pass/fail basis.

NOTE 2 The durability requirement covers the performance of all essential structural components of the panel, for example backface coatings, adhesion layers and core material.

PUR panels manufactured using the blowing agents covered within EN 13165 and a combination of these blowing agents, but excluding CO₂ blown foams shall be considered to satisfy the durability requirements without testing. PUR panels manufactured with other blowing agents shall be tested according to test DUR1 and the colour reflectivity levels shall be declared (B.2.5).

Table 3 – Durability tests and deemed to satisfy criteria

Insulating core material	Test method (Annex B)	Note
Mineral wool (MW)	DUR2	DUR2 including the wedge test (B.5)
Polystyrene (EPS or XPS)	DUR1	DUR1 including wedge test (B.5)
Polyurethane (PUR), – auto-adhesive bond	DUR1	No test required for panels manufactured using the blowing agents covered within EN 13165 and combinations of these agents, but excluding foams blown solely by CO ₂ . Other blowing agents shall be tested to DUR1.
Polyurethane (PUR), – adhesive bond	DUR1	No test required for panels manufactured using the blowing agents covered within EN 13165 and combinations of these agents, but excluding CO ₂ blown foams. Other blowing agents shall be tested to DUR1 including the wedge test (B.5). The wedge test (B.5) shall be carried out.
Phenolic (PF)	DUR1, thermal shock B.7 and repeated loading B.6	PF panels with an adhesive bond shall be tested to DUR1 including the wedge test (B.5).
Cellular glass (CG)	DUR1, thermal shock B.7 and repeated loading B.6	Including the wedge test (B.5).

5.2.3.2 Resistance to point loads and access loads – ceiling panels and roofs

Where required, the ability of a sandwich panel to resist point loads and access loads shall be determined in accordance with A.9.1. For applications where there will be more frequent access than occasional foot traffic (see Note), the procedure described in A.9.2 shall also be carried out.

NOTE 1 Point loads are loads resulting from a single person walking on the panel, for occasional access both during and after erection.

The span capabilities of a ceiling panel and its supporting system should be checked before access is allowed.

NOTE 2 Ceiling panels are generally unsuitable for regular foot traffic.

Ceiling panels should be protected when used on regular walking routes or working areas both during installation and in end use.

Panels should allow a wide and safe support for a foot and should not be subject to permanent deformations under occasional foot traffic for access or maintenance. For maintenance purposes, only one person at a time should be allowed to walk on a panel.

5.2.4 Fire characteristics

5.2.4.1 Reaction to fire

The reaction to fire classification of the product shall be determined according to EN 13501-1. The classification shall apply to panel applications defined in Clause 1 (Scope) of this European Standard.

Test arrangements for reaction to fire tests shall be in accordance with the following, as appropriate for the intended class:

- EN ISO 1182;
- EN ISO 1716 including determination of adhesives set out in C.4;
- EN 13823 and EN ISO 11925-2 together with the additions set out in C.1.

NOTE The European Commission has made the following statement after consultation of the Committee referred to in Article 19 of the Directive 89/106/EEC. The reaction to fire classification derived from the provisions in this standard provides regulators and other users with an essential parameter concerning fire performance of sandwich panels. Exclusively based on fire safety needs and with explicit justification, regulators may, for specific intended uses, set additional requirements for ensuring the fire safety of the construction works, in accordance with EN 13501-1. Other classifications, such as fire resistance, may also be required to achieve the intended fire safety objectives. In addition, in exceptional cases, other instruments, such as fire safety engineering, specific to the building incorporating the products and associated assembly characteristics, may be used to assess the fire safety of the building.

5.2.4.2 Fire resistance

Where required, the fire resistance classification of the product shall be determined according to EN 13501-2.

The test methods for sandwich panels shall be in accordance with the following standards:

- EN 1364-1 (non-load bearing walls) together with the additions set out in C.2.3;
- EN 1364-2 (ceilings);
- CEN/TS 13381-1 (ceilings – horizontal protection);
- ENV 13381-2 (walls)
- EN 1365-2 (load bearing roofs) together with the additions set out in and C.2.3;
- EN 14135 (fire protection ability).

5.2.4.3 External fire performance – roofs

Where the manufacturer wishes to declare external fire performance (e.g. when subject to regulatory requirements), the product shall be tested and classified in accordance with EN 13501-5.

Sandwich panels that satisfy the criteria set out in C.3.1 shall be considered to satisfy the requirements for the characteristic external fire performance without the need for further testing in accordance with Decision 2006/600/EC. These products shall be given a B_{ROOF} (t1, t2 and t3) classification as satisfying CEN/TS 1187 Test Methods 1, 2 and 3.

Test arrangements for external fire performance tests shall be in accordance CEN/TS 1187 together with the additions set out in C.3.2 to C.3.5.

5.2.5 Dimensional tolerances for sandwich panels

The dimensional tolerances for sandwich panels shall be in accordance with Table 4.

Table 4 – Dimensional tolerances for panels

Dimension	Tolerance (maximum permissible)	Measurement method
Thickness of the panel ^a	$D \leq 100 \text{ mm}$ $\pm 2 \text{ mm}$ $D > 100 \text{ mm}$ $\pm 2 \%$	D.2.1
Deviation from flatness (according to the length of measurement L)	For $L = 200 \text{ mm}$ – Deviation from flatness 0,6 mm For $L = 400 \text{ mm}$ – Deviation from flatness 1,0 mm For $L > 700 \text{ mm}$ – Deviation from flatness 1,5 mm	D.2.2
Depth of metal profile (ribs) (mm)	$5 < h \leq 50 \text{ mm}$ $\pm 1 \text{ mm}$ $50 < h \leq 100 \text{ mm}$ $\pm 2,5 \text{ mm}$	D.2.3
Depth of stiffeners and light profiling	$d_s \leq 1 \text{ mm}$ $\pm 30 \%$ of d_s $1 \text{ mm} < d_s \leq 3 \text{ mm}$ $\pm 0,3 \text{ mm}$ $3 \text{ mm} < d_s \leq 5 \text{ mm}$ $\pm 10 \%$ of d_s	D.2.4
Length of the panel	$L \leq 3 \text{ m}$ $\pm 5 \text{ mm}$ $L > 3 \text{ m}$ $\pm 10 \text{ mm}$	D.2.5
Cover width of the panel	$w \pm 2 \text{ mm}$	D.2.6
Deviation from squareness	$0,006 \times w$ (nominal cover width)	D.2.7
Deviation from straightness (on length)	1 mm per metre, maximum 5 mm	D.2.8
Bowing	2 mm per metre length, maximum 20 mm 8,5 mm per metre width for flat or lightly profiled – $h \leq 10 \text{ mm}$ 10 mm per metre width for profiles – $h > 10 \text{ mm}$	D.2.9
Pitch of the profile (p)	If $h \leq 50 \text{ mm}$ $p: \pm 2 \text{ mm}$ If $h > 50 \text{ mm}$ $p: \pm 3 \text{ mm}$	D.2.10
Width of the ribs (b_1) and width of the valleys (b_2)	For $b_1 \pm 1 \text{ mm}$ For $b_2 \pm 2 \text{ mm}$	D.2.11

^a For calculation of the thickness of panels with profiled facings, see Figure D.1.

5.2.6 Water permeability

Where required, the water permeability (resistance to driving rain) of a complete assembly of sandwich panels shall be assessed, i.e. the assembly that is to be installed in a building, including the product and its coatings, factory applied seals, standard joints, site applied seals, representative flashings, and a method of fixing as appropriate to the test.

The resistance classification of a sandwich panel assembly to driving rain under pulsating air pressure shall be determined according to A.11. The test method shall be used for both external wall and roof applications.

Sandwich panels covered by this European Standard are metal faced. When correctly manufactured and if satisfying an appropriate visual inspection they may be deemed to be impermeable to water. The water tightness of the assembly is a function of its installation. Water permeability is only relevant to the joints and fixings.

5.2.7 Air permeability

Where required, the air permeability of a complete assembly of sandwich panels shall be assessed, i.e. the assembly that is to be installed in a building, including the product and its coatings; factory applied seals, standard joints, site applied seals, representative flashings and a method of fixing as appropriate to the test.

The measurement of air permeability of a sandwich panel assembly shall conform to A.12. The test method shall be used for both external wall and roof applications.

Sandwich panels covered by this European Standard are metal faced. When correctly manufactured and if satisfying an appropriate visual inspection they may be deemed to be impermeable to air. The air tightness of the assembly is a function of its installation. Air permeability is only relevant to the joints and fixings.

5.2.8 Water vapour permeability

For the purposes of this European Standard, the water vapour transmission coefficient for the metal facings used is considered to be infinity. Metal faced sandwich panels are therefore considered to be impermeable to water vapour.

5.2.9 Airborne sound insulation ($R_w(C;C_{tr})$)

Where required, the airborne sound insulation of a sandwich panel assembly shall be determined according to A.13. The result shall be declared as a $R_w(C;C_{tr})$ rating to EN ISO 717-1.

C is a spectrum adaptation term calculated with A-weighted pink noise. C_{tr} is a spectrum adaptation term calculated with A-weighted urban traffic noise.

5.2.10 Sound absorption (α_w)

Where required, the sound absorption of a sandwich panel assembly shall be determined according to A.14. The result shall be declared as single number rating to EN ISO 11654.

5.2.11 Dangerous substances

National regulations on dangerous substances may require verification and declaration on release, and sometimes content, when construction products covered by this European Standard are placed on those markets.

In the absence of European harmonised test methods, verification and declaration on release/content should be done taking into account national provisions in the place of use.

NOTE An informative database covering European and national provisions on dangerous substances is available at the Construction website on EUROPA accessed through: <http://ec.europa.eu/enterprise/construction/cpd-ds/>

5.3 Actions and safety level requirements

5.3.1 Mechanical resistance to design loads

The product shall have sufficient mechanical resistance to the design loads arising from the actions of self-weight, snow, wind, temperature and pressure gradients and access, where these loads shall be factored such that, either alone or in combination, they do not impair the performance of the product in service.

The safety of the product shall be verified by design procedures based on the limit state concept. This requires that the 'design value of the resistance' shall be greater than the 'design value of the effect of the actions' and shall be satisfied at both the serviceability limit state and the ultimate limit state. Verification shall be by calculation in accordance with Annex E.

Information shall be produced which gives all values necessary for both mechanical design and the production of load tables together with the corresponding characteristic values obtained during initial type testing and factory production control. For the purpose of this European Standard provision of this information shall be regarded as part of the product.

5.3.2 Actions and combinations of actions

In design for mechanical resistance the following actions: permanent actions, variable actions and actions due to long-term effects, shall be taken into account in the calculations. They shall be considered either individually or in combination using the combination factors in Annex E.

6 Evaluation of conformity, testing, assessment and sampling methods

6.1 General

The conformity of a sandwich panel to the requirements of this European Standard and to the stated values including classes shall be demonstrated by:

- initial type testing (ITT);
- factory production control (FPC) by the manufacturer, including product assessment;
- where required, initial inspection (FPC);
- where required, continuous surveillance (FPC).

The principle of grouping products into families may be used in order to obtain more uniform characteristic values and material safety factors as the parameters within a range of similar products are varied, or to reduce testing costs.

Where the manufacturer produces products that have the same physical and chemical characteristics on more than one production line or in more than one factory there shall be no need to repeat ITT for the different production lines.

If there is a difference between the characteristic values for products from two different lines, the worst values shall be used.

6.2 Initial type testing – ITT

6.2.1 Initial type evaluation

Initial type testing shall be conducted to show conformity to this European Standard in accordance with Table 4.

Whenever a change occurs in the product, raw material or supplier of the components, or the production process (subject to the definition of a family), which would change significantly one or more characteristics, the type tests shall be repeated for the appropriate characteristic(s).

In addition, initial type testing shall be performed at the beginning of the production of a new panel type (unless a member of the same family) or at the beginning of a new method of production where this may affect the declared properties or conformity of the product.

Characteristics which are required for specific applications, e.g. permeabilities or acoustics, shall be tested on a 'where required' basis.

6.2.2 Existing ITT test data

In general, it is not required to repeat ITT tests previously performed in accordance with the provisions of EN 14509:2006 (same product, same characteristics, test method, sampling procedure, system of attestation of conformity etc.). Data obtained from earlier tests may be used without the need for further testing to the revised procedures providing the declared data does not change significantly. There are two exceptions as follows.

- a) Reaction to fire test EN ISO 11925-2. In cases where the edge was protected in the original test and is unprotected in the new test (See C.1.2) the product shall be retested.
- b) Where the thermal transmittance was calculated using the tabulated values in A.10, the thermal transmittance shall be recalculated.

6.2.3 Sampling for ITT and audit testing purposes

6.2.3.1 General

Samples shall be representative of the product to be placed on the market and the manufacturer shall keep satisfactory records as part of his factory production control.

All samples shall preferably be from the same batch or, if this is not practicable, the manufacturer shall ensure availability of sufficient proof allowing comparison of the ITT or audit test results with those for samples from other batches.

The number of test specimens (for ITT) shall be in accordance with the test methods in Table 5. The sample taken, i.e. panel, shall be a simple random sample, drawn from a finite panel population.

Where test specimens are obtained from a single panel, the specimens shall be taken from a range of positions covering the width of the panel. At least one specimen shall be taken from the middle of the panel and at least one specimen from close to the edge of the panel, with the first cut edge not greater than 10 % of the cover width of the panel from an outside edge.

Conditioning of the test specimens, before or after the test, shall not be carried out unless otherwise specified in the test method.

The minimum age of specimens for initial type tests shall be at least 24 h. The date and time of production shall be recorded at the time of sampling.

Test specimens are very sensitive to the process of cutting and the accuracy of testing, in particular for tensile test measurements. Considerable care is required in the cutting process, especially if the core material is relatively weak or has brittle tendencies. The cutting can be carried out with a band saw with a fine-toothed blade. It may be advantageous to sandwich the specimen between two pieces of plywood or similar material in order to reduce vibration during the cutting process. It is suggested that specimens should be carefully inspected after cutting. Specimens that show evidence of delamination caused by the cutting process should be rejected (up to a maximum of 30 % of those cut for any family of tests).

6.2.3.2 Sampling marking and records

All samples intended for ITT purposes shall be marked as follows:

- date and time of sampling;
- production line or unit;
- identification mark.

The sampling records shall provide at least the following information:

- manufacturing plant;
- place of sampling;
- stock or batch quantity (from which the samples have been taken);
- quantity of samples;
- reference to this European Standard, i.e. EN 14509;
- marking of the product by the manufacturer;
- identification mark of the samples;
- properties to be tested;
- place and date;
- signature(-s) of the person(-s) responsible for sampling.

If a third party is responsible for sampling, the sampling records of that third party may be used.

6.2.4 Testing and compliance criteria – ITT

All characteristics in Table 5, where relevant, shall be subject to ITT tests with the exception of external fire performance when using the CWFT option, where measurement in accordance with C.3.1 is required to ensure that the product meets the definition required for CWFT.

Unless the test method requires otherwise, all testing shall be carried out under ambient laboratory conditions, without any special conditions.

For mechanical properties, unless stated otherwise, the mean value and the characteristic value (5 % fractile value assuming a confidence level of 75 %) for each population of the test results shall be determined according to ISO 12491 using the formula and fractile factors in A.16.3.

The results of all type tests shall be recorded and held by the manufacturer for at least 10 years after the last date of production of the product(s) to which they belong.

6.2.5 Shortened testing programme – ITT (product change)

6.2.5.1 General

If there is only a change of the core material or the adhesive for a panel family, a shortened test programme (not the whole range of ITT) – see Table 6 may be used to compare the values of shear strength and modulus; tensile strength and modulus; compression strength and modulus of the core; and creep against the values from the original ITT.

Provided that all of these characteristic material values for the new core material are better than or equal to the values declared as a result of the original ITT test, the existing declared values for the mechanical properties of the panel may be retained without further ITT.

If there is only a change in the grade of the facing material a shortened test programme to compare the bending moment capacity values shall be used (see Table 6).

6.2.5.2 Calculation and comparison criteria – mechanical properties

The shortened test programme requires that the following characteristics are tested in accordance with Table 6:

- shear strength f_{cv} (see Formula (A.5)) and shear modulus of the core G_c (see Formula (A.7));
- tensile strength f_{ct} (see Formula (A.1)) and tensile modulus of the core E_{ct} (see Formula (A.2));
- compression strength f_{cc} (see Formula (A.3)) and compression modulus of the core E_{cc} (see Formula (A.4));
- creep coefficient;
- bending moment capacity and wrinkling stress (see 6.2.5.1).

If the performance of the above 6 characteristics are better than or equal to the values from the existing ITT but there is a reduced performance with respect to creep, where relevant, then the existing values of tensile, shear and compression strength may be retained but the creep test shall be repeated and a new creep coefficient shall be declared.

6.2.5.3 No shortened programme - Other characteristics

Where there is a change of the core material or the adhesive for a panel family, there is no shortened test programme for the remaining characteristics listed in Table 5 – density, thermal transmittance, durability, fire, permeability and sound. New ITT tests shall be carried out where applicable.

In the case of the fire characteristics any requirement for a retest shall be in accordance with the direct application rules, C.1.3 – reaction to fire and C.2.4 – fire resistance.

Table 5 – Test methods, test specimens, type of the test and conditions for ITT

Characteristic	Test method	Type of test	Tested panel thickness	Min. number of ITT specimens	Compliance criteria and specific conditions
5.1.2 Mechanical properties of a face	EN ISO 6892-1 ^a			3 ^a	
Technical properties of a panel and its core material					
5.2.1.2 Shear strength and modulus	A.3 or A.4	ITT	Minimum, maximum and intermediate (Max, Min, I)	3	Statement of declared values
5.2.1.4 Compressive strength and modulus	A.2	ITT		6	
5.2.1.5 Reduced shear strength ^c	A.3.2	ITT		1/10 ^d	
5.2.1.6 Cross panel tensile strength: (and modulus ^b)	A.1	ITT		6	
5.2.1.7 Bending moment capacity and wrinkling stress	A.5	ITT		3	
5.2.1.8 Bending moment capacity and wrinkling stress over a central support	A.7	ITT	(Max, Min, I)	3	-
5.2.1.3 Creep coefficient ^c	A.6	ITT	Max	1	[Number]
Cross panel tensile modulus at elevated temperatures ^{b,f}	A.1.6	ITT	(Max, Min, I)	3	
Density	A.8	ITT record	(Max, Min, I)		The average value shall be declared
5.2.2 Thermal transmittance	A.10	ITT	(Max, Min, I) ^g	See A.10	Limit value according to A.10
5.2.3 Durability ^e	Annex B	ITT	Max, Min		Pass (see 5.2.3 and Annex B)
5.2.4.1 Reaction to fire	EN ISO 1716, EN ISO 1182	ITT		As specified in EN 13501-1	Classification in accordance with EN 13501-1
	EN 13823 (SBI)		Min, Max –		Specific

	EN ISO 11925-2		see Table C.1		conditions C.1	see
5.2.4.2 Fire resistance ^e	EN 1364-1 or 1364-2	ITT	Manufacturer choice	1	Classification in accordance with EN 13501-2 Specific conditions see C.2	
	EN 1365-2 or CEN/TS 13381-1		Manufacturer choice	1		
	EN 14135		Manufacturer choice	1		
5.2.4.3 External fire performance-roofs ^e	CEN/TS 1187	CWFT or ITT	Manufacturer choice	see CEN/TS 1187	Classification in accordance with EN 13501-5 Specific conditions see C.3	
5.2.6 Water permeability ^e	EN 12865	ITT	Manufacturer choice	1	EN 12865 and in accordance with A.11	
5.2.7 Air permeability ^e	EN 12114	ITT	Manufacturer choice	1	EN 12114 and in accordance with A.12	
5.2.9 Airborne sound insulation ^e	EN ISO 10140	ITT	Manufacturer choice	1	Declaration $R_w(C;C_{tr})$ (see A.13)	
5.2.10 Sound absorption ^e	EN ISO 354	ITT	Manufacturer choice	1	EN ISO 11654 (see A.14)	
5.2.5 Dimensional tolerances	Annex D	ITT	Manufacturer choice	1	-	

^a These values are required to adjust test results in accordance with A.5.5.4.

^b Required for design purposes only – not declared.

^c Roof/ceiling applications only.

^d 1/10 = a single test series with 10 specimens.

^e Where required.

^f Not declared. Required to calculate the wrinkling stress at elevated temperatures.

^g Alternatively use manufacturers' declared values. Values shall be in the same orientation as in the panel).

Table 6 – Shortened testing programme, test specimens, type of the test and conditions for ITT

Characteristic	Test method	Type of test	Tested panel thickness	Min. number of ITT specimens	Compliance criteria
5.2.1.2 Shear strength and modulus	A.3 or A.4	ITT	Maximum	3	G_c and $f_{cv} \geq$ original value
5.2.1.3 Creep coefficient ^c	A.6	ITT	Maximum	1	[Number $\leq$ original value]
5.2.1.4 Compressive strength and modulus	A.2	ITT	Maximum	6	E_{cc} and $f_{cc} \geq$ original value
5.2.1.6 Cross panel tensile strength: (and modulus ^b)	A.1	ITT	Maximum	3	E_{ct} and $f_{ct} \geq$ original value
5.2.1.6 Cross panel tensile strength at elevated temperatures (f_{ct})	A.1.6	ITT	Maximum	1	E_{ct} and $f_{ct} \geq$ original value
5.2.1.7 Bending moment capacity (M_u) and wrinkling stress	A.5	ITT	Maximum	1	[Number $\geq$ original value]

6.3 Factory Production Control (FPC)

6.3.1 General

The manufacturer shall establish, document and maintain an FPC system to ensure that the products placed on the market conform to the stated performance characteristics. The FPC system shall consist of procedures, regular inspections and tests and/or assessments and the use of the results to control raw and other incoming materials or components, equipment, the production process and the product.

An FPC system conforming to the requirements of EN ISO 9001, and made specific to the requirements of this European Standard, shall be considered to satisfy the above requirements.

Where this European Standard permits alternative test procedures to be used, all FPC tests shall be carried out using the test procedure that was used for the corresponding ITT tests.

Where CE marking is based on the use of existing ITT test data in accordance with 6.2.2, and where a subsequent change in the required test speed results in a significant change in the FPC results, it is permissible to use the same test speed for FPC tests that was used for the original ITT tests.

The results of inspections, tests or assessments requiring action shall be recorded, as shall any action taken. The procedure and action to be taken in cases of non-conformity shall be clearly stated.

When products of the same family (see 6.1) are produced using the same process equipment, the manufacturer may use common ITT results providing conformity can be shown, in which case factory production control procedures shall be the same.

Where a manufacturer operates different production lines or units in the same factory or production lines or units in different factories and these are covered by a single overall FPC system, the manufacturer shall keep control records for each separate production line or unit.

In addition to the test results, the following minimum information shall also be recorded:

- date and time of manufacture;
- type of product;
- product specification, including materials and components.

6.3.2 Results of FPC tests

Each individual value of a declared mechanical property determined by FPC shall be equal to or higher than the value declared as a result of ITT. If one or more values are lower, a statistical evaluation of this property shall either be carried out over the previous year and the 5 % fractile value determined or, if FPC of this property has been carried out for less than one year, all available results shall be included in the evaluation. This 5 % fractile value shall be equal to or higher than the declared value.

For each declared value, if the fractile value is lower than the declared value, additional FPC tests shall be carried out on material from the same batch and a corrected 5 % fractile value determined. If this value is lower than the declared value, the batch shall be rejected.

If sustained FPC results indicate that the declared value cannot be attained, either the declared value shall be reduced on the basis of the existing ITT tests, or a new set of ITT tests shall be carried out and a new value for the relevant property shall be declared.

Where values shall be reduced, any related characteristics that are not subject to FPC shall be adjusted.

NOTE The number of additional tests required is at the discretion of the manufacturer.

Where the results of FPC consistently exceed the declared value these results may be used to determine a 5 % fractile value which may be used as the basis for an increase in the declared value.

6.3.3 Equipment

Tests to demonstrate conformity of the finished product to this European Standard shall be carried out using equipment described in the relevant test methods referred to in this European Standard.

All weighing, measuring and testing equipment necessary to achieve, or produce evidence of, conformity shall be calibrated or verified and regularly inspected according to documented procedures, frequencies and criteria. Calibration and/or checking shall be against equipment or test specimens traceable to relevant international or nationally recognised reference test specimens (standards). Where no such reference test specimens exist, the basis used for internal checks and calibration shall be documented.

All equipment used in the manufacturing process shall be regularly inspected and maintained to ensure use, wear or failure does not cause inconsistency in the manufacturing process.

Inspections and maintenance shall be carried out and recorded in accordance with the manufacturer's written procedures and the records retained for the period defined in the manufacturer's FPC procedures.

The manufacturer shall ensure that handling, preservation and storage of test equipment is such that its accuracy and fitness for purpose is maintained.

When production is intermittent, the manufacturer shall ensure that any test equipment which may be affected by the interruption is suitably checked and/or calibrated before use.

The calibration of all test equipment shall be repeated if any repair or failure occurs which could upset the calibration of the test equipment.

6.3.4 Raw materials and components

6.3.4.1 General

The specifications of all incoming raw materials and components shall be documented, as shall the inspection scheme for verifying their conformity.

The manufacturer shall have written procedures which specify how non-conforming raw materials and components shall be dealt with. Any such events shall be recorded as they occur and these records shall be kept for the period defined in the manufacturer's written procedures.

Conformity for metal facings shall be in accordance with 6.3.4.2, pre-manufactured core components with 6.3.4.3 and adhesives with 6.3.4.4.

6.3.4.2 Metal facings

Where provided by the facing manufacturer, declarations shall be according to EN 10204, document Type 3.1, and shall be provided for every 50 t of coil material. For all metals that do not have a guaranteed yield stress, material certification shall be provided for every batch.

6.3.4.3 Prefabricated lamella and preformed core material

Pre-formed material for the cores of sandwich panels shall undergo factory production control testing (see Table 7). The panel manufacturer shall determine or obtain a manufacturer's declaration for the following properties in accordance with the relevant insulation product standard (EN 13162 to EN 13167):

- tolerances (particularly consistency of thickness);
- thermal conductivity.

NOTE In the context of this European Standard, declaration means the supplier's formal declaration of the properties.

6.3.4.4 Adhesives

The panel manufacturer shall obtain the supplier's declaration for the following:

- description and specification;
- viscosity/speed;
- shelf life.

6.3.5 Product testing and assessment – FPC

6.3.5.1 General

The manufacturer shall establish procedures to ensure that the stated values of all of the characteristics are maintained in accordance with 6.3.5.2 and 6.3.5.3.

The factory production control procedures shall be organised so that every product type appears in the statistical control in approximate proportion to the volume of production.

Suppliers who purchase the product from a manufacturer whose production plant is outside the EEA shall establish procedures to ensure that the stated values of all of the characteristics are maintained in accordance with 6.3.6.

6.3.5.2 FPC procedures for panels

The minimum factory production control procedure for the manufacture of panels shall include testing according to Table 7.

Factory production control tests shall be carried out either on aged specimens or on specimens taken immediately after production.

The number of test specimens for FPC shall be in accordance with the test methods in Table 7.

The specimens shall be taken from a range of positions covering the width of the panel. At least one specimen shall be taken from the middle of the panel and at least one specimen from close to the edge of the panel, with the first cut edge not greater than 10 % of the cover width of the panel from an outside edge.

NOTE 1 Test specimens are very sensitive to the process of cutting and the accuracy of testing in particular for tensile test measurements. Considerable care is required in the cutting process, especially if the core material is relatively weak or has brittle tendencies. The cutting can be carried out with a band saw with a fine-toothed blade. It may be advantageous to sandwich the specimen between two pieces of plywood or similar material in order to reduce vibration during the cutting process. It is suggested that specimens should be carefully inspected after cutting. Those that show evidence of delamination caused by the cutting process may be rejected (up to a maximum of 30 % of those cut for any family of tests).

For panels without joints in the core, if Formula (A.20) (A.5.5.3) is used or if the wrinkling strength and the bending resistance are determined by calculation on the basis of A.5, it is not necessary to carry out the wrinkling stress tests. Then the FPC control of the tension and compression moduli shall be carried out in accordance with Table 7.

If the ultimate bending moment is controlled at least once per week then there is no requirement to control the tension and compression moduli.

Table 7 – FPC procedures for panels

Type of test	Test method	Minimum number of specimens	Minimum frequency
Density of core material	A.8	3	1 per shift/6 or 8h ^a
Cross-panel tensile strength and modulus (with faces)	A.1	3	1 per shift/6 or 8h ^a
Compressive strength and modulus of core material	A.2	3	1 per week ^a
Shear strength and modulus of core material ^e	A.3	3	1 per week ^a
Tensile strength of face material (or declaration – 6.3.4.2)	-	3	All deliveries
Thickness of face material (or declaration – 6.3.4.2)	-	3	All deliveries
Shear strength and modulus of the core material based on the testing of a complete panel ^b	A.4	1	1 per 2 weeks ^a
Wrinkling stress (optional see text above)	A.5	1	1 per week ^a
Dimensional control: — Panel thickness — Deviation from flatness — Depth of profile — Depth of stiffeners — Length of panel — Cover width — Deviation from squareness — Deviation from straightness — Bowing (curvature) — Pitch of profile — Width of valleys/ribs	- D.2.1 D.2.2 D.2.3 D.2.4 D.2.5 D.2.6 D.2.7 D.2.8 D.2.9 D.2.10 D.2.11	1	1 per shift/6 h or 8 h
Reaction to fire – (6.3.5.3) ^c	-	-	Specification Record
Resistance to fire – (6.3.5.3) ^c			
External fire performance – (6.3.5.3) ^c or CWFT			
Thermal insulation performance	A.10.2.1.1 ^d	1	1 per month
Water permeability – 5.2.6 Air permeability – 5.2.7 Water vapour permeability – 5.2.8	Visual inspection ^a	-	-

^a Where production volumes are below 2 000 m² per shift, the manufacturer shall only test every 2 000 m² or at least every three months. Dimensional control tests and permeability inspections, however, shall be carried out every shift.

^b This can be an alternative for panels with MW lamella core material and other panels with joints in the core, see A.4.1

^c Manufacturer's specification record (see 6.3.5.3) or supplier's statement of fire performance of components.

^d Procedure tests λ_i (single test result of thermal conductivity) in accordance with the appropriate product standard for the core material (A.10.2.1.1) and shall be representative of the material at the time of manufacture of the panel.

^e Where a complete shear panel test has been used in ITT to measure the shear strength and modulus it shall also be used in FPC.

NOTE 1 The control of the thickness of pre-formed core material or lamellas and the positioning of the joints between individual slabs are of fundamental importance and is frequently checked (e.g. every 2 h).

NOTE 2 Typical allowable difference in cutting thickness between adjacent pre-manufactured pieces for fabrication with stiff platens is $\pm 0,5$ mm.

6.3.5.3 FPC controls for fire characteristics

FPC controls for fire characteristics shall be carried out as follows:

- a) Panels with insulation created by foaming (chemical action) during the manufacturing process shall be controlled by recording the precise specification of all chemical components, fire retardants etc. for each production batch including origin of supply; proportions used etc. In the case of chemical systems supplied by an external manufacturer, a sufficient statement of the specification shall be provided. The panel design/type shall be recorded to confirm the panel to panel joint detail.
- b) Panels with pre-formed or lamella insulation produced by bonding shall be controlled by recording the precise specification of all pre-formed or lamella components for each production batch including as applicable the full chemical specification; density; fire retardants; binders; adhesives; or other organic material, including backing coats etc. In the case of pre-formed or lamella and other components (i.e. adhesives) supplied by an external manufacturer a sufficient statement of the specification shall be provided. The panel design/type shall be recorded to confirm the panel to panel joint detail.

Indirect tests on components shall be carried out according to Table 8.

Table 8 – Minimum testing frequencies for components for reaction to fire characteristics

Component	Test method	Frequency
Core material	Check of raw material or chemical formulation, and density (A.8)	1 per shift/6 or 8h
Adhesive	Check for maximum amount and thickness of adhesive layer (C.4)	1 per shift/6 or 8h
Facings	Manufacturer's declaration	1 per week

6.3.6 Conformity of Factory Production Control – supplier purchases

6.3.6.1 General

Where a supplier purchases the product from a manufacturer whose production plant is outside the EEA, the supplier shall take full responsibility for demonstrating conformity for the product in accordance with 6.3.6.2.

Where a supplier purchases the product from a manufacturer who does not operate an FPC system as described in 6.3, either the manufacturer shall be obliged to operate such a system or the supplier shall take full responsibility for the product in accordance with 6.3.6.2.

6.3.6.2 FPC procedures – products purchased by suppliers

Where a product is purchased by a supplier under the conditions given in 6.3.6.1, the supplier shall take full responsibility for demonstrating the conformity of the product and shall operate an FPC system, including test equipment and non-compliance procedures, to ensure that conformity is maintained with the same degree of certainty as if a full FPC system in accordance with 6.3 had been operated.

Conformity shall be based on product testing of the whole panel or specimens taken from a panel in accordance with Table 9.

Values of the following characteristics shall also be provided in accordance with 6.3.4.2 and 6.3.4.3:

- compressive strength and modulus of the core material;
- shear strength and modulus of the core material;
- tensile strength of the face material (or declaration – 6.3.4.2);

— thickness of face material (or declaration – 6.3.4.2).

The frequency of testing for these characteristics shall be every 2 000 m² and at least once per delivery.

Table 9 – Supplier purchases: FPC system requirements for panels

Type of test	Test method	Minimum number of specimens	Minimum frequency
Density of core material	A.8	3	All deliveries
Cross-panel tensile strength and modulus (with faces)	A.1	3	
Shear strength of complete panel ^a	A.4	1	
Dimensional control: — Panel thickness — Deviation from flatness — Depth of profile — Depth of stiffeners — Length of panel — Cover width — Deviation from squareness — Deviation from straightness — Bowing (curvature) — Pitch of profile — Width of valleys/ribs	- D.2.1 D.2.2 D.2.3 D.2.4 D.2.5 D.2.6 D.2.7 D.2.8 D.2.9 D.2.10 D.2.11	- 1 	- All deliveries
Reaction to fire – (6.3.5.3) ^b	-	-	Specification Record
Resistance to fire – (6.3.5.3) ^b	-	-	
External fire performance – (6.3.5.3) ^b or CWFT	-	-	
Thermal insulation performance – 5.2.2	A.10		Every 3 months
Water permeability – 5.2.6 Air permeability – 5.2.7 Water vapour permeability – 5.2.8	Visual inspection	-	All deliveries
^a Panels with MW lamella insulating cores and incompletely bonded panels only.			
^b Manufacturer's specification record (see 6.3.5.3) or supplier's statement of fire performance of components.			

6.4 Characteristic values from families of tests

The concept of families is described in 6.1. This concept is generally applied to mechanical characteristics and the parameters, which may vary within a family, include core depth, geometry of the faces, span and face material characteristics.

The evaluation of families of test results shall follow the principles given in EN 1990:2002, Annex D. The procedure that follows is a simplified version of the more general procedure given in EN 1990, which is deemed to be adequate for the purposes of this European Standard.

The characteristic resistances of the members of the family shall be determined on the basis of a suitable design expression 'x_{des}' that relates the test results to all of the relevant parameters. This design expression may either be based on the appropriate formulae of structural mechanics or determined on an empirical basis.

The design expression shall be modified to predict the measured resistance as accurately as possible by adjusting the coefficients in order to optimise the correlation.

NOTE 1 An optimum design expression may be determined on the basis of a regression analysis but this is not essential. A limited amount of trial and error is sufficient to meet the requirements of this clause.

Where possible, design expressions with a linear variation between the varying parameter(s) and the required values should be preferred.

NOTE 2 This method remains valid if the required "design expression" is a constant value.

In order to calculate the standard deviation, each test result 'x' should first be normalised by dividing it by the corresponding value predicted by the design expression.

$$x_n = \frac{x}{x_{des}}$$

The number of tests 'n' should be taken as the total number of tests in the complete family. For a family of at least four tests, the characteristic resistance R_k shall then be obtained using the following formula:

$$R_k = x_p = x_{des} e^{(\bar{y}_n - k\sigma_{yn})}$$

Where

x_p is the 5 % fractile value of population x;

$y_n = L_n(x_n)$;

$\bar{y}_n$ is the mean value of y_n ;

k is the fractile value given in Table A.5;

σ_{yn} is the standard deviation of y_n .

$$\bar{y}_n = \frac{1}{n} \sum_{i=1}^n L_n(x_{n,i})$$

7 Classification and designation

A sandwich panel shall be classified and designated in accordance with Table 10 where required, for example when subject to regulatory requirements. Declared values shall be rounded to two or three significant figures.

Table 10 – Classification and designation

Clause	Designation	Units or class
5.2.1	Mechanical properties: — metal grade / thickness / tolerance system — cross panel tensile strength — shear strength (core) — shear modulus (core) — creep coefficient ^a — compressive strength (core) — long term shear strength ^a — wrinkling strength ^c or bending resistance ^c —	Statement MPa MPa MPa (number) MPa Mpa MPa kNm/m
	Density	Kg/m ³
5.2.2	Thermal transmittance and thermal conductivity	W/m ² ·K and W/m·k
5.2.3	Long term mechanical properties – Durability	Pass (colours-see Annex B) / Fail
5.2.4.1	Reaction to fire	See EN 13501–1
5.2.4.2	Fire resistance	See EN 13501–2 ^b
5.2.4.3	External fire performance for roofs	B _{ROOF(t1, t2, t3)} (CWFT) or EN 13501–5 ^b
5.2.6	Water permeability	Class: e.g. A (1 200 Pa): B (600 Pa): C (300 Pa). ^b
5.2.7	Air permeability	C and n values ^b
5.2.9	Airborne sound insulation	Rating: R _w (C;C _{tr}) ^b
5.2.10	Sound absorption	Single value rating: α _w ^b
^a Characteristic only required for panels used as roofs and ceilings. ^b These characteristics may be designated NPD (No Performance Determined, see ZA.3) where the intended use is not subject to regulatory requirements. ^c Either the wrinkling strength or bending resistance shall be declared. The wrinkling strength or bending resistance shall be declared for both positive and negative bending. Where one or both faces are flat or lightly profiled, the wrinkling strength shall be declared for such faces (A.5.5.3).		

8 Marking, labelling and packaging

8.1 Marking and labelling

The following information shall be supplied by the manufacturer with or attached to every pack, or bundle of sandwich panels or supplied with the commercial documentation:

- name or registered identification of the manufacturer and address of production plant or identification, where applicable, of his agent within the EEA;
- number of this European Standard, i.e. EN 14509;
- information on the type of product including product reference/name;
- mass of the product in kg/m²;

- e) thickness of the product;
- f) description of the metal faces including grade of metal, and coatings where applicable;
- g) description of the core material including material identification, thickness, density etc.;
- h) values of the characteristics in Table 10.

NOTE Where ZA.3 covers the same information as in 8.1, the requirements of this subclause are met.

Manufacturers may wish to supply additional information with the product as appropriate.

8.2 Packaging, transport, storage and handling

Any instructions regarding transport, storage and handling shall be clearly visible on the package or in the accompanying documentation.

If severe service conditions are expected during transportation, storage or processing, the product may be supplied with an additional protection of a temporary, strippable film, wax or oil.

The type, thickness, adhesion properties, formability, tear strength and light fastness should be taken into consideration when choosing protective films. All protective films can be exposed to outdoor weathering for only a limited period without deterioration.

Annex A (normative)

Testing procedures for material properties

A.1 Cross panel tensile test

A.1.1 Principle

This test measures the cross panel tensile strength and the E-modulus of the core material.

The characteristic value of the cross panel tensile strength shall be determined in accordance with EN 1607 and the following subclauses.

A.1.2 Apparatus

The tensile test apparatus shall be in accordance with EN 1607.

A.1.3 Test specimens

Sampling and conditioning of the test specimens shall comply with 6.2.2 and 6.2.3.

The test shall be performed with the faces of the panel intact (in place) in order to include the tensile bond strength between the faces and the core or to demonstrate adequate bond.

For panels with profiled faces the specimens shall be cut from the predominant thickness (see examples in Figure A.1).

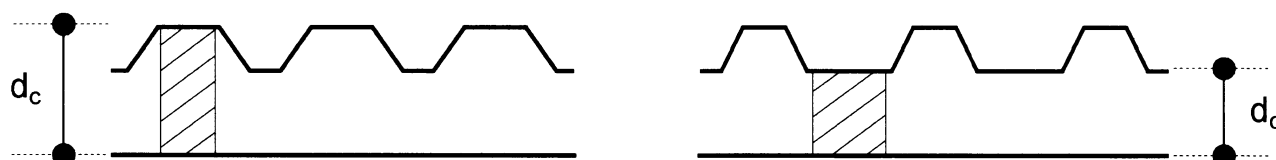


Figure A.1 – Cutting of specimens

Test specimens shall be of square cross-section having side dimensions between 100 mm and 300 mm. Where applicable the test specimen shall include the full width of lamellas.

For incompletely bonded panels, the specimens shall be cut from the fully-bonded part of the cross-section (see the right hand example in Figure A.1).

The dimensions of the specimen shall be measured in accordance with EN 12085. The tolerance on side dimension shall be ± 3 mm.

Test specimens are very sensitive to the process of cutting and the accuracy of testing in particular for tensile test measurements. Considerable care is required in the cutting process, especially if the core material is relatively weak or has brittle tendencies. The cutting can be carried out with a band saw with a fine toothed blade. It may be advantageous to sandwich the specimen between two pieces of plywood or similar material in order to reduce vibration during the cutting process. It is suggested that specimens should be carefully

inspected after cutting. Those that show evidence of delamination caused by the cutting process shall be rejected (up to a maximum of 30 % of those cut for any family of tests).

Where it is not possible to cut a specimen with two plain faces, due to the profile of the faces, the specimen shall be prepared with an appropriately shaped filling piece, which is glued to the profiled face (see examples in Figure A.2).

Additional thin layers may be adhered to the faces in order to ensure that the loading platens of the testing machine are parallel at the commencement of the tensile test.

NOTE As an alternative to the use of shaped filling pieces and if the shape of the profiled face is suitable, it may be possible to glue two specimens together in such a way that the profiled faces mate.



Figure A.2 – Examples of specimens with shaped filling pieces

A.1.4 Procedure

The test shall be carried out by loading the specimen continuously, or in at least 10 increments, using a tensile testing machine. The deflection rate shall have a minimum value of 1 % of d_c per minute and shall not exceed 3 % of d_c per minute. During the test the extension shall be measured with a precision of 0,01 mm.

The test shall be continued until the ultimate load (F_u) is reached (Figure A.3). If the specimen does not exhibit a clearly defined ultimate load the test shall be discontinued when the relative deformation exceeds 20 %.

The tests shall be performed under normal laboratory conditions of temperature and humidity except when carrying out the test at elevated temperature (A.1.6).

A.1.5 Calculations and results

A.1.5.1 Cross panel tensile strength (f_{ct})

A load-deflection curve shall be drawn (see Figure A.3) and the tensile strength shall be calculated as follows.

The tensile strength f_{ct} is given by Formula (A.1):

$$f_{ct} = \frac{F_u}{A} \quad (\text{A.1})$$

Where

F_u is the ultimate load;

A is the cross-sectional area of the specimen determined from the measured dimensions.

NOTE For specimens that do not exhibit a well-defined ultimate load, F_u may alternatively be defined as the load at a specified relative deformation. For polyurethane foams, 10 % relative deformation ($0,1 d_c$) may be an appropriate limit. For materials with a more rigid cell structure or of non-cellular structure, a lower value may be used.

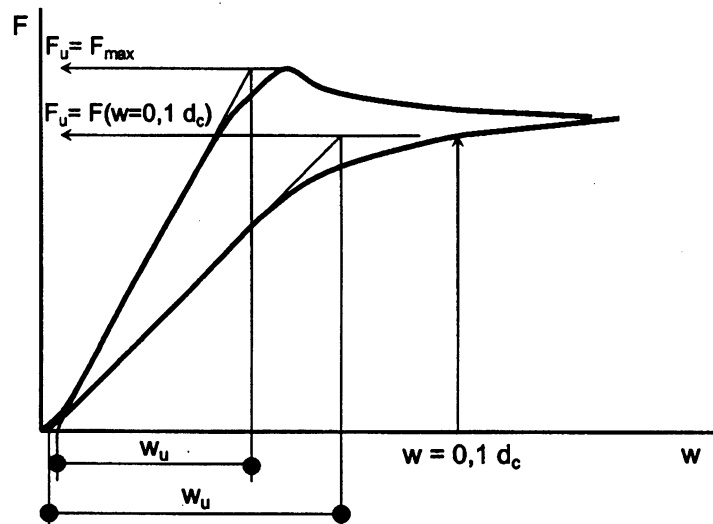


Figure A.3 – Load against deflection curve (F_u against displacement 'w')

Recording and interpretation of test results shall comply with A.16.

The test report shall state the characteristic value (6.2.3) for tensile strength and shall state the failure mode, i.e. whether failure was in the adhesion layer or in the core.

Special attention should be given in cases where the failure is close to the adhesion layer to determine the location of the failure.

A.1.5.2 Tensile E-modulus of the core (E_{ct})

The test report shall also give the characteristic E-modulus for the core material.

The tensile modulus E_{ct} is given by Formula (A.2):

$$E_{ct} = \frac{F_u d_c}{w_u A} \quad (\text{A.2})$$

where

F_u is the ultimate load;

d_c is the thickness;

w_u is the ideal displacement at ultimate load based on the linear part of the curve as shown in Figure A.3;

A is the cross-sectional area of the specimen determined from the measured dimensions.

A.1.6 Cross panel tensile modulus at elevated temperature

Where required for design and ITT but not for FPC procedures of external panels, the test described in A.1.1 to A.1.5 shall also be carried out on specimens which have been heated for 20 h to 24 h in a heating chamber at a temperature of 80^{+3}_{-1} °C. The tensile test shall be carried out immediately, before the specimen has cooled.

The test may be carried out by heating the specimens together with the load distributing platens to a temperature a little above 80 °C and then carrying out the tensile test before the specimen has cooled below 80 °C (limits 80⁺³₋₁ °C).

The characteristic value for the E-modulus at elevated temperature shall be added to the test report.

A.2 Compressive strength and modulus of the core material

A.2.1 Principle

This test measures the compressive strength and E-modulus in compression of the core material.

The characteristic value of the compressive strength of the core material shall be determined in accordance with EN 826 and the following subclauses.

A.2.2 Apparatus

The apparatus shall be in accordance with EN 826.

A.2.3 Test specimens

Sampling and conditioning of the test specimens shall comply with 6.2.2 and 6.2.3.

Test specimens shall be prepared as described in A.1.3. If the profile of the face(s) requires the use of filling pieces then these shall not be glued to the loading platen.

A.2.4 Procedure

The specimen shall be placed between the two parallel stiff loading plates of a compression testing machine. The deflection rate shall have a minimum value of 1 % of d_c per minute and shall not exceed 3 % of d_c per minute. During the test the displacement shall be measured with a precision of 0,01mm and a load-deflection curve drawn (see Figure A.3).

The tests shall be performed under normal laboratory conditions of temperature and humidity.

A.2.5 Calculations and results

A.2.5.1 Compressive strength (f_{Cc})

The compressive strength f_{Cc} of the core material shall be calculated using Formula (A.3):

$$f_{Cc} = \frac{F_u}{A} \quad (A.3)$$

where

F_u is the ultimate load;

A is the cross-sectional area of the specimen determined from the measured dimensions.

NOTE For specimens which do not exhibit a well-defined ultimate load, F_u may alternatively be defined as the load at a specified relative deformation. For polyurethane foams, 10 % relative deformation (0,1 d_c) may be an appropriate limit (see Figure A.3). For materials with a more rigid cell structure or of non-cellular structure, a lower value may be used.

A.2.5.2 Compressive E-modulus of the core (E_{Cc})

The test report shall also give the characteristic E-modulus for the core material.

The compressive modulus E_{Cc} of the core material shall be calculated using Formula (A.4):

$$E_{Cc} = \frac{F_u d_c}{w_u A} \quad (\text{A.4})$$

Where

F_u is the ultimate load;

d_c is the thickness;

w_u is the ideal displacement at ultimate load based on the linear part of the curve as shown in Figure A.3;

A the cross-sectional area of the specimen determined from the measured dimensions.

Recording and interpretation of test results shall comply with A.16.

The test report shall state the characteristic value (6.2.3) for compressive strength and modulus of the core material.

A.3 Shear test on the core material

A.3.1 Principle

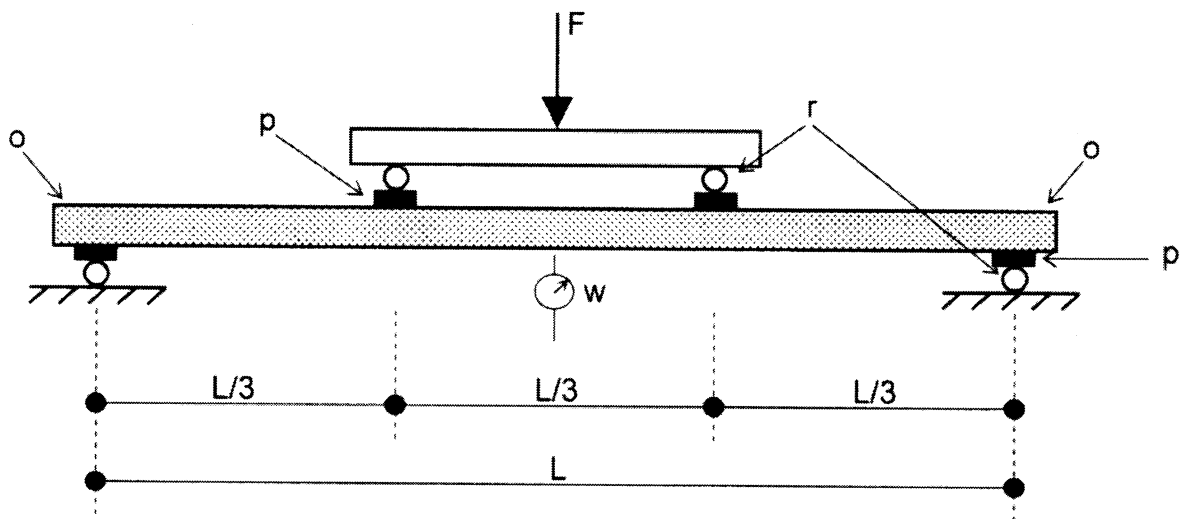
This test determines the shear strength and shear modulus of the core material. The ultimate load carried by the specimen failing in shear shall be measured and the shear modulus calculated from the load deflection curve.

A.3.2 Apparatus

The test apparatus is illustrated in Figure A.4.

Steel load spreading plates (p) are required below the load points and over the supports. The thickness of the load spreading plates shall be between 8 mm and 12 mm.

The width L_s of the load spreading plates at the support and load points shall be a minimum of 60 mm. This value shall be increased as necessary, in order to avoid local crushing of the core and to achieve the maximum possible shear stress at failure. The clear distance between the load plate and support plate shall not be less than $1,2 d_c$.



Key

- F applied load
- r rollers, radius 15 mm
- w measured deflection
- p metal load spreading plates of width L_s
- o overhang not exceeding 50 mm

Figure A.4 – Test with two load points

A.3.3 Test specimens

Conditioning of the test specimens shall comply with 6.2.2 and 6.2.3.

The specimens shall be cut in the lengthwise direction of the panel. The position shall be chosen so that the faces of the specimen are flat and parallel.

NOTE 1 Faces may incorporate light profiling.

For all core materials except MW lamellas, the width of the specimen shall be $100 \text{ mm} \pm 2 \text{ mm}$. For MW lamellas the width to be used shall be $\geq 100 \text{ mm}$ and shall be chosen to incorporate at least one full width of lamellas. There shall be no cut ends of lamellas or pre-formed core material within the length of the test specimen.

NOTE 2 With thicker panels and panels with lamella cores, it may be preferable to use the test described in A.4 to determine the shear strength and modulus of panels.

Span L shall be chosen so that a shear failure is obtained. The recommended span is 1 000 mm. If the recommended span does not result in a shear failure similar to that illustrated in Figure A.5, the span shall be reduced in increments of 100 mm until a shear failure is obtained. Subsequent tests shall then be carried out at the reduced span.

NOTE 3 With thicker panels it may be advantageous to use spans greater than 1 000 mm.

If the test does not result in shear failure, the results may be used for ITT and FPC as the outcome will be safe.

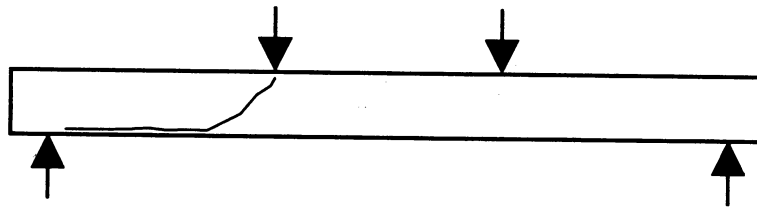


Figure A.5 – Typical shear failure

A.3.4 Procedure

The specimen shall be loaded as shown in Figure A.4. The loading rate shall be uniform and such as to result in failure between 1 min and 5 min after the commencement of the test. During the test the deflection shall be measured with a precision of 0,01mm. The loading shall be continued until failure and a load-deflection curve shall be drawn.

In the case of thick panels, test procedures using four point loads may be used to achieve shear failure.

The tests shall be performed under normal laboratory conditions of temperature and humidity.

The metal thickness, excluding all protective coatings, of both faces of each test specimen shall be measured and recorded.

A.3.5 Calculations and results – short-term loading

A.3.5.1 Shear strength of the core material (f_{cv})

The ultimate shear strength f_{cv} of the core material shall be calculated from the maximum load attained in a specimen failing in shear as follows (A.5):

$$f_{cv} = k_v \frac{F_u}{2Be} \quad (\text{A.5})$$

Where

F_u is the ultimate load carried by the specimen failing in shear;

B is the measured width of the specimen;

e is the measured depth between the centroids of the faces;

k_v is the reduction factor for cut ends in pre-formed or lamella cores.

The shear strength for panels with offset pre-formed or lamella cores shall be reduced to take account of the fact that the cut ends of the core materials have little or no shear strength. For non-lamella panels with pre-formed cores, no reduction in shear strength shall be considered when the joints are adhered.

If no reduction is taken into account it is important that the joints between the ends of the lamellas are completely adhered, usually by adhesion. The manufacturer should demonstrate adequate performance.

For panels with the core material foamed *in situ* or pre-formed in a single piece, or for panels with cut ends which are adhered, $k_v = 1,0$. For other panels with pre-formed or lamella cores, unless a better result can be justified by testing a full cover width of panel to A.4, k_v shall be calculated by Formula (A.6):